

PROJECT MANUAL FOR: NEW INDOOR PRACTICE FACILITY

VOLUME 3 OF 3

DIVISION 27 - APPENDICES

PROJECT NUMBER: CP210981

AT

UNIVERSITY OF MISSOURI – COLUMBIA, MISSOURI

FOR:

THE CURATORS OF THE UNIVERSITY OF MISSOURI

PREPARED BY:

HELLMUTH, OBATA & KASSABAUM, INC.

300 W. 22nd Street

Kansas City, Missouri 64108

DATE: JULY 13, 2021

I hereby certify that these Drawings and/or Specifications have been prepared by me, or under my supervision. I further certify that to the best of my knowledge these Drawings and/or Specifications are as required by and in compliance with Building Codes of the University of Missouri.

Signature: _____

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END OF SECTION

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SECTION 27 00 10 - GENERAL COMMUNICATIONS REQUIREMENTS

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 27 of these Specifications, and Drawings numbered with prefixes TA and/or TN, generally describe these systems, but the scope of the Communications Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.2 ABBREVIATIONS AND ACRONYMS

- A. ADA Americans with Disabilities Act
- B. AFF Above Finished Floor
- C. AHJ Authority Having Jurisdiction
- D. ANSI American National Standards Institute
- E. ASTM American Society for Testing and Materials
- F. BICS Building Industry Consulting Service International
- G. ETL Electrical Testing Laboratories, Inc.
- H. FCC Federal Communications Commission
- I. FM Factory Mutual
- J. GE Grounding Equalizer
- K. IEEE Institute of Electrical and Electronic Engineers
- L. LED Light Emitting Diode
- M. NEC National Electric Code
- N. NESC National Electrical Safety Code
- O. NEMA National Electrical Manufacturers Association

P.	NFPA	National Fire Protection Association
Q.	NRTL	Nationally Recognized Testing Laboratory
R.	OEM	Original Equipment Manufacturer
S.	OFCI	Owner Furnished Contractor Installed
T.	OSHA	Occupational Safety and Health Administration
U.	OSP	Outside Plant
V.	RCDD	Registered Communications Distribution Designer
W.	TBB	Telecommunications Bonding Backbone
X.	TGB	Telecommunications Grounding Bus-bar
Y.	TIA	Telecommunications Industries Association
Z.	TMGB	Telecommunications Main Grounding Bus-bar
AA.	UL	Underwriters Laboratories
BB.	UON or UNO	Unless Otherwise Noted

1.3 DEFINITIONS

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 2. Approved Equivalents or Equal - For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.
 3. As Directed - means as directed by the Contract Administrator, or his representative.
 4. Communications Room - means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring, as well as those for audio video systems and potentially other low-voltage systems such as security and fire alarm (electronic safety and security). This room is recognized in ANSI/TIA-569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities.
 5. Concealed - means embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
 6. Conditionally Approved – the manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
 7. Contract Administrator: Where referenced in this Division, "Contract Administrator" is the primary liaison between the Owner and the Contractor. Specifically, for this project this is "the Architect.
 8. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Contract Administrator, as defined in the General and/or Supplementary Conditions. When used in this Division, it means increased involvement by,

and obligations to, the Design Professional, in addition to involvement by, and obligations to, the "Contract Administrator".

9. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."
 10. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division.
 11. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
 12. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.
 13. Provide - "To furnish and install complete, and ready for the intended use."
 14. Submit - means submit to Contract Administrator for review.
 15. Substitution - means a product meeting all requirements and specifications and having been approved by the Design Consultant to replace another product specifically identified herein.
 16. Wet Location - means a pathway that does not protect cables from moisture levels that are beyond the intended operating range of "inside" premises cable.
 - a. For example: Slab-on-grade construction where pathways are installed underground or in concrete slabs that are in direct contact with soil (e.g., sand and gravel) is considered a "wet location."
 - b. Also refer to the:
 - 1) Telecommunications Distribution Methods Manual (TDMM) for definitions of Wet locations
 17. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by or acceptable to the Design Consultant as equivalent to the item or manufacturer specified".
- C. The term "approved" shall mean labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
- D. The following definitions apply to excavation operations:
1. Additional Excavation: Where excavation has reached indicated sub-grade elevations, if unsuitable bearing materials are encountered, continue excavation until suitable bearing materials are reached. The Contract Sum may be adjusted by an appropriate Contract Modification.
 2. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.

3. Sub-grade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
4. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Contract Administrator.

1.4 REFERENCE STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes. Bring all conflicts observed between codes, ordinances, rules, regulations and these documents to the Contract Administrator's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
- B. If the conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Contract Administrator and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes, including, but not limited to the following, except where these Drawings and Specifications exceed them.
- E. The references to the following codes, references and standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the latest revision or printing (UON):
 1. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
 2. NFPA 70 – National Electrical Code (NEC)
 3. IEEE National Electrical Safety Code (NESC)
 4. Americans with Disabilities Act (ADA) of 1990, as amended

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Coordinate with other Divisions for Communications work to be included but not listed in Division 27 or indicated on Communications Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Communications Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as

closely as the actual construction and the work of other trades will permit. Provide all offsets, fittings, and accessories, required to clear equipment, beams and other structural members which may be required but not shown on the Drawings.

- D. Provide materials with trim that will fit properly the types of ceiling, wall, or floor finishes actually installed.
- E. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Communications systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.
- F. Carry on the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- G. Work of this Division shall progress according to the "Construction Schedule" approved by the Contract Administrator. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.
- H. Carefully check space requirements with other trades to ensure that equipment can be installed in the spaces allotted.
- I. Refer to Coordination requirements in specific sections for additional information.
- J. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Contract Administrator and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- K. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Contract Administrator for review. At completion include a set of these drawings with each set of Record Drawings.
- L. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.
- M. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Contract Administrator.

1.6 MEASUREMENTS AND LAYOUTS

- A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional cost to the Owner, errors that could have been avoided by proper checking and inspection.

1.7 SUBMITTALS

- A. Refer to General Conditions for general submittal requirements. Refer to individual Division 27 Sections for additional submittal requirements. Unless otherwise noted, it is recommended to submit electronically in PDF format.
- B. Submittals and shop drawings shall not contain Henderson Engineers' firm name or logo, nor shall it contain the Engineer of Record's seal and signature. They shall not be photocopies or

reproductions of Henderson Engineers' work product. If the contractor desires to use elements of such product, the license agreement for transfer of information at the end of this section shall be used.

- C. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- D. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct phases:
 - 1. Pre-bid
 - a. Required no less than two weeks prior to the due date for the submission of bids, such as:
 - 1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
 - 2) Alternate personnel credentials to be reviewed for approval
 - 3) And as required by individual sections in this Division
 - 2. Bid
 - a. Required at the time of the submission of bids, such as:
 - 1) Bid Response Forms
 - 2) Unit Pricing (if required by sections in this Division)
 - 3) Personnel Qualifications
 - 4) Contractor Qualifications (Previous project references)
 - 5) Voluntary Bid Alternates
 - 6) And as required by individual sections in this Division
 - 3. Pre-construction
 - a. Required after the award of the project to the winning bidder and prior to starting construction.
 - b. Submit the following items no longer than four weeks after receiving the notice to proceed:
 - 1) Division of Labor amongst sub-contractors. Include:
 - a) Company Name
 - b) Address
 - c) Name of project manager for this project, including:
 - i) E-mail
 - ii) Telephone number
 - 2) Construction schedule showing important milestone dates and activities. Schedule shall be coordinated with overall project construction schedule.
 - 3) Updated Personnel and Contractor Qualifications where different from those submitted during the Bid phase.
 - 4) A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this

Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.

- 5) Manufacturers' cut-sheets:
 - a) Cut-sheets are to be in the same order as in the specification sections.
 - b) At a minimum all cut-sheets shall contain the following:
 - i) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
 - ii) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo somewhere on the page
 - iii) All parts, pieces, and equipment submitted for review shall be clearly identified by stamp, markup, or highlight in such a manner that the product(s) being submitted are clearly identifiable and distinguished from all other materials, parts, or equipment that may be on the submittal.
 - iv) For cut-sheets with accessories, additional parts, or derivations of the product being submitted, all shall be clearly identified for the reviewer and acceptance.
 - v) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
 - 6) Samples – refer to individual sections for specific sample requirements.
 - a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer shall cover all associated fabrication and shipping costs.
 - c. Submit the following items sufficiently prior to installation of each respective portion of work:
 - 1) Shop Drawings
 - a) Shall be furnished per the requirements of each Division 27 specification Section.
4. Project Completion
- a. Required after the substantial completion but prior to final approval for completion, such as:
 - 1) Record Drawings
 - 2) Operation and Maintenance Data
 - 3) Project test reports
 - 4) Cable Databases (as applicable)
 - 5) Warranty Certificate(s)
 - 6) Lead Installer / Project manager letter with signature stating the project has been installed in accordance with referenced industry standards and contract documents.
 - 7) And as required by individual sections in this Division

- E. For electronic submittals, Contractor shall include the website, user name, and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Contract Administrator and Design Consultant's designated representatives. Contractor shall allow the Design Consultant review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- F. Identify each sheet of printed submittal pages (using arrows, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out non-applicable information. Note specified features such as materials or paint finish.
- G. Provide submittals in sufficient detail to demonstrate compliance with these Contract Documents and the design concept.
- H. Transmit submittals as early as required to support the project schedule. Allow for two weeks Design Consultant review time, plus to/from mailing time via the Contract Administrator, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before construction starts.
- I. No part of the work shall be started in the shop or in the field until the shop drawings and samples for that portion of the work have been submitted and accepted.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is mutually compatible with and suitable for the intended use. Verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.
- L. Submittals shall contain the following information. Submittals not so identified will be returned to the Contractor without action:
 - 1. The project name
 - 2. The applicable Specification Section and paragraph
 - 3. The submittal date
 - 4. The submitting (sub-)contractor's company name and the project manager's name and contact information.
- M. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping and service connection data.
- N. The Design Consultant's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Design Consultant's and Contract Administrator's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.

- O. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.
- P. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- Q. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

1.8 SUBSTITUTIONS

- A. Materials, products, equipment, and systems described in the Bidding Documents establish a standard of required function, dimension, appearance and quality to be met by the proposed substitution.
- B. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.
- C. Request for Substitution:
 - 1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 - 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 - 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Contract Administrator, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of the Authorities Having Jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- D. Substitution Consideration:
 - 1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 - 2. No substitutions will be considered prior to receipt of bids unless written request for approval to bid has been received by the Engineer at least ten (10) calendar days prior to the date for receipt of bids.
 - 3. If the proposed substitution is approved prior to receipt of bids, such approval will be stated in an addendum. Bidders shall not rely upon approvals made in any other manner. Verbal approval will not be given.
 - 4. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.9 ELECTRONIC DRAWING FILES

- A. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet.
- B. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form.
- C. Contact the Contract Administrator for written authorization.
- D. The following must be received before electronic drawing files will be sent:
 - 1. Contract Administrator's written authorization
 - 2. Engineer's release agreement form
 - 3. Payment

1.10 QUALITY ASSURANCE

- A. Execute all work under this Division in a thorough and professional manner by competent and experienced workmen duly trained to perform the work specified.
- B. Install all work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- C. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer whenever practicable.
- D. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.

1.11 OPERATION AND MAINTENANCE MANUALS

- A. Refer to General Conditions for Operation and Maintenance Manuals in addition to requirements specified herein.
- B. Submit manuals prior to requesting the final punch list and before all requests for Substantial Completion.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Prior to Substantial Completion of the project, furnish to the Contract Administrator, for Engineer's review, and for the Owner's use, four (4) copies of Operation and Maintenance Manuals in labeled, hard-back three-ring binders, with cover, binding label, tabbed dividers and plastic insert folders for Record Drawings. Include local contacts, complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- E. Each manual shall contain equipment data, approved submittals, shop drawings, diagrams, capacities, spare part numbers, manufacturer service and maintenance data, warranties and guarantees.

- F. For electronic manuals, Contractor shall submit the documents in accordance with this Section. Contractor shall notify the Contract Administrator and Engineer that the manuals have been posted. Contractor shall include the website, user name and password information needed to access the manuals. For manuals sent by e-mail, Contractor shall copy the Contract Administrator's and Engineer's designated representatives.

1.12 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division.

1.13 RECORD DRAWINGS

- A. A set of work prints of the Contract Documents shall be kept on the jobsite during construction for the purpose of noting changes. During the course of construction, the Contractor shall indicate on these Documents changes made from the original Contract Documents. Particular attention shall be paid to those items which need to be located for servicing. Underground utilities shall be located by dimension from column lines.
- B. At the completion of the project, the Contractor shall obtain, at their expense, reproducible copies of the final drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done by a skilled drafter. Each sheet shall be marked "Record Drawing", along with the date. These drawings shall be delivered to the Contract Administrator.

1.14 DELIVERY, STORAGE AND HANDLING

- A. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- B. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Contract Administrator.
- C. Be responsible for the safe storage of tools, material and equipment.

1.15 WARRANTIES

- A. Organize warranty documents into an orderly sequence based on the table of contents of the Project Manual.
- B. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a period of 12 months from date of Substantial Completion, unless specific items are noted to carry a longer warranty in these Construction Documents or manufacturer's standard warranty exceeds 12 months. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions.
- C. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- D. Perform the remedial work promptly, upon written notice from the Contract Administrator or Owner.
- E. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each

warranty instrument being addressed to the Owner and stating the commencement date and term.

1.16 TEMPORARY FACILITIES

- A. Temporary Utilities: The types of services required include, but are not limited to, electricity, telephone, and internet. When connecting to existing franchised utilities for required services, comply with service companies' recommendations on materials and methods, or engage service companies to install services. Locate and relocate services (as necessary) to minimize interference with construction operations.

1.17 FIELD CONDITIONS

- A. Conditions Affecting Excavations: The following project conditions apply:
 - 1. Maintain and protect existing building services that transit the area affected by selective demolition.
 - 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- C. Use of explosives is not permitted.
- D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.1 NOT USED

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.

3.2 EXISTING CONDITIONS

- A. Existing conditions indicated on the Drawings are taken from the best information available from the Owner, existing record drawings, and from limited, in-situ, visual site observations; and, they are not to be construed as "AS BUILT" conditions. The information is shown to help establish the extent of the new Work.
- B. Verify all actual existing conditions at the project site and perform the Work as required to meet the existing conditions and the intent of the Work indicated.

3.3 EXISTING UTILITIES

- A. Existing utility services not specifically indicated to be removed or altered shall remain as they presently exist.
- B. Where existing services interfere with demolition or construction, alter or reroute such existing equipment to facilitate demolition or construction after obtaining written permission from the

Contract Administrator. Notify in writing giving two weeks advance notice or planned alteration prior to altering any existing condition is required.

- C. Schedule and coordinate with the utility company, Owner and with the Contract Administrator all connections to, relocation of, or discontinuation of normal services from any existing service provider line. Include all premium time required for all such work in the Bid.
- D. Preserve continuity of service of existing facilities (related to damage or alteration due to new construction). Unauthorized alteration to existing equipment shall be corrected without additional cost to the Owner.
- E. Repair all existing utilities damaged due to construction operations to the satisfaction of the Owner or Utility Company without additional cost.
- F. Do not leave utilities disconnected at the end of a workday or over a weekend unless authorized by representatives of the Owner or Contract Administrator.
- G. Make repairs and restoration of utilities before workmen leave the project at the end of the workday in which the interruption takes place.
- H. Include in Bid the cost of furnishing temporary facilities to provide all services during interruption of normal utility service.

3.4 WORK IN EXISTING FACILITIES

- A. The Drawings describe the general nature of remodeling to the existing facilities; however, visit the Site prior to submitting a Bid, to determine the nature and extent of Work involved.
- B. Schedule Work in the existing facility with the Owner.
- C. Certain demolition work shall be performed prior to the remodeling. Perform the demolition that involves communications systems, conduit, wiring, equipment, equipment supports or foundations and materials.
- D. Remove all of these articles that are not required for the new Work. Unless otherwise indicated, each item removed during this demolition shall be removed from the premises and disposed of in accordance with all state and local regulations.
- E. Interruption of Existing Communications Service: Do not interrupt communication service to facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary communication service according to requirements indicated:
 - 1. Notify Contract Administrator and the Owner no fewer than 7 days in advance of proposed interruption of communication service.
 - 2. Do not proceed with interruption of communication service without Contract Administrator and the Owner's written permission.
 - 3. Owner reserves the right to require Contractor to cease work in any area Owner requires access to on an emergency basis.
- F. Reconnect communication circuits serving equipment required to remain in service to other cable termination fields, patch panels or splices as indicated on the Drawings or as appropriate. Provide additional cable and termination hardware where there is insufficient available capacity in remaining existing equipment for reconnection.
- G. Relocate and reconnect all communications facilities that must be relocated in order to accomplish the remodeling shown in the Drawings or indicated in the Specifications. Where communications devices or equipment are removed, cap all unused raceways behind the floor line or wall line to facilitate restoration of finish, and, remove all existing wiring from abandoned raceways.

- H. Finish materials are specified in other divisions.
- I. Where removal of existing wiring interrupts continuity of communication circuits that are to remain in use, provide necessary wiring, raceways, junction boxes, etc., to ensure continued communication continuity.
- J. Channel walls and floors as required to produce the desired result; however, obtain permission from the Contract Administrator for all channeling not specifically noted on the Drawings.

3.5 PERMITS AND FEES

- A. Secure and Pay all required fees and obtain all required permits related to the Communications Infrastructure installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.

3.6 SELECTIVE DEMOLITION

- A. Refer to General Conditions for Selective Demolition requirements.
- B. General: Demolish, remove, demount, and disconnect abandoned communications materials and equipment indicated to be removed and not indicated to be salvaged or saved.
- C. Materials and Equipment to Be Salvaged:
 - 1. Communications Infrastructure equipment to be removed that is in good working order shall be carefully removed and offered to the Owner. Items rejected by the Owner shall be removed from the project site and legally and properly disposed of.
 - 2. Remove, demount, and disconnect existing communications materials and equipment indicated to be removed and salvaged, and deliver materials and equipment to the location designated for storage.
- D. Remove existing conduit and wire back to the Communications Equipment room, unless a specific extent of removal is indicated on the Drawings.
- E. Communications Materials and Equipment: Demolish, remove, demount, and disconnect the following items:
 - 1. Inactive and obsolete raceways, fittings, supports and specialties, equipment, wiring, controls, fixtures, and insulation:
 - a. Raceways and outlets embedded in floors, walls, and ceilings may remain if such materials do not interfere with new installations. Cut embedded raceways to below finished surfaces, seal, and refinish surfaces as specified or as indicated on the Architectural Finish Drawings. Remove materials above accessible ceilings. Cap raceways allowed to remain.
 - b. Perform cutting and patching required for demolition in accordance with General Conditions and "Cutting and Patching" portion of this Section in Division 27.

3.7 ACCESS TO EQUIPMENT

- A. Locate all pull boxes, junction boxes and controls so as to provide easy access for operation, service inspection and maintenance. Provide an access door where equipment or devices are located above inaccessible ceilings. Refer to Division 26 Section "Common Work Results for Electrical".
- B. Maintain all code required clearances and clearances required by manufacturers.

3.8 PENETRATIONS

- A. Unless otherwise noted as being provided under other divisions, provide sleeves, box frames, or both, for openings in floors, walls, partitions and ceilings for all electrical work that passes through construction. Refer to Division 27 Section "Common Work Results for Communications".
- B. Provide sleeves, box frames, or both, for all conduit, cable, and cable trays that pass through masonry, concrete or block walls.
- C. The cutting of new and/or existing construction will not be permitted except by written approval of the Contract Administrator.

3.9 EXCAVATION AND BACKFILLING

- A. Refer to General Conditions for Excavation and Backfilling in addition to the requirements specified herein.
- B. Perform excavation of every description, of whatever substance encountered and to the depth required in connection with the installation of the work under this division. Excavation shall be in conformance with applicable Divisions and sections of the Specifications.
- C. Restore roads, alleys, streets and sidewalks damaged during this work to the satisfaction of Authorities Having Jurisdiction.
- D. Do not excavate trenches close to walks or columns without prior consultation with the Contract Administrator.
- E. Erect barricades around excavations, for safety, and place an adequate number of amber lights on or near the work and keep those burning from dusk to dawn. Be responsible for all damage that any parties may sustain in consequence of neglecting the necessary precautions in prosecuting the work.
- F. Slope sides of excavations to comply with local, state and federal codes and ordinances. Shore and brace as required for stability of excavation.
- G. Shoring and Bracing: Establish requirements for trench shoring and bracing to comply with local, state and federal codes and authorities. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - 1. Remove shoring and bracing when no longer required. Where sheeting is allowed to remain, cut top of sheeting at an elevation of 30 inches below finished grade elevation.
- H. Install sediment and erosion control measures in accordance with local codes and ordinances.
- I. Dewatering: Prevent surface water and subsurface or ground water from flowing into excavations and from flooding project site and surrounding area.
 - 1. Do not allow water to accumulate in excavations. Remove water to prevent softening of bearing materials. Provide and maintain dewatering system components necessary to convey water away from excavations.
 - 2. Establish and maintain temporary drainage ditches and other diversions outside excavation limits to convey surface water to collecting or run-off areas. Do not use trench excavations as temporary drainage ditches. In no case shall sewers be used as drains for such water.
- J. Material Storage: Stockpile satisfactory excavated materials where directed, until required for backfill or fill. Place, grade, and shape stockpiles for proper drainage.
 - 1. Locate and retain soil materials away from edge of excavations. Do not store within drip-line of trees indicated to remain.
 - 2. Remove and legally dispose of excess excavated materials and materials not acceptable for use as backfill or fill.

- K. Excavation for Underground Structures: Conform to elevations and dimensions shown within a tolerance of plus or minus 0.10 foot; plus a sufficient distance to permit placing and removal of concrete formwork, installation of services, other construction, and for inspection.
1. Excavate, by hand, areas within drip-line of large trees. Protect the root system from damage and dry-out. Maintain moist conditions for root system and cover exposed roots with burlap. Paint root cuts of one inch in diameter and larger with emulsified asphalt tree paint.
 2. Take care not to disturb bottom of excavation. Excavate by hand to final grade just before concrete reinforcement is placed.
- L. Trenching: Excavate trenches for electrical installations as follows:
1. Excavate trenches to the uniform width, sufficiently wide to provide ample working room and a minimum of six to nine inches clearance on both sides of raceway and cables.
 2. Excavate trenches to depth indicated or required for raceway and cables to establish slope, away from buildings and indicated elevations. Beyond building perimeter, excavate trenches to an elevation below frost line.
 3. Limit the length of open trench to that in which raceway and cables can be installed, tested, and the trench backfilled within the same day.
 4. Where rock is encountered, carry excavation below required elevation and backfill with a layer of crushed stone or gravel prior to installation of raceway and cables. Provide a minimum of six inches of stone or gravel cushion between rock bearing surface and raceway and cables.
 5. Excavate trenches for raceway, cables, and equipment with bottoms of trench to accurate elevations for support of raceway and cables on undisturbed soil.
- M. Cold Weather Protection: Protect excavation bottoms against freezing when atmospheric temperature is less than 35 degrees F.
- N. Backfilling and Filling: Place soil materials in layers to required subgrade elevations for each area classification listed below, using materials specified in Part 2 of this Section.
1. Under walks and pavements, use a combination of subbase materials and excavated or borrowed materials.
 2. Under building slabs, use drainage fill materials.
 3. Under raceway and cables, use subbase materials where required over rock bearing surface and for correction of unauthorized excavation.
 4. For raceway and cables less than 30 inches below surface of roadways, provide 4-inch-thick concrete base slab support. After installation and testing of raceway and cables, provide a 4-inch thick concrete encasement (sides and top) prior to backfilling and placement of roadway subbase.
 5. Other areas use excavated or borrowed materials.
- O. Backfill excavations as promptly as work permits, but not until completion of the following:
1. Inspection, testing, approval, and locations of underground utilities have been recorded.
 2. Removal of concrete formwork.
 3. Removal of shoring and bracing, and backfilling of voids.
 4. Removal of trash and debris.

- P. Placement and Compaction: Place backfill and fill materials in layers of not more than 8 inches in loose depth for material compacted by heavy equipment, and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
1. For vertical and diagonal raceway installations, thoroughly support raceways from permanent structures or undisturbed earth at no less than 10-foot intervals, while placing backfill materials, so that raceways are not deflected, crushed, broken, or otherwise damaged by the backfill placement.
- Q. Before compaction, moisten or aerate each layer as necessary to provide optimum moisture content. Compact each layer to required percentage of maximum dry density or relative dry density for each area classification specified below. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost or ice.
- R. Place backfill and fill materials evenly adjacent to structures, piping, and equipment to required elevations. Prevent displacement of raceways and equipment by carrying material uniformly around them to approximately same elevation in each lift.
- S. Compaction: Control soil compaction during construction, providing minimum percentage of density specified for each area classification indicated below:
1. Percentage of Maximum Density Requirements: Compact soil to not less than the following percentages of maximum density for soils which exhibit a well-defined moisture-density relationship (cohesive soils), determined in accordance with ASTM D 1557 and not less than the following percentages of relative density, determined in accordance with ASTM D 2049, for soils which will not exhibit a well-defined moisture-density relationship (cohesionless soils).
 - a. Areas Under Structures, Building Slabs and Steps, Pavements: Compact top 12 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - b. Areas Under Walkways: Compact top 6 inches of subgrade and each layer of backfill or fill material to 90 percent maximum density for cohesive material, or 95 percent relative density for cohesionless material.
 - c. Other Areas: Compact top 6 inches of subgrade and each layer of backfill or fill material to 85 percent maximum density for cohesive soils, and 90 percent relative density for cohesionless soils.
 2. Moisture Control: Where subgrade or layer of soil material must be moisture conditioned before compaction, uniformly apply water. Apply water in minimum quantity necessary to achieve required moisture content and to prevent water appearing on surface during, or subsequent to, compaction operations.
- T. Subsidence: Where subsidence occurs at mechanical installation excavations during the period 12 months after Substantial Completion, remove surface treatment (i.e., pavement, lawn, or other finish), add backfill material, compact to specified conditions, and replace surface treatment. Restore appearance, quality, and condition of surface or finish to match adjacent areas.

3.10 CUTTING AND PATCHING

- A. Cut walls, floors, ceilings, and other portions of the facility as required to install work under this Division.
- B. Obtain permission from the Architect prior to cutting. Do not cut or disturb structural members without prior approval from the Architect and Structural Engineer.
- C. For post-tension slabs, x-ray slab and closely coordinate all core drill locations with Architect and Structural Engineer prior to performing any work. Obtain approval from Architect and Structural Engineer for all core drills and penetrations at least four days prior to performing work.

- D. Penetrations shall be made as small as possible while maintaining required clearances between the building element penetrated and the system component.
- E. Patch around openings to match adjacent construction, including fire ratings, if applicable.
- F. Repair and refinish areas disturbed by work to the condition of adjoining surfaces in a manner satisfactory to the Architect.

3.11 PAINTING

- A. Refer to Division 09 Section "Painting" for painting requirements.
- B. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under individual sections and Division 09 of the Specifications; colors shall be as selected by the Contract Administrator.
- C. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
- D. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
- E. Where factory finishes are provided and no additional field painting is specified, touch up or refinish, as required by, and to the acceptance of, the Contract Administrator, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Contract Administrator, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.

3.12 CLEANING

- A. Remove dirt and refuse, resulting from the performance of the Work, from the premises as required to prevent accumulation. Cooperate in maintaining reasonably clean premises at all times.
- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.
- C. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- D. Touch up and restore damaged finishes to their original condition.
- E. All communications equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation as required.

3.13 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all equipment furnished and/or installed under this Division.
- B. Check and test protective devices for specified and required application, and adjust as required.
- C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- D. Notify the Contract Administrator immediately of all operational failures caused by defective material, labor or both.
- E. Refer to individual Sections for additional and specific requirements.

3.14 START-UP OF SYSTEMS

- A. Prior to start-up of each system, check all components and devices to confirm compliance with manufacturers' recommended installation procedures.

- B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- C. Refer to individual Sections for additional and specific requirements.

3.15 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit results of systems tests and adjustments per each individual section.
 - 2. Submit complete Operation and Maintenance Data.
 - 3. Submit complete Record Drawings.
 - 4. Perform all required training of Owner's personnel.
 - 5. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
 - 6. Perform start-up tests of all systems.
 - 7. Remove all temporary facilities from the site.
 - 8. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.
- B. Request in writing a review for Substantial Completion and scheduling of final acceptance. Provide a minimum of five (5) business days notice prior to the review for project sites within a 4-hour drive from the office where the design was created; provide a minimum of eight (8) business days notice for sites beyond a 4-hour drive.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Contract Administrator will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Contract Administrator and Design Consultant for time and expenses incurred for the visit.
- F. Upon completion of the review, the Contract Administrator and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.16 EARLY OCCUPANCY

- A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.
 - 1. Refer to individual sections for additional requirements.
- B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION

SECTION 27 05 00 - COMMON WORK RESULTS FOR COMMUNICATIONS

PART 1 - GENERAL REQUIREMENTS

1.1 SECTION INCLUDES

- A. This Section includes general construction materials and methods, communications equipment coordination, and common communications installation requirements for Division 27 systems as follows:
1. Grounding and Bonding for Communications
 2. Pathways for communications systems.
 - a. Cable Supports
 - b. Conduit
 - c. Outlet Boxes
 - d. Floor Boxes and Poke Throughs
 - e. Pull Boxes
 - f. Cable Tray
 3. Firestopping Systems
 4. Access Panels
 5. Identification

1.2 RELATED REQUIREMENTS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in the following Sections: 27 Section "General Communications Requirements"
- B. Division 07 Section "Penetration Firestopping" for fire stopping materials and installation at penetrations through walls, ceilings, and other fire-rated elements.
- C. Division 26 for reference regarding materials and methods for additional requirements.
- D. Division 27 "General Communications Requirements"

1.3 DEFINITIONS

- A. AV – Audio Video
- B. Cable Tray System – A unit or assembly of units or sections and associated fittings forming a structural system used to securely fasten or support cables and raceways.
- C. Common Work – all Work specified in this section.
- D. Conduit Body – A separate portion of a conduit or tubing system that provides access through a removeable cover(s) to the interior of the system at a junction of two or more sections of the system or at a terminal point of the system. Boxes such as FS and FD or larger cast or sheet metal boxes are not classified as conduit bodies.
- E. Conveniently Accessible – Capable of being reached from the floor or via the use of an 8 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.
- F. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F),

fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.

- G. Floor Box Assembly (Floor Box) – An on-grade solution or above grade (with a native fire classification or in combination with an approved Firestopping System) solution for in-floor terminations. The Assembly consists of pour pan (as applicable), Firestopping System (as applicable), floor box (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates), and access door / cover / lid.
- H. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- I. IMC – Intermediate Metal Conduit
- J. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- K. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.
- L. Point of Entrance (Building Entrance) – The point within a building where the Outside Plant (OSP) communications cabling emerges from an external wall, a concrete floor slab, or IMC/RMC. If Communications Point of Entrance isn't identified on the drawings, assume the Main Communications (MDF) also acts as the Point of Entrance.
- M. Poke Through Assembly (Poke-Thru) – An above grade solution with a native fire classification for in-floor terminations. The Assembly consists of pre-pour sleeve (as applicable), Firestopping System, fire resistant conduit stub, poke thru (compartment), plate mounting brackets, line voltage divider plates, termination plates, termination connectors, electrical receptacle(s), gang plates (termination cover plates, as applicable), and access door / cover / lid.
- N. Quality Control Specialist – as it pertains to Work within this section, Quality Control Specialist is either the Project RCDD, as defined in Division 27 Section "Structured Cabling System", for Common Work for Telecommunications or the Project AVIXA CTS-I, as defined in Division 27 Section "Audio Video Systems", for Common Work for AV.
- O. RMC – Rigid Metal Conduit
- P. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- Q. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- R. UL – Underwriters Laboratory

1.4 REFERENCE STANDARDS

- A. Follow all applicable codes, references, guidelines, and standards listed in Division 27 Section "General Communications Requirements".
- B. Follow the additional codes, references, standards and guidelines:
 - 1. NEMA VE 1-2017 – "Metallic Cable Tray Systems"
 - 2. NEMA VE 2-2013 with 2016 Corrections – "Cable Tray Installation Guidelines"
 - 3. ASTM E 814 and ANSI/UL1479 – "Fire Tests Through Penetration Firestops"

4. ASTM E 84 and ANSI/UL 723 "Surface Burning Characteristics of Building Materials"
5. ASTM E 119 and ANSI/UL 263 "Fire Tests of Building Construction Materials"

1.5 ADMINISTRATIVE REQUIREMENTS

- A. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication:
 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.
 3. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for communications items that are behind finished surfaces or otherwise concealed.

1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section "General Communications Requirements".
- B. Bid Submittal
 1. Contractor Qualifications for Firestopping Systems: Provide copies of training/certification as required in the Quality Assurance portion of this specification section.
- C. Pre-construction Submittal
 1. Manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:
 - a. In addition to Division 27 Section "General Communications Requirements", include the following:
 - 1) Size – including physical and loading dimensions
 - 2) Maximum span length
 - 3) Weight supported
 - 4) Type
 - 5) Fittings to be used
 - 6) Method of attachment to structure
 - 7) Firestop system assembly information for each system to be installed:
 - a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
 - i) Firestop manufacturer
 - ii) UL system number

- iii) F, T, and L Ratings
 - iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.
- 8) As well as any additional information required by individual sections of this Division
2. Shop Drawings
- a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
 - 1) Each pathway shall be identified by type and size on the drawings.
 - a) Example #1: 4" EMT
 - b) Example #2: 4" x 12" Cable Tray
 - 2) Each grounding conductor shall be identified by size (and insulation):
 - a) Example: #3/0 insulated ground
 - 3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.
 - a) Example #1 – Firestopping Sleeve:
EZ-Path Series 22, UL System W-L-3255
 - b) Example #2 – Backbox in Fire-Rated Wall:
Specseal Power Shield, UL System QCSN/CLIV.R14288
 - 4) Each pullbox and access panel shall be identified by size and height above finished floor.
 - a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.
 - b. Unless otherwise required by these specifications, it is permissible to show pathways systems (conduit, cable tray, auxiliary supports, etc.) on the same shop drawing along with the cabling and system work to be installed through those pathways.
 - 1) Division 271000 "Structured Cabling System" and Division 274100 "Audio Video Systems" and their individual pathways shall be separate shop drawings; shared pathways such as cable tray shall be shown on both shop drawings.

D. Project Completion Submittal

1. Record Drawings:

- a. The Quality Control Specialist shall review the installation and Record Drawings for the Common Work Results required for their scope of work and shall stamp the final Record Drawings with their RCDD or CTS-I stamp before submission. By stamping the Record Drawings, the Quality Control Specialist indicates that the Common Work Results have been installed per the Contract Documents and all associated codes, standards, and guidelines, and all changes to the drawings have been incorporated into the Record Drawings.

1.7 QUALITY ASSURANCE

- A. Submittals and Shop Drawings for all Common Work Results specified in this section shall, if not created by, be reviewed by the Quality Control Specialist.

1. The Quality Control Specialist shall stamp all relevant submittals for their associated Division 27 sections, which indicates that at a minimum the proposed work has been reviewed by them and found to be in compliance in regards to:
 - a. All applicable codes and industry standards and guidelines referenced in Division 27.
 - b. Being fully-coordinated with all other trades and to be installed per the Construction Documents.
 - c. And installed per manufacturer's direction.
- B. The Quality Control Specialist shall also make weekly inspections during construction to ensure all work installed per this section is correct.
 1. Any deficiencies encountered prior to and during installation shall be corrected by the installing contractor under the direction of the Quality Control Specialist and/or the Design Consultant.
- C. Firestopping Systems
 1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
 2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:
 - a. FM Research, approved in accordance with FM AS 4991.
 - b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

PART 2 - PARTS AND MATERIALS

2.1 GROUNDING AND BONDING FOR COMMUNICATIONS

- A. Refer to drawings and Division 27 Sections "Telecommunications Equipment Room Fittings" and "Audio Video Systems" for exact grounding and bonding requirements.

2.2 PATHWAYS FOR COMMUNICATIONS SYSTEMS

- A. General
 1. All non-continuous cable supports shall be designed to prevent degradation of cable performance and pinch points that could damage cable
 2. Non-continuous cable supports shall have flared edges to prevent damage while installing cables.
 3. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.
- B. Cable Supports
 1. The following manufacturers are Conditionally Approved.
 - a. Cooper/B-Line
 - b. Hilti
 - c. Monosystems
 - d. nVent Caddy
 - e. Panduit

- f. Snake Tray
- g. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
- 2. Metal Hook Supports (“J-hooks”)
 - a. Specifications
 - 1) Have a flat bottom and sufficient width to comply with the minimum bend radius of all cabling as required by the referenced standards and manufacturers recommendations.
 - 2) Be open for easy lay-in and removal of cabling
 - 3) Be designed so the mounting hardware is recessed to prevent cable damage
 - 4) Cable hooks for non-corrosive areas shall be pre-galvanized steel, ASTM A653. Where additional strength is required, cable hooks shall be spring steel with a zinc-plated finish, ASTM B633, SC3
 - 5) Cable hooks for corrosive areas shall be stainless steel, AISI Type 304
 - 6) Be factory assembled for direct attachment to walls, hanger rods, beam flanges, purlins, strut, floor posts, etc. to meet job conditions
 - 7) Be factory assembled multi-tiered cable hooks shall be used where required to provide separate cabling compartments, or where additional capacity is needed
 - b. Cable hooks for installation above ceilings shall be
 - 1) B-Line series BCH21, BCH32, BCH64
 - 2) Caddy CABLE-CAT 21 or 32 series hangers
 - 3) Or equivalent from Conditionally Approved manufacturer
- 3. Fabric Saddle Supports
 - a. Specifications
 - 1) Suitable for air handling spaces (plenum)
 - 2) Adjustable strap allows for multiple support sizes to reduce inventory.
 - b. Cable supports for installation above ceilings shall be
 - 1) nVent CADDY CAT 425, 425A6
 - 2) Arlington Fittings TL20P, TL25P, TL50P
- C. Conduit
 - 1. Specifications
 - a. Refer to Electrical Division 26 for specific product and material information.
 - 1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
 - b. Conduits provided as connection to incoming services, utilities, including private services to other buildings or outside connection points shall be rigid metal or intermediate metal conduit at the point it enters the building, emerges from an exterior wall or ground floor slab to the final termination/transition point.
 - c. If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet (15.3 m) for the equipment needed for transitioning

these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated. Generally this connection point will be a designated Entrance Room for Communications or the Main Telecommunication space. If space has not been identified the contractor shall request information prior to bid.

- d. Follow Electrical Division 26 for conduits underground, in slab or anywhere not within the building.
- e. Provide conduit as indicated on the Drawings or required by this Specification. Minimum conduit size shall be 1 inch (25.4 mm) for structured cabling. Provide a polypropylene or monofilament plastic line with not less than 200-lb (90.7 kg) tensile strength in each empty conduit. Permanently mark or tag each conduit or pull box, identifying it as communications (Telecom), AV, TV, Broadcast, Intercom, etc.), at intervals of not more than 75 feet (22.9 m). Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.
- f. Route an empty conduit from each outlet box into the ceiling space above and terminate with a nylon bushing. In rooms with a non-accessible ceiling, route conduits to the nearest accessible corridor ceiling or communications space.

<u>Number of Structured Cabling Outlets/Connectors</u>	<u>Conduit Size</u>
Up to 4	1-1/4 inch
Up to 9	1-1/2 inch

D. Acoustical Pathway

1. Specifications

- a. For use in non-rated walls only.
- b. For use in place of conduit sleeves through walls of noise critical spaces.
- c. Plenum Rated (to UL2043)
- d. Sound Transmission Classification (STC) as tested per ASTM E90 shall be greater than 60.

2. Manufacturer shall be:

- a. Hilti CS-SL SA
- b. Specified Technologies, Inc. - NEZ33

E. Outlet Boxes

1. Specifications

- a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
- b. Telecommunications – for outlets shown on TN series drawings:
 - 1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches (119.1 mm) width by 4-11/16 inches (119.1 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match that of wall gypsum board(s).

- a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings); or
 - b) RANDL T-55017; or
 - c) Or equivalent from
 - i) Emerson/Appleton
 - ii) Thomas & Betts/Steel City
 - iii) Approved Substitution
- 2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches (101.6 mm) width by 4 inches (101.6 mm) height by 2-1/8 inches (54 mm) depth, with a dual-gang or single-gang raised cover/extension ring (as indicated on the drawings) a minimum of 3/8" deep. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).
- a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
 - b) Or equivalent from
 - i) Emerson/Appleton
 - ii) Thomas & Betts/Steel City
 - iii) Approved Substitution
- 3) For 6" or 8" deep masonry walls: where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 3-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 3-1/2 inches deep.
- a) Single gang – RACO 695
 - b) Double gang – RACO 696
- 4) Weatherproof: Aluminum die cast, weatherproof box with 1" conduit connection. Where single-gang faceplates are shown on the drawings, provide single-gang backbox a minimum of 2-1/2 inches deep; where double-gang faceplates are shown on the drawings, provide double-gang backbox a minimum of 2-1/2 inches deep.
- a) Single gang – Thomas and Betts – IHD3-3 or equivalent
 - i) Or equivalent from
 - (1) Emerson/Appleton
 - (2) Hubbell/RACO
 - (3) Approved Substitution
 - b) Double gang – Thomas and Betts – 2IHD5-3 or equivalent
 - i) Or equivalent from
 - (1) Emerson/Appleton
 - (2) Hubbell/RACO
 - (3) Approved Substitution

- c. Audio Video – for outlets and boxes shown on TA series drawings:
 - 1) Refer to box schedule on TA series drawings for size requirements.
 - 2) Boxes specifically identified on drawings by manufacturer and model number form the basis of design. Other equivalent manufacturers will be considered, but fully-coordinate proposed alternative with Division 274100 contractor and submit substitution request.

F. Floor Boxes

1. General

- a. Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
 - b. Floor Box Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
 - c. Provide a complete Floor Box Assembly.
 - d. UL514A listed for scrub water exclusion for all floor types.
 - e. The following items are not provided per this specification section:
 - 1) Electrical receptacle(s) shall be provided per Division 26 Section “Wiring Devices” or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.
 - 2) Include provisions for mounting Commscope Systimax communications faceplates and connectors. Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section “Communications Horizontal Cabling”. Coordinate all other Assembly components to ensure compatibility.
 - 3) Audio Video custom termination plates and connectors shall be provided per Division 27 Section “Audio Video Systems” and/or “Audio Video Systems Equipment”. Coordinate all other assembly components to ensure compatibility.
2. **Box Type E - Multi-Service (2 compartment):** For slab on grade: watertight, Class 1, fully adjustable, cast iron. For slab above grade: concrete-tight, Class 2, fully adjustable, stamped galvanized steel. Two compartments - one side plate with knockouts for communications faceplate and connectors; one side plate with provisions for one duplex receptacle. Furnish polycarbonate or nylon cover and flange piece with standard color as directed by Architect. Conduits shown on plans are minimum size; select appropriate floorbox based on slab type, thickness, and minimum conduit size. Shallow above-grade slabs necessitate use of Poke-Through Outlet.

<u>MFR</u>	<u>CAST IRON</u> <u>BOX</u>	<u>STAMPED</u> <u>STEEL BOX</u>	<u>RECEP</u> <u>TACLE</u> <u>PLATE</u>	<u>BLANK PLATE</u>	<u>COVER</u>
Steel City	664-CI (accepts	664	664-RP,	664-BP	664-CST Series

	(3) 1" conduits in Communication s compartment)		664-GP (Decorat or Style)		
Wiremold	RFB2-OG	RFB2-SS	RFB2DP , RFB2B (Decorat or Style)	RFB2B	FP Series
Hubbell	3SFBC (accepts (1) 1-1/4" conduit in Communication s compartment)	3SFBSS (accepts (1) 1" conduit in Communicatio ns compartment)	3SFBRP , 3SFBDS (Decorat or Style)	3SFBB	3SFBCxxA Series

3. **Box Type F - AV / Multi-Service (3 or 4 compartment):**

- a. Refer to Audio Video drawings and specifications for exact floorbox requirements. If there are no AV drawings and specifications, then the following requirements apply:
 - 1) For slab on grade: watertight, Class 1, fully adjustable, cast iron, unless otherwise noted. For slab above grade: concrete-tight, Class 2, fully adjustable, stamped galvanized steel.
 - 2) Three to four compartments, 3-1/2-inch maximum overall depth, and provisions for power receptacles and communications faceplate and connectors. Furnish hinged cover and nylon or polycarbonate flanged trim with standard color as directed by Architect.
 - 3) Conduits shown on plans are minimum size; select appropriate floorbox based on slab type, thickness, and minimum conduit size.

<u>MFR</u>	<u>SLAB-ON-GRADE BOX</u>	<u>STAMPED STEEL BOX</u>	<u>ELECTRICAL RECEPTACLE PLATE</u>	<u>BLANK PLATE</u>	<u>COVER</u>
FSR	FL-500P-3" (accepts up to (4) 1-1/4" conduits) with Pour Pan (concrete-tight, acceptable only when used with Pour Pan)	FL-500P-3" (accepts up to (4) 1-1/4" conduits)	FL-P3"-DECORA	FL-P3"	FL-500P Series
Steel City	665-CI	665	665-RP, 665-GP (Decorator Style)	665-BP	665-CST Series
Wiremold	RFB4-CI	RFB4	RFB-DR, RFB-GFI (Decorator Style)	RFB-B	FP Series
Hubbell	HBLCFB401CB	HBLCFB301 BASE	HBLST302SGY, HBLDE301SGY (Decorator Style)	HBLBL300SGY	HBLTCGNT Series

G. Poke-Through Outlets (Multi-Service)

1. General
 - a. Basis-of-Design Product: The specified floor box is based on the product named. Subject to compliance with requirements, provide either the named product or a comparable product by one of the other equivalent manufacturers specified in the schedule.
 - b. Poke-Through Schedule on drawings: Where titles in this section are column or row headings that introduce lists, the requirements listed for that title apply to product selection.
 - c. Provide a complete Poke Through Assembly.
 - d. Assembly shall be UL listed and UL Fire Classified, flush type, with one- to four-hour fire rating, as required by floor rating and type.
 - e. Telecommunications pathways shall be routed back to serving Communications Room. Refer to Drawings for additional information.
 - f. The following items are not provided per this specification section:
 - 1) Electrical receptacle(s) shall be provided per Division 26 Section "Wiring Devices" or as indicated on the Drawings. Refer to Electrical Drawings and Division 26 Specifications for receptacle types, quantities and colors. Unless otherwise noted, all floor boxes shall contain electrical power receptacles. If no requirements are listed elsewhere, provide a minimum of one normal 20A, 125V NEMA 5-20R duplex receptacle.
 - 2) Include provisions for mounting Commscope Systimax communications faceplates and connectors. Telecommunications outlet termination plate and termination connectors shall be provided per Division 27 Section "Communications Horizontal Cabling". Coordinate all other Assembly components to ensure compatibility.
 - 3) Audio Video custom termination plates and connectors shall be provided per Division 27 Section "Audio Video Systems" and/or "Audio Video Systems Equipment". Coordinate all other assembly components to ensure compatibility.
 - g. UL514A listed for scrub water exclusion for all floor types.
 - h. Provide with cover plate, with individual device covers, and floor flange for specific floor material for all types. Provide color as directed by the contract administrator.
2. **Type D – Flush:** Dual Service for Power and Telecommunications only, with outlets flush in the floor
 - a. Capable of supporting, at a minimum, a duplex 20A/125V receptacle (or equivalent), and one decora style opening / mounting plate for telecommunications.
 - b. Coordinate cover type and color with Architect.
 - c. Manufacturer shall be:
 - 1) Legrand/Wiremold 6ATC Series with 6DEC Mounting Plate.
 - 2) Hubbell S1PT Series
3. **Type E – Furniture Feed:** Dual Service for Power and Telecommunications only, with cables to extend through flexible conduit into modular furniture.
 - a. Poke Thru and cover plate shall support 3/4" trade size screw plug opening for electrical and 1-1/4" trade size screw plug opening for telecommunications.
 - b. Coordinate cover finish with Architect.

- c. Manufacturer shall be:
 - 1) Legrand/Wiremold 6ATCFF Series
 - 2) Hubbell S1PTFF Series
- 4. **Type F – Flush (with AV):** Multiple Service for Power, Telecommunications, and AV
 - a. Refer to Audio/Video drawings and specifications for exact floorbox requirements. If there are no AV drawings and specifications, then the following requirements apply:
 - 1) Capable of supporting, at a minimum, a duplex 20A/125V receptacle (or equivalent), pre-wired to a junction box, and one decora style opening / mounting plate for telecommunications.
 - 2) Coordinate cover type and color with Architect.
 - 3) Manufacturer shall be:
 - a) Wiremold 8ATC Series with (2) 68REC-25 Duplex Receptacles for power and (1) 8DEC Mounting Plate for telecommunications. Coordinate with Owner / AV installer for other required inserts; if direction is not given in a timely manner, provide blank inserts for remaining of openings.
 - b) FSR SmartFit 8” Series with (2) SF8-SPO3 Duplex Receptacles for power and (1) SF8-SPC4 decora style opening / mounting plate for telecommunication. Coordinate with Owner / AV installer for other required inserts; if direction is not given in a timely manner, provide blank inserts for remaining of openings.
- H. Pull Boxes – for interior use only
 - 1. Specifications
 - a. NEMA 1
 - b. Refer to Execution section for sizing requirements.
 - 2. The following manufacturers are Conditionally Approved.
 - a. Hoffman
 - b. NEMA Enclosures
 - c. Wiegmann
 - d. Or Equivalent
- I. Handholes – for exterior, in-grade applications only; refer to “Underground Conduit Requirements” in Part 3 for more information.
 - 1. For use with one or two conduits, 2” diameter and smaller are installed, manufacturer shall be:
 - a. Quazite PG 11”x18”
 - b. Or Approved Equivalent
- J. Flexible cable tray
 - 1. The following manufacturers are Conditionally Approved.
 - a. Atkore/Cope
 - b. Bettermann Group/Chalfant
 - c. Chatsworth

- d. Eaton/Cooper B-Line
 - e. Hubbell
 - f. Legrand/Cablofil
 - g. MonoSystems
 - h. MPHusky
 - i. nVent/Hoffman
 - j. Schneider Electric/WIBE
 - k. Snake Tray
 - l. Thomas & Betts
 - m. WBT LLC
 - n. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications
- a. Cable Tray Size: Size identified on drawings indicate minimum width and depth size. Provide cable tray of sufficient size to accommodate a maximum calculated fill ratio of 50% for all Division 27 and 28 cabling, to include all cables installed plus 25% growth.
 - b. Cable tray systems shall be pre-fabricated structures for supporting and routing cables or conductors that are pulled or laid in place after the pathway has been installed as a complete system
 - c. Flexible cable tray systems shall consist of straight sections, fittings, and accessories as necessary for a complete, continuously grounded system.
 - 1) Cable tray and accessories shall be UL Classified as an equipment ground conductor.
 - d. Wire basket shall be made of high strength steel wires and formed into a standard 2 inch by 4 inch wire mesh pattern with intersecting wires welded together. All wire ends along wire basket sides (flanges) shall be rounded during manufacturing for safety of cables and installers.
 - e. Cable Tray Materials: Steel rod and/or wire; corrosion resistant to the degree suitable for the environment where it is to be installed; field-bendable.
 - f. Cable Tray Types:
 - 1) Wire cable tray: a cable tray manufactured from metal wire welded at all intersections and is formed to provide a channel for the cables.

2.3 FIRESTOPPING SYSTEMS

A. General

- 1. All firestopping systems for Division 27 conduit, sleeves, cabling, boxes, etc. shall be from a single manufacturer, unless otherwise noted.
- 2. The following manufacturers are Conditionally Approved.
 - a. 3M
 - b. Hilti
 - c. Specified Technologies, Inc

3. Communications ladder rack and cable tray shall not continue through a fire-rated wall. Stop the tray, install multiple fire-rated pathway devices, and continue tray on the other side. Ensure grounding of the tray is continuous through the wall.
- B. Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)
1. Specifications
 - a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
 - d. Allows the installation and removal of cables without the need to remove or add any materials.
 - e. Used to seal penetrations of cables through fire rated partitions
 - f. Not subject to the single manufacturer requirement
 2. Manufacturer shall be:
 - a. EZ-Path family of products by Specified Technologies Inc.
 - b. Hilti Firestop Speed Sleeve CP 653 Series
 - c. Wiremold Flamestopper
- C. Firestopping for Backboxes in Fire-Rated Walls
1. Specifications
 - a. Used to seal backboxes in fire rated partitions.
 - b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
 - c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 2. Manufacturer shall be:
 - a. Hilti CP 617 or CFS-P PA
 - b. Specified Technologies Inc., SpecSeal Power Shield
 - c. Or equivalent from Conditionally Approved manufacturer.
- D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications
1. For fire-rated penetrations where the conduit pathway extends beyond a single fire-rated partition/floor, and other required firestopping applications not previously addressed in this specification.
 2. Specifications:
 - a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.

3. Manufacturer shall be:
 - a. Hilti – submit UL System documentation for each floor/wall type and product cutsheets for all Hilti materials to be utilized
 - b. Specified Technologies Inc. – submit UL System documentation for each floor/wall type and product cutsheets for all STI materials to be utilized
 - c. Or equivalent from Conditionally Approved manufacturer.

2.4 ACCESS PANELS

A. Access Panels

1. Where pullboxes are required above inaccessible ceiling spaces, or for other required conditions, provide an appropriately-sized access panel. The following manufacturers are Conditionally Approved.
 - a. Activar/J.L Industries
 - b. Acudor Products
 - c. Alfab/Barco
 - d. Elmdor Products
 - e. Karp Associates, Inc.
 - f. Milcor
 - g. Nystrom Building Products
 - h. Williams Brothers
 - i. Wind-lock
 - j. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)
2. Specifications:
 - a. Steel Access Doors and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
 - b. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 - c. Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
 - 1) For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - 2) For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - 3) For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 - d. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 - e. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
3. Locking Devices: Where indicated, provide 5-pin or 5-disc type cylinder locks, individually keyed; provide 2 keys.

4. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.5 IDENTIFICATION FOR COMMON WORK FOR COMMUNICATIONS SYSTEMS

A. Labels

1. All labeling shall be furnished and installed by Owner.

PART 3 - EXECUTION

3.1 PATHWAYS FOR COMMUNICATIONS

A. General

1. Refer to Electrical Division 26 for additional installation requirements.
 - a. Where a conflict exists between Division 26 and Division 27 the more stringent requirements shall apply.
2. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.
3. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
4. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
5. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling when contractor performs conduit sizing calculations, otherwise follow conduit sizes indicated on drawings.
6. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
7. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
8. Install all communications pathways:
 - a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
 - b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
 - c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
 - d. So that the maximum allowable pulling tension is not exceeded.
 - e. To meet the requirements of the structure and the requirements of all other Work on the Project
 - f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and

- the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
- h. Parallel or perpendicular to building lines or column lines.
 - i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
9. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
- a. Except when supported by ladder racking within each Telecommunications room, UON.
10. Provide adequate communications pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for communications cabling purposes. Any deviation from this will not be accepted.
- a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports. UON
 - b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports; UON
11. Provide appropriately sized sleeves where cables are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a minimum of 3 inches (76.2 mm) beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 50% of the cross-sectional area is utilized by the cabling to be installed. The minimum inside diameter of each sleeve shall be nominal 2 inches (50.8 mm).
12. Suspended cables shall be installed with at least 3 inches (76.2 mm) of clear vertical space above the ceiling tiles and support channels (T-bars).
13. Waterproofing
- a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
 - b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.
14. Cutting and Patching
- a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
 - b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
 - c. Patch around all openings to match adjacent construction.

- d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
 - e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
 - f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.
15. Mounting Heights
- a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
 - 1) Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.
 - b. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
 - c. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.
16. Painting
- a. Refer to Division 9 Section "Painting" for painting requirements.
 - b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
 - c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
 - d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
 - e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
 - f. Provide touch-up paint as required by Specification Sections in this Division.
17. Fastenings
- a. Fasten equipment to building structure in accordance with the best industry practice.
 - b. Where weight applied to the attachment points is 100 pounds or less, conform to the following as a minimum:
 - 1) Wood: Wood screws.
 - 2) Concrete and solid masonry: Bolts and expansion shields.
 - 3) Hollow construction: Toggle bolts.
 - 4) Solid metal: Machine screws in tapped holes or with welded studs.

- 5) Steel decking or sub-floor: Fastenings as specified below for applied weights in excess of 100 pounds.
 - c. Where weight applied to building attachment points exceeds 100 pounds, but is 300 pounds or less, conform to the following as a minimum:
 - 1) At concrete slabs provide 24 inch x 24 inch x ½ inch steel fishplates on top with through bolts. Fishplate assemblies shall be chased in and grouted flush with the top of slab screed line, where no fill is to be applied.
 - 2) At steel decking or sub-floor for all fastenings, provide through bolts or threaded rods. The tops of bolts or rods shall be set at least one inch below the top fill screed line and grouted in. Suitable washers shall be used under bolt heads or nuts. In cases where the decking or sub-floor manufacturer produces specialty hangers to work with his decking or sub-floor such hangers shall be provided.
 - d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
 - 1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
 - e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
 - f. Wall mounted equipment may be directly secured to wall by means of steel bolts. Groups or arrays of equipment may be mounted on adequately sized steel angles, channels, or bars. Prefabricated steel channels as manufactured by Kindorf or Unistrut are acceptable.
 - g. Bridle rings are prohibited for Division 27 cables, unless otherwise noted on drawings.
 18. For large quantities of cables (greater than 50) that converge upon a common run such as at a rack, in corridors, and other areas, provide cable trays or other special supports that are specifically designed to support the required cable weight and volume.
 19. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces. Install Acoustical Pathway(s) through walls of noise critical spaces
- B. Access to pathways and associated equipment
1. Locate all cable trays, open hanger cable supports, j-hooks, pull boxes, junction boxes and fire stopping systems so as to provide easy access for operation, service inspection and maintenance.
 2. Provide an Access Panel where equipment or devices are located above inaccessible ceilings. Where access doors are necessary but not shown on the plans, coordination type and location with Architect and Design Consultant through an RFI.
 - a. Pathways requiring access such as open hanger cable supports, j-hooks, and cable trays shall have an access door or other means of direct access at a minimum of 10 feet (3 m) intervals.
 - b. Cables or cable pathways requiring access such as open hanger cable supports, j-hooks, and cable trays may not change directions above an inaccessible ceiling unless complete access to the change of direction in pathway or cable route is within arms reach 3 feet (0.9 m) from adjacent accessible point.

3. Maintain all code required clearances and clearances required by manufacturers.
- C. Cable distribution
1. Provide pathways for Telecommunications (Structured Cabling System) to allow cabling to be installed in the following manner:
 - a. For typical new walls:
 - 1) Conduit from outlet location to accessible ceiling then j-hooks to main run of cable tray.
 - b. For phone and data lines to all Elevator Equipment Rooms and Fire Alarm panels:
 - 1) Homerun method: Conduit from outlet location all the way back to the Telecommunications Room/Space.
 - c. See drawings for clarification
 2. Provide pathways for Audio Video Systems to allow cabling to be installed in the following manner:
 - a. For typical new walls:
 - 1) Homerun method: Conduit from outlet location to accessible ceiling then j-hooks to conduit in wall for AV Rack.
 - b. See drawings for clarification.
- D. Conduits
1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
 2. Adequate access shall be available where cables enter conduits
 3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements and with TIA-607D – “Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises.
 4. Install conduits in the most direct route possible, running parallel to building lines
 5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
 6. Conduits which enter Telecommunications rooms shall extend 3 inches (76.2 mm) AFF or through the wall.
 7. Conduits which enter Entrance Facilities shall extend 4 inches (101.6 mm) AFF or below the finished ceiling (if exists).
 8. Flexible conduits may only be used where specifically allowed by these contract documents.
 - a. Flexible conduit sections shall be less than 20 feet (6.1 m) in length.
 9. No continuous section of a conduit may exceed 100 feet (30.5 m) without a pullbox.
 10. For structured cabling, no more than (2) 90° bends, or equivalent will be allowed between pullboxes.
 - a. Each and any offset shall be considered a 90° bend.
 - b. A pullbox is required wherever a reverse bend is installed.
 11. The minimum bend radius for conduits is
 - a. (6) times the inside diameter for 2 inches (50.8 mm) conduits or less.

- b. (10) times the inside diameter for conduits greater than 2 inches (50.8 mm).
- 12. Any single conduit run may not serve more than (1) outlet location unless expressly indicated on the drawings.
- 13. Where building entrance conduits (for service provider and owner's WAN cabling) do not enter the building directly into the Communications Entrance Room/Facility, extend those entrance conduits via RMC or IMC into the Communications Entrance Room/Facility.
 - a. Coordinate with Contractor for Division 27 Sections "Communications Backbone Cabling" and "Communications Horizontal Cabling" for potential other pathways where IMC/RMC are required.
- 14. Conduits shall contain no electrical condulets (also known as LBs).
 - a. Exception: Pre-approved (by the Design Consultant) condulets specifically manufactured for communications cabling and will maintain minimum bend radius for cabling to be installed. These locations are to be called out on the shop drawings.
- 15. Underground Conduit Requirements
 - a. For Structured Cabling System horizontal cabling and pathways within the footprint of the building and serving voice and data outlets exterior to the building, such as emergency phones/towers, security cameras and wireless access points attached to exterior light poles, etc.
 - b. For Audio Video System cabling serving pole-mounted loudspeakers, broadcast boxes, etc.
 - c. Requirements
 - 1) Refer to applicable details on drawings for illustrative requirements.
 - 2) Wherever practical, slab-on-grade floorboxes shall have conduit extended underground or in-slab from box to serving communications room or equipment cabinet.
 - a) Only one horizontal bend is allowed, 90 degrees or less.
 - b) Indicate proposed routing and stub-up locations on shop drawings.
 - 3) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.
 - a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are not to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.
 - 4) Approved conduit types:
 - a) When routed in slab-on-grade:
 - i) Horizontal conduit shall be RMC or Schedule 40 PVC, including horizontal bends. If PVC is installed, also install tracer wire.
 - ii) Vertical bends shall be RMC.
 - b) When routed below slab-on-grade or outside the footprint of the building:

- i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
 - ii) All vertical and horizontal bends shall be RMC.
 - 16. Install approved expansion/deflection fittings where raceways pass through or over building expansion joints.
 - 17. Route raceway through roof openings for piping and ductwork or through roof seals approved by the Architect, the roofing contractor, or both. Obtain approval for all roof penetrations and seal types from the Architect, Owner, roofing contractor, or all three as required to maintain new or existing roofing warranties.
- E. Outlet boxes
 - 1. No outlet boxes shall be located back-to-back in a wall cavity.
 - a. Where possible offset to next stud cavity, with a minimum of 6 inch (152.4 mm) separation.
 - 2. Outlet boxes shall be within 3 feet (0.9 m) of nearest electrical outlet.
 - 3. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
 - 4. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.
- F. PullBoxes
 - 1. Pullboxes shall be placed in Conveniently Accessible locations.
 - 2. Coordinate the location and installation of all pullboxes to ensure adequate access is provided.
 - 3. Pullboxes above an accessible ceiling shall:
 - a. Be aligned directly over the ceiling grid to allow access
 - b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
 - 4. No directional changes shall be allowed in pullboxes. Conduit Shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
 - 5. Size pullboxes according to the following chart (all sizes are minimums):

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
1" or smaller	4"	4"	2-1/8"	Not applicable
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	27"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	8"

- G. Cable Tray
 - 1. Cable trays shall be installed in accordance with the applicable electrical code and standards.

2. The inside of the cable support system shall be free of burrs, sharp edges or projections that can damage cable insulation. Abrasive supports (e.g., threaded rod) installed within the cable fill area shall have that portion within the tray rigidly protected with a smooth, non-scratching covering so that cable can be pulled without physical damage such as appropriately rated (plenum) plastic tubing.
3. Cables shall remain unattached to its pathway and shall simply lay at rest on the supports provided by its pathway. Wire ties, velcro straps, electrical tape or other methods shall **not** be used to attach cables to cable supports; UON.
4. Installation of cables shall not exceed the fill requirements stated above.
5. Cable trays shall not extend through fire-rated walls and walls for noise critical spaces.
6. Cable trays shall not extend over 6' lengths (or greater) of inaccessible ceilings. Stop cable trays just before the inaccessible ceiling and provide overhead conduits of quantity and size bridging the two sections of cable tray so that conduit cable capacity (square inches per fill ratio) is equal to that of the cable tray.
 - a. The cable fill ratio for cable tray shall be 50%.
 - b. The cable fill ratio for conduits shall be 40%.
 - c. Example: a 4" x 12" cable tray has 48 square inches of total capacity, and 24 square inches of cable capacity. Per the NEC, a 4" trade size EMT conduit has a 40% cable capacity of 4.62 inches. 24 divided by 4.62, rounding up to the next whole number equals (6) 4" conduits shall be provided for a 4" x 12" cable tray.
7. Cable trays and cable runways shall not be used as walkways or ladders.
8. A minimum of 12 inches (300 mm) access headroom shall be provided and maintained above a cable tray system or cable runway.
9. Care shall be taken to ensure that other building components (e.g., air conditioning ducts, pipes, conduits) do not restrict access.
10. Flexible cable trays shall be supported according to manufacturer's instruction via one of the following:
 - a. Trapeze/Unistrut under the cable connected to the cable tray and to (2) 3/8" (or greater) rods to structure above.
 - 1) Center-hung, single-rod supports are not allowed.
 - b. Shelf or L-brackets attached to wood or metal studs.
11. Test cable tray systems to ensure electrical continuity of bonding and grounding connections, and to demonstrate compliance with maximum grounding resistance.

3.2 LABELING

A. Labeling Installation

1. Labels that are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on:
 - a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.

- b. All pathways (e.g., conduit, innerduct, etc.) installed under this work.
 - 1) Label all conduit and innerduct with “TELECOM” or “AV” according to the intended system/use of the installed (or future) cabling. Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.
 - a) For wall stub-up locations, label overhead only.
 - b) For conduits greater than 10’, label both ends of conduit with far end location and Room/Number.
 - i) Example – “AV to AV Rack R01”.
 - c) For conduits that stub directly up or into a Communications Room, label both ends of conduit.
 - i) Example: underslab conduit from Telecom Room 1A to the Floor Box in Conference Room 101A shall be labeled as follows:
 - (1) Conduit stub-up location in Telecom Room 1A – “Telecom to Conf. Rm 101A Floorbox”
 - (2) Bottom of floorbox, immediately adjacent to serving Telecom conduit – “Telecom to Telecom Room 1A”
 - 2) All pullboxes and junction boxes for Communications shall be labeled such as “TELECOM PULLBOX”, “AV JUNCTION BOX”, “TV”, etc. on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.
 - a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie “To AV Box Q:212:01 in Control Rm 212”.
 - 3) Wherever raceways for future use are terminated outside of the building, stake the location with a 2-foot long, 1 inch x 1-inch clear heart redwood stake.
- c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.
- d. Refer to individual Division 27 Communications sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

- 1. Provide fire-resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
- 2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.
 - a. Assume all floors are fire-rated, unless otherwise noted.
 - b. Also install fire stops at any other locations indicated in the Specifications or Drawings.

3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
 - a. Fire stop Manufacturer
 - b. Installer and company
 - c. Date installed
 - d. UL system number with all relevant ratings indicated
 4. Include labels in each telecom room in which one or more fire rated walls is installed. Provide a 2" block letter stencil label on the inside of the telecom room to indicate rating for each barrier.
 5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.
- B. Penetration Sealant – Conduits
1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.
- C. Penetration Sealant – Voids, Cavities, and Openings
1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
 2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
 3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.
- D. Fire-Rated Pathway Device
1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.
 2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
 3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
 4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
 5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF SECTION

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SECTION 27 05 43 - UNDERGROUND DUCTS AND RACEWAYS FOR COMMUNICATIONS SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. This Section includes:
 - 1. Raceways, fittings, boxes, handholes, and manholes for direct buried and concrete-encased communications distribution pathways.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 26 Sections "General Electrical Requirements" and "Common Work Results for Electrical" for general requirements and related documents that apply to this Section.
- B. Division 27 Section "General Communications Requirements" for general requirements and related documents that apply to this Section.
- C. Division 27 Section "Common Work Results for Communications" for limited scope general construction materials and methods.

1.3 SUBMITTALS

- A. General: Division 27 Section "General Communications Requirements":
 - 1. Product data for the following products:
 - a. Raceways, Raceway fittings, separators, and accessories, duct-bank materials, manholes/handholes, solvent cement, sealants, tracer wire, warning tape / warning planks.
 - 2. Shop drawings for:
 - a. Detailing fabrication and installation for custom manholes or handholes including duct entry provisions, reinforcing details, frame and cover design, manhole frame support rings, ladder details, grounding details, sump details, joint details, and cable racks, pulling irons, lifting irons.
 - b. Detailing of pathway and placement of manhole/handhole devices for underground duct bank pathways.
- B. Record Drawings: Submit Record Drawings as required by Division 27 Section "General Communications Requirements":
 - 1. Accurately record actual routing of all exterior buried raceway including coordination with other surrounding utilities and underground structures. Provide scaled plans and sections that indicate dimensions from finished grade or other fixed structural elements for all components of the pathway (duct bank sizing and location, conduit quantities and placement within the duct bank, tracer wire locations and sizing, warning plank location and sizing, manhole/handhole placement as well as sizing of each manhole/handhole installed).

1.4 DEFINITIONS

- A. Terminology used in this specification is as defined below:
 - 1. GRS: Galvanized Rigid Steel Conduit
 - 2. RMC: Rigid Metal Conduit
 - 3. RNC: Rigid Nonmetallic Conduit

- B. Refer to Division 27 Section “General Communications Requirements” for additional abbreviations / definitions.

1.5 CODE, STANDARDS, AND GUIDELINES

- A. The following codes and standards contain provisions that, through reference in this text, constitute provisions of document. At the time of publication the editions indicated were valid. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following standards and codes published by the following organizations, where applicable
1. Federal Communications Commission (FCC)
 2. Institute of Electrical and Electronics Engineers, Inc (IEEE)
 3. National Fire Protection Association (NFPA)
 4. National Electric Code (NEC)
 5. American National Standards Institute (ANSI)
 6. Telecommunications Industry Association (TIA)
 7. Electronics Components Industries Association (ECIA)
 8. Building Industry Consulting Service International (BICSI)
 9. National Electrical Contractors Association (NECA)
 10. International Building Code (IBC)
 11. FCC Regulations Part 68
 12. NFPA-70 National Electrical Code Chapter 8 – Communications Systems
 13. NFPA-71 Central Signaling Systems
 14. NFPA-780 Protection of Electronic and Computer Data Processing Equipment
 15. NFPA-780 Lightning Protection Code
 16. NFPA-101 Life Safety Code
 17. ANSI/TIA-569 Commercial Building Standard for Telecommunications Pathways and Spaces
 18. TIA-606 Administration Standard for the Telecommunications Infrastructure of Commercial Buildings
 19. TIA-STD-J-607 Commercial Building Bonding and Grounding requirements for Telecommunications
 20. ANSI/NESC – National Electrical Safety Code
- B. All equipment, construction practices, design principles, and installation shall conform to the latest version of any or all of the following guidelines published by the following organizations, where applicable
1. BICSI Methodologies
 - a. BICSI Telecommunications Distribution Methods Manual
 - b. BICSI ITS Installation Methods Manual
 - c. Customer Owned Outside Plant Design Manual
- C. Additional requirements for Manholes and Handholes:

1. Manholes shall be designed in compliance with the following ASTM standards:
 - a. ASTM C857-87 "Standard Practice for Minimum Structural Design Loading for Underground Pre-cast Concrete Utility Structures",
 - b. ASTM C478 "Standard Specification for Pre-cast Reinforced Concrete Manhole Sections",
 - c. ASTM C858-83 "Standard Specifications for Underground Pre-Cast Concrete Utility Structures"
 - d. All reinforcing steel shall conform to ASATM 432 "Standard Guide for Selection of a Leak Testing Method" and
 - e. ASTM 305 "Standard Practice for Mechanical Mixing of Hydraulic Cement Pastes and Mortars of Plastic Consistency".
 - f. ASTM C990, "Specification for Joints for Concrete Pipe, Manholes, and Precast Box Sections Using Preformed Flexible Joint Sealants"
 - g. ASTM 432, "Standard Guide for Selection of a Leak Testing Method:
 - h. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
2. Manholes to be designed per ACI 318-02 "Building Code Requirements for Structural Concrete".
3. Test and inspect pre-cast concrete utility structures according to ASTM C 1037
4. 4.Non-concrete Handholes and Pull-Box Prototype Test: Test prototypes of manholes and boxes for compliance with SCTE 77.

1.6 QUALITY ASSURANCE

- A. Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification
Pre-cast concrete manholes to be manufactured at a plant that holds a current NPCA certification.
- B. Materials shall be manufactured by companies that have been specializing in the products specified in this Section, for a minimum of 5 years.
- C. Communications and Electrical Components, Devices, and Accessories:
 1. Listed and labeled as defined in NFPA 70, Article 100, by an NRTL as defined by OSHA in 29 CFR 1910.7, and that is acceptable to AHJ.
 2. Marked for intended use.
- D. Strength tests shall be for specified tier ratings of products supplied.
 1. Tests of materials shall be performed by an independent testing agency.
 2. Strength tests of complete boxes and covers shall be by either an independent testing agency or the manufacturer. A qualified registered professional engineer shall certify tests by manufacturer.
 3. Testing machine pressure gages shall have current calibration certification complying with ISO 9000 and ISO 10012, and traceable to NIST standards
- E. Refer to Division 27 Section "General Communications Requirements" for additional Quality Assurance requirements.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Deliver ducts to project site with ends capped and store nonmetallic ducts with supports to prevent bending, warping, and deformation.

- B. Store pre-cast and other factory-fabricated underground utility structures at Project site as recommended by manufacturer to prevent physical damage. Arrange so identification markings, if present, are visible.
- C. Lift and support pre-cast concrete units only at designated lifting or supporting points.

1.8 PROJECT CONDITIONS

- A. Interruption of existing communications services to occupied facilities shall not occur unless permitted under the following conditions and then only after arranging to provide temporary electrical and communications services according to requirements indicated.
 - 1. Notify Architect no fewer than two weeks in advance of proposed interruption of the electrical or communications services.
 - 2. Coordinate all service interruptions with the other trades, customer AHJ and architectural team.
 - a. Confirmation of the interruption shall be confirmed with a signed notice from the above mentioned parties.

1.9 COORDINATION

- A. Coordinate layout and installation of ducts, manholes, handholes, tracer wires, warning planks, and boxes with final arrangement of other utilities, site grading, and surface features as determined in the field.
- B. Coordinate elevations of ducts and duct-bank entrances into manhole, handholes, tracer wires, warning planks, and boxes with final locations and profiles of ducts and duct banks as determined by coordination with other utilities, underground obstructions, and surface features. Revise locations and elevations from those indicated as required to suit field conditions and to ensure that duct runs drain to manholes and handholes, and as approved by the Architect.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. In other Part 2 articles where titles below introduce lists, the following requirements apply to product selection:
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the manufacturers specified.
- B. Where a list is provided, manufacturers are listed alphabetically and not in accordance with any ranking or preference.

2.2 RACEWAYS AND FITTINGS

- A. Metal Conduit
 - 1. Manufacturers:
 - a. AFC Cable Systems, Inc.
 - b. Alfex Corporation, a Southwire Company
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Electri-Flex Co.
 - e. Indalex

- f. Manhattan/CDT/Cole-Flex
 - g. O-Z/Gedney; Unit of General Signal (Fittings)
 - h. Republic Raceway
 - i. Tyco International; Allied Tube & Conduit Div.
 - j. Wheatland Tube Co.
 - k. Or approved equivalent
2. RMC:
- a. GRS: Hot-dip galvanized steel (including threads): ANSI C80.1, UL 6
 - b. Plastic-Coated GRS and Fittings: NEMA RN 1, UL-listed. Coating thickness of 0.40 inches (1 mm), minimum.
 - c. Fittings: NEMA FB 1; compatible with raceway and tubing materials.
- B. Nonmetallic Raceway
1. Manufacturers:
- a. AFC Cable Systems, Inc.
 - b. American International.
 - c. Anamet Electrical, Inc.; Anaconda Metal Hose.
 - d. Arnco Corp.
 - e. Cantex Inc.
 - f. Certainteed Corp.; Pipe & Plastics Group.
 - g. Condux International.
 - h. ElecSYS, Inc.
 - i. Electri-Flex Co.
 - j. Lamson & Sessions; Carlon Electrical Products.
 - k. Manhattan/CDT/Cole-Flex.
 - l. RACO; Division of Hubbell, Inc.
 - m. Spiralduct, Inc./AFC Cable Systems, Inc.
 - n. Superflex Ltd.
 - o. Thomas & Betts Corporation.
2. RNC: Extra-heavy Schedule 80 conduit type EPC-80-PVC, PVC: NEMA TC 2, UL 651.
- a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.
3. RNC: Heavy Schedule 40 conduit type EPC-40-PVC, PVC: NEMA TC 2, UL 651.
- a. Fittings: match to raceway type and material: NEMA TC 3, NEMA TC 6, UL 651, as applicable and UL listed for direct burial as well as above ground use.
- C. Duct Accessories
1. Innerduct
- a. Install size and quantity of innerduct within conduits as identified on the drawings.

- b. Requirements:
 - 1) Suitable for installation within the installed conduits
 - 2) Sequential foot markings
 - 3) Manufacturer shall be: Maxcell
2. Duct Separators shall be factory-fabricated rigid interlocking spacers, sized for type and sizes of ducts with which used, and selected to provide minimum duct spacings indicated while supporting ducts during concreting or backfilling.
3. Underground-line warning tape / tracer wire:
 - a. Description: Permanent, bright-colored, continuous-printed, polyethylene tape.
 - 1) Not less than 6 inches (150 mm) wide by 4 mils (0.102 mm) thick.
 - 2) Compounded for permanent direct-burial service.
 - 3) Embedded continuous metallic strip or core.
 - 4) Printed legend shall indicate type of underground line.
4. Refer to details on drawings for additional accessories.

2.3 PRE-CAST MANHOLES

- A. Pre-cast-concrete manholes shall be furnished in sizes as indicated on the plans and as specified herein. Pre-cast manholes shall be constructed of reinforced concrete with a minimum 28-day concrete compressive strength for concrete at 3,500PSI (min). All concrete used in the construction of the manhole shall contain steel reinforcing bars to conform to all applicable building codes. All reinforcing steel shall conform to ASTM432 "Standard Guide for Selection of a Leak testing Method" and ASTM 305 " Standard Practice for Mechanical mixing of Hydraulic Cement pastes and Mortars of Plastic Consistency".
- B. Manholes shall be provided complete with all appurtenances and accessories required.
 1. Product(s) identified on drawings forms Basis-of-Design. Equivalent product(s) that meet or exceed the specifications of the Basis-of-Design product and the specifications listed below will be considered from the following manufacturers:
 2. Manufacturers: Subject to compliance with requirements and hold a current NPCA certification, provide products by one of the following:
 - a. Barbour Concretes.
 - b. PreTech Corp.
 - c. Precision Precast Co.
 - d. Oldcastle Pre-cast Group.
 - e. Utility Concrete Products, LLC.
 3. Substitution of Other Manufacturers: Subject to compliance with requirements; pre-caster shall hold a current NPCA certification. Requests to utilize an alternate pre-cast manufacturer shall be provided in writing and approved by Engineer prior to procurement and implementation.
- C. Comply with ASTM C478, "Standard Specification for Precast Reinforced Concrete Manhole Sections", as specified in Part 3 "Underground Enclosure Application" and with interlocking mating sections, complete with accessories, hardware, and features.

- D. Windows: Pre-cast openings in walls, arranged to match dimensions and elevations of approaching ducts and duct banks plus an additional 12 inches vertically and horizontally to accommodate alignment variations.
 - 1. Windows shall be located no less than 6 inches from interior surfaces of walls, floors, or roofs of manholes, but close enough to facilitate racking of cables on walls.
 - 2. Window opening shall have cast-in-place, welded wire fabric reinforcement for field cutting and bending to tie into concrete envelopes of duct banks.
 - 3. Window openings shall be framed with at least two additional No.4 steel reinforcing bars in concrete around each opening.
 - 4. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.
- E. Duct Entrances in Manhole Walls: Cast end-bell or duct-terminating fitting in wall for each entering duct.
 - 1. Type and size shall match fittings to duct or conduit to be terminated
 - 2. Fittings shall align with elevations of approaching ducts and be located near interior corners of manholes to facilitate racking of cable
 - 3. Installer to coordinate location of openings with the design as depicted on the Telecommunications sheet/s for additional details.
- F. Concrete Knockout Panels: 1-1/2 to 32 inches thick, for future conduit entrance and sleeve for ground rod.
- G. Each manhole shall provide a sump drywell of at 18" in diameter and 2" deep.
- H. Joint Sealant: Asphaltic-butyl material with adhesion, cohesion, flexibility, and durability properties necessary to withstand maximum hydrostatic pressures at the installation location with the ground-water level at grade.
- I. Bonding Ribbon
 - 1. A clamped bonding ribbon shall be attached to rebar prior to encasement by concrete. Bonding ribbon shall exit manhole/handhole wall within 12" of top and between wall-mounted cable racks. Length shall be sufficient to attach to Ground Rod that stubs up 3" through manhole/handhole floor. Refer to detail on drawings and Chapter 6 of BICSI Outside Plant Manual for more information.
- J. Size: Manholes shall be 6'x12'x7' inside dimensions.

2.4 UTILITY STRUCTURE ACCESSORIES

- A. Utility structures shall be installed complete including accessories as listed below.
 - 1. Manufacturers: Subject to compliance with requirements, provide products by one of the following
 - a. Elmhurst-Chicago Stone Co.
 - b. McKinley Iron Works, Inc.
 - c. Neenah Foundry Company.
 - d. NewBasis
 - e. Oldcastle Precast Group
 - f. Osburn Associates, Inc.

- g. Pennsylvania Insert Corporation.
 - h. Precision Precast
 - i. PreTech Corp
 - j. Riverton concrete Products; a division of Cretex Companies, Inc.
 - k. Strongwell Corporation; Lenoir City Division.
 - l. Underground Devices, Inc.
 - m. Utility Vault Co.
 - n. Wausau Tile, Inc
 - o. Or Approved Equivalent
2. Contractor shall provide cut sheets and engineered shop drawings for the manhole for review and approval prior to procurement and installation.
- B. Manhole Frames, Covers, and Chimney Components: Comply with structural design loading specified for manhole.
1. Frame and Cover: Weatherproof, gray cast iron complying with ASTM A 48/A 48M, Class 30B with milled cover-to-frame bearing surfaces; diameter, 32 inches; cover to be rated for heavy traffic H-20, UON.
 - a. Cover Finish: Nonskid finish shall have a minimum coefficient of friction of 0.50.
 - b. Special Covers: recess in face of cover designed to accept finish material in paved areas
 - c. For any MV 12' to 20' in length two (2) covers shall be provided; for MV over 20' three (3) covers shall be provided.
 - d. Product shall be: Neenah Foundry N1750-series
 2. Cover Legend: Cast in. Selected to suit system.
 - a. "COMMUNICATIONS"
 3. Manhole Chimney Components: Pre-cast concrete rings with dimensions matching to those of roof opening.
 - a. Mortar for Chimney Ring and Frame and Cover Joints: Comply with ASTM C 270, Type M, except for quantities less than 2.0 cu. ft. where packaged mix complying with ASTM C387, Type M, may be used. Manhole Sump Frame and Grate: ASTM A48/A 48M, Class 30B, gray cast iron.
 4. Pulling Irons in Concrete Walls:
 - a. Locate centrally over conduit ingress/egress locations: manufactured by Cooper Power Systems, Joslyn Manufacturing and Supply, Hubbell / Chance, or pre-approved equal. Devices shall be 7/8" in diameter with a length of 12" and a width of 10-7/8"; irons shall be embedded within the walls with a max tension of 13,000 LBF.
- C. Pulling-In and Lifting Irons in Concrete Floors: 7/8 inch diameter, hot-dip galvanized, bent rod; stress relieved after forming; and fastened to reinforcing rod. Exposed triangular opening.
1. Ultimate Yield Strength: 40,000-lbf shear and 60,000-lbf tension
- D. Bolting Inserts for concrete Utility Structure Cable Racks and Other Attachments: Flared, threaded inserts of non-corrosive, chemical-resistant, non-conductive thermoplastic material; 1/2-inch ID by 2-3/4 inches deep, flared to 1-1/4 inches minimum at base.

1. Tested Ultimate Pullout Strength: 12,000-lbf minimum.
- E. Expansion Anchors for Installation after Concrete is Cast: Zinc-plated, carbon-steel-wedge type with stainless-steel expander clip with ½-inch bolt, 5300-lbf rated pullout strength, and minimum 6800-lbf rated shear strength.
- F. Cable Rack Assembly: Stainless Steel stanchions and Non-metallic arms. Components fabricated from nonconductive, fiberglass-reinforced polymer.
 1. Stanchions shall extend from 6" AFF to 6" from the ceiling.
 2. Stanchions shall be placed 18" from the corners and every 3' along the walls.
- G. Duct-Sealing Compound: Non-hardening, safe for contact with human skin, not deleterious to cable insulation, and workable at temperatures as low as 35 deg F. Capable of withstanding temperature of 300 deg F without slump and adhering to clean surfaces of plastic ducts, metallic conduits, conduit coatings, concrete, masonry, lead, cable sheaths, cable jackets, insulation materials, and common metals.
- H. Fixed Manhole Ladders: Arranged for attachment to wall of manhole. Ladder and mounting brackets and braces shall be fabricated from nonconductive, structural-grade, fiberglass-reinforced resin.
- I. Cover Hooks: Heavy duty, design for lifts 60-lbf and greater; two required, to be delivered to the Owner prior to Substantial Completion.

2.5 GROUNDING

- A. Ground Rods: UL-listed:
 1. Copper-clad steel; bonded copper electrolytically-applied to minimum thickness of 10 mils.
 2. 5/8" thick, by 6' long
 3. Manufacturer shall be:
 - a. Copperweld Steel Company
 - b. ITT Weaver
 - c. Thomas & Betts
 - d. Pre-Approved equal.
- B. Grounding Conductors and Connectors
 1. Manufacturers:
 - a. Apache Grounding/Erico Inc.
 - b. Boggs, Inc.
 - c. Chance/Hubbell.
 - d. Copperweld Corp.
 - e. Dossert Corp.
 - f. Erico Inc.; Electrical Products Group.
 - g. FCI/Burndy Electrical.
 - h. Galvan Industries, Inc.
 - i. Harger Lightning Protection, Inc.
 - j. Hastings Fiber Glass Products, Inc.

- k. Heary Brothers Lightning Protection Co.
 - l. Ideal Industries, Inc.
 - m. ILSCO.
 - n. Kearney/Cooper Power Systems.
 - o. Korns: C. C. Korns Co.; Division of Robroy Industries.
 - p. Lightning Master Corp.
 - q. Lyncole XIT Grounding.
 - r. O-Z/Gedney Co.; a business of the EGS Electrical Group.
 - s. Panduit, Inc
 - t. Raco, Inc.; Division of Hubbell.
 - u. Robbins Lightning, Inc.
 - v. Salisbury: W. H. Salisbury & Co.
 - w. Superior Grounding Systems, Inc.
 - x. Thomas & Betts, Electrical.
 - y. Or approved equivalent
2. Grounding Conductors
- a. Grounding Electrode Conductors: Bare, stranded, unless otherwise indicated.
 - b. Underground Conductors: Tinned-copper conductor, No. 2/0 AWG minimum stranded, unless otherwise indicated.
 - c. Bare Copper Conductors: Comply with the following:
 - 1) Solid Conductors: ASTM B 3.
 - 2) Assembly of Stranded Conductors: ASTM B 8.
 - 3) Tinned Conductors: ASTM B 33.
 - d. Copper Bonding Conductors: As follows:
 - 1) Bonding Cable: 28 kcmil, 14 strands of No. 17 AWG copper conductor, 1/4 inch in diameter.
 - 2) Bonding Conductor: No. 4 or No. 6 AWG, stranded copper conductor.
 - 3) Bonding Jumper: Bare copper tape, braided bare copper conductors, terminated with copper ferrules; 1-5/8 inches wide and 1/16 inch thick.
3. Connector Products
- a. Comply with IEEE 837 and UL 467; listed for use for specific types, sizes, and combinations of conductors and connected items.
 - b. Bolted Connectors: Bolted-pressure-type connectors
 - 1) Compression Connectors: Burndy Hyground, or equal, permanent, pure, wrought copper, meeting ASTM 8 1 87, essentially the same as the conductors being connected; clearly and permanently marked with the information listed below:
 - a) Company symbol and/or logo.
 - b) Catalog number.

- c) Conductors accommodated.
 - d) Installation die index number or die catalog number is required.
 - e) Underwriters Laboratories "Listing Mark:".
 - f) The words "Suitable for Direct Burial" or, where space is limited, "Direct Burial" or "Burial" per UL Standard ANSI/UL467 (latest revision).
- 2) Cast connectors: copper base alloy according to ASTM B 30 (latest revision).
- c. Welded Connectors: Exothermic-welded type, in kit form, and selected per manufacturer's written instructions.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.

3.2 UNDERGROUND DUCT APPLICATION

- A. Underground Ducts for Telephone, Communications, or Data Utility Service Cables: RNC, NEMA Type EPC-40 PVC, in concrete-encased, rebar reinforced duct bank, unless otherwise indicated
1. For all changes in elevation or direction, conduit shall be concrete-encased PVC.

3.3 UNDERGROUND ENCLOSURE INSTALLATION

- A. Handholes and boxes Telephone, Communications, and Data Wiring:
1. Units in roadways and Other Deliberate Traffic Paths: Pre-cast concrete. AASHTO HB H-20 structural load rating.
 2. Units in Driveway, Parking Lot, and Off-Roadway Locations, Subject to Occasional, Non-deliberate Loading by Heavy Vehicles: Pre-cast Concrete, AASHTO HB 17, H-20 structural load rating.
 3. Units in Sidewalk and Similar Applications with a Safety Factor for Non-deliberate loading by Vehicles: Pre-cast Concrete, AASHTO HB 17, H-10 structural load rating.
 4. Units Subject to Light-Duty Pedestrian Traffic Only: Fiberglass-reinforced Polyester resin, structurally tested according to SCTE 77 with 3000-lbf vertical loading
 5. Handholes shall be used as pull-through points only. Handholes shall not be used as splice points, unless authorized in writing by the design team.
 6. Handholes shall not be used in conduit runs that have more than (3) three 4" conduits.
 7. Joint use of handholes by other trades is not allowed.
- B. Manholes: Pre-cast concrete.
1. Units Located in Roadways and Other Deliberate Traffic Paths by Heavy or Medium Vehicles: H-20 structural load rating according to AASHTO HB 17.
 2. Units Not Located in Deliberate Traffic Paths by Heavy or Medium Vehicles: H-10 load rating according to AASHTO HB 17.

3.4 EARTHWORK

- A. Excavation and Backfilling: do not use heavy-duty, hydraulic-operated, compaction equipment.

- B. Restore surface features at areas disturbed by excavation and reestablish original grades, unless otherwise indicated. Replace removed sod immediately after backfilling and compaction is complete.
- C. Restore areas disturbed by trenching, storing of dirt, cable laying, and other work. Restore vegetation and include necessary top soiling, fertilizing, liming, seeding, sodding, sprigging, and mulching.
- D. Cut and patch existing pavement in the path of underground ducts and utility structures.

3.5 DUCT INSTALLATION

- A. Maintain a minimum trench depth to allow for the top row of conduits in the duct bank to be 36" below grade
- B. Contractor shall remove all rock and debris from backfill material. Contractor shall remove all excess material from the site and compact the excavation. Unpaved areas shall be finished flush with the surrounding natural ground. Contractor shall restore damaged grassed areas.
- C. Contractor shall tamp backfill material in 6" lifts with a mechanical tamp until compact density is at least equal to surrounding density
- D. For concrete and driveway approaches, contractor shall replace the entire joint of the approach unless otherwise directed by the Engineer. In areas with brick sidewalks, remove only the existing brick pavers necessary to install the conduit. Replace the brick pavers within seven (7) days of their removal. Furnish new bricks of similar type necessary to restore sidewalk area to its original appearance. Any new bricks shall identically match the existing brick pavers.
- E. Contractor shall backfill the trench at locations along the trench path where non-movable objects, such as rocks and boulders, cannot be avoided causing a deviation in the elevation height of the multi-duct conduit system. The purpose of the backfill is to provide a gradual change in elevation of the trench, from the bottom to the highest point of the obstruction such that excessive bending and stress will not be transferred to the conduits once the conduit system is installed.
- F. Slope: Pitch ducts a minimum slope of ½ % down toward manholes and handholes and away from buildings and equipment. Slope ducts from a high point in runs between two manholes to drain in both directions
- G. All underground conduits shall be slurry capped sealed.
- H. Conduit lengths shall contain no continuous sections longer than 500 feet. If conduit lengths total more than 500 feet, pull points (manholes / handholes) shall be provided. The use of pull boxes to changes directions is prohibited, unless expressly detailed or indicated on the drawings.
- I. Conduits shall have no more than 270 degrees of cumulative bends between pull points or more than 90 degrees of bends at any one point. All bends must be long, sweeping bends with a radius of not less than six times the internal diameter of conduits 50mm (2 inches) or smaller, or ten times the internal diameter of conduits larger than 50mm (2 inches). 48" sweeps are preferred.
 - 1. For all changes in elevation or direction conduit shall change to RMC from PVC.
- J. Required separation from other utilities.
 - 1. Power up to 1KVA:
 - a. 12" of well-packed earth
 - b. 4" of masonry
 - c. 3" of concrete
 - 2. Gas, Oil, Water, etc.:
 - a. 12" when parallel

- b. 6" when crossing
- K. All conduits shall be mandrelled prior to installation of cable or (for spare conduits) prior to substantial completion; the OD of the test mandrel shall be no smaller than one trade size smaller than the installed conduit.
- L. Joints: Use solvent-cemented joints in ducts and fittings and make watertight according to manufacturer's written instructions. Stagger couplings so those of adjacent ducts do not lie in the same plane.
- M. Duct Entrances to Manholes and Handholes: Use end bells, spaced approximately 10-inches OC for 4-inch ducts, and vary proportionately for other duct sizes.
 - 1. Begin change from regular spacing to end-bell spacing 10 feet from the end bell with out reducing duct line slope and without forming a trap in the line.
 - 2. Direct-Buried Duct Banks: Install an expansion and deflection fitting in each conduit in the area of disturbed earth adjacent to manhole or handhole.
 - 3. Grout end bells into structure walls from both sides to provide watertight entrances
 - 4. All ends of conduits must be reamed.
 - 5. All conduits in the Telecommunications duct bank shall enter one end of the manhole / handhole and exit the opposite end, UON.
- N. Building Wall Penetrations: Make a transition from underground duct to rigid steel conduit at least 10 feet outside the building wall without reducing duct line slope away from the building, and without forming a trap in the line. Use fittings manufactured for duct-to-conduit transition. Install conduit penetrations of building walls.
- O. All conduits entering a building must be pitched to drain away from the building to avert water intrusion. To prevent conduit shearing, conduits entering through walls shall be RMC and extend to undisturbed earth, particularly where such backfill is susceptible to load bearing tension.
- P. Sealing: Provide temporary closure at termination of ducts that enter buildings. After cables have been installed, seal ducts (including spare) at termination.
- Q. Pulling Cord: Install 1500-lbf ½-inch (min) wide mule tape in all conduits and in all innerducts installed, including spares; all mule tape shall provide footage markers and be indexed to facilitate future identification.
- R. Concrete-Encased Ducts: Support ducts on duct separators.
 - 1. Separator installation: Space separators close enough to prevent sagging and deforming of ducts, with not less than 5 spacers per 20 feet of duct. Spacers shall be installed / utilized per the manufacturer's standard specifications. Couplings for conduits shall be staggered at least six (6) inches. Secure separators to earth and ducts to prevent floating during concreting. Stagger separators approximately 6-inches between tiers. Tie entire assembly together using fabric straps; do not use tie wires or reinforcing steel that may form conductive or magnetic loops around the ducts or duct group.
 - 2. Concreting Sequence: Pour each run of envelope between manholes or other terminations in one continuous operation.
 - a. Start at one end finish at the other, allowing for expansion and contraction of ducts as their temperature changes during and after the pour. Use expansion fittings installed according to the manufacturer's written recommendations, or use other specific measures to prevent expansion-contraction damage.

- b. If more than one pour is necessary, terminate each pour in a vertical plane and install $\frac{3}{4}$ -inch reinforcing rod dowels 18-inches into concrete on both sides of joint near corners of envelope.
3. Pouring Concrete: Spade concrete carefully during pours to prevent voids under and between conduits and at exterior surface of envelope. Do not allow a heavy mass of concrete to fall directly onto ducts. Use a plank to direct concrete down sides of bank assembly to trench bottom. Allow concrete to flow to center of bank and rise up in middle, uniformly filling all open spaces. Do not use power-driven agitating equipment unless specifically designed for duct bank application.
4. Reinforcement: Reinforce concrete-encased duct banks where they cross disturbed earth and where indicated. Arrange reinforcing rods and ties without forming conductive or magnetic loops around ducts or duct groups.
5. Forms: Use walls of trench to form side walls of duct bank where soil is self-supporting and concrete envelope can be poured without soil inclusions; otherwise, use forms.
6. Minimum Space between Ducts: 3-inches between ducts and exterior envelope wall, 2-inches between ducts for like services, and 4-inches between power and signal ducts.
7. Depth: Install top of duct bank at least 36-inches below finished grade, unless otherwise indicated.
8. Stub-Ups: Use manufactured rigid steel conduit elbows for stub-ups at poles and equipment and at building entrances through the floor.
 - a. Couple steel conduits to ducts with adapters designed for this purpose, and encase coupling with 3-inches of concrete.
 - b. Stub-ups to Equipment: For equipment mounted on outdoor concrete bases, extend steel conduit horizontally a minimum of 60-inches from edge of base. Install insulated grounding bushings on terminations at equipment.
9. Warning Tape: Bury warning tape approximately 18 inches above all concrete-encased ducts and duct banks. Align tape parallel to and within 3-inches of the centerline of duct bank. Provide an additional warning tape for each 12-inch increment of duct-bank width over a nominal 18-inches. Space additional tapes 12-inches apart, horizontally
10. Tracer Wire: Provide an orange #6 AWG high strength copper clad steel with a high density polyethylene coated tracer wire' install by strapping it to the top row center conduit every 8-feet with a polyethylene-based tape; only (1) one tracer wire is required within the duct bank regardless of the number of conduits present. Tracer wire to terminate within every manhole / handhole to facilitate the application of an electrical current to the wire to aid in locating the duct bank in the future once the duct bank is buried.

3.6 TEXTILE INNERDUCT INSTALLATION

- A. Manufacturer may provide on-site installation assistance free of charge to contractors unfamiliar with product. Use of this service is highly encouraged. Contact Maxcell at 888-387-3828 to find closest Territory Manager.
- B. Provide textile innerduct in conduit using continuous unspliced lengths of textile innerduct between maintenance holes, pull boxes, and/or termination points as indicated on the drawings.
- C. Make a 2" incision, approximately 18" from the end of textile innerduct. Pull out and cut off approximately 2 feet of pull-tape. Thus allowing the pull tape ends to retract back into the cells.
- D. Using approximately 6 feet of pull tape, tie a non-slip knot to the incision. Then tie 3 to 6 half-hitch knots down to the end of textile innerduct. Apply black vinyl tape over all knots and the end of

textile innerduct. Using a Bow Line knot tie a swivel to the end of 3 feet pull tape. For multi-pack installations one swivel is sufficient, but stagger each textile innerduct.

- E. Using a Bow Line knot, attach the pull rope located in the rigid conduit to the other end of the swivel. Install textile innerduct – ensuring that no twist is introduced to the innerduct.
- F. Provide suitable textile innerduct slack in the maintenance holes, hand holes, pull boxes, and at turns to ensure there is no kinking or binding of the product.
- G. Textile Innerduct Mountings, Hangers and Attachments: When exposed indoors or in maintenance holes, hold firmly in place using independent support.
- H. Maintenance Hole and Hand Hole Installation:
 - 1. At locations where textile innerduct will be continuous through a manhole or hand hole, allow sufficient slack so that the innerduct may be secured to the side of the vault maintaining the minimum bend radius.
 - 2. At maintenance holes serving as the junction location, pull the exposed end of the innerduct to the far end of the vault, install termination bag, and secure to the vault.
- I. 3.4 Penetrations
 - 1. Seal all conduit and textile innerduct entering structures at the first box or outlet to prevent entrance into the structure of gases, liquids or rodents.

3.7 INSTALLATION OF CONCRETE MANHOLES, HANDHOLES, AND BOXES

- A. Precast Concrete Handhole and Manhole Installation:
 - 1. Comply with ASTM C891, unless otherwise indicated.
 - 2. Install each unit level and plumb and with orientation and depth coordinated with connecting ducts to minimize bends and deflections required for proper entrances.
- B. Elevations:
 - 1. Install manholes / handholes per manufacturer's instructions; lid to manhole / handhole to be flush with the surrounding terrain so that no earth, roadway or sidewalk removal is required to access the manhole / handhole interior. Contractor to provide chimney/ extensions / collars to facilitate the placement of the manholes / handholes so as to maintain the minimum distance to the surface above the highest row of conduits in the duct bank given the location of the manhole / handhole at the point of installation.
 - 2. Manhole Roof: Install with rooftop at least 15-inches below finished grade.
 - 3. Handhole Covers: Set surface flush with finished grade.
- C. Drainage: Install drains in bottom of manholes where indicated. Coordinate with drainage provisions indicated.
- D. Manhole Access: Circular opening in manhole roof; sized to match cover size.
 - 1. Manholes with Fixed Ladders: Offset access opening from manhole centerlines to align with ladder.
 - 2. Install chimney, constructed of precast concrete collars and rings to support frame and cover and to connect cover with manhole roof opening. Provide moisture-tight masonry joints and waterproof grouting for cast-iron frame to chimney.
- E. Waterproofing: Apply waterproofing to exterior surfaces of manholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, waterproof joints and connections and touch up abrasions and scars. Waterproof exterior of manhole chimneys after mortar has cured at least three days

- F. Dampproofing: Apply dampproofing to exterior surfaces of manholes after concrete has cured at least three days. After ducts have been connected and grouted, and before backfilling, dampproof joints and connections and touch up abrasions and scars. Dampproof exterior of manhole chimneys after mortar has cured at least three days.
- G. Hardware: Install removable hardware, including pulling eye, cable stanchions, cable arms, and insulators, as required for installation and support of cable and conductors and as indicated.
- H. Fixed Manhole Ladders: Arrange to provide for safe entry with maximum clearance from cables and other items in manholes.
- I. Field-Installed Bolting Anchors in Manholes and Concrete Handholes: Do not drill deeper than 3-7/8-inches for manholes and 2-inches for handholes, for anchor bolts installed in the field. Use a minimum of two anchors for each cable stanchion.
- J. Warning Sign: Install "Confined Space Hazard" warning sign on the inside surface of each manhole cover

3.8 GROUNDING

- A. Manholes and Handholes: Install a 6' long driven ground rod close to wall in two opposite corners of the manhole and set rod depth so 3 inches will extend above finished floor. If necessary, install ground rod before manhole is placed and provide a No. 1/0 AWG bare, tinned-copper conductor from ground rod into manhole through a waterproof sleeve in manhole wall. Protect ground rods passing through concrete floor with a double wrapping of pressure-sensitive tape or heat-shrunk insulating sleeve from 2 inches above to 6 inches below concrete. Seal floor opening with waterproof, nonshrink grout.
- B. Connections to Manhole Components: Connect exposed-metal parts, such as inserts, cable racks, pulling irons, ladders, and cable shields within each manhole or handhole, to ground rod or grounding conductor. Make connections with No. 6 AWG minimum, stranded, hard-drawn copper conductor. Train conductors level or plumb around corners and fasten to manhole walls. Connect to cable armor and cable shields as recommended by manufacturer of splicing and termination kits.
- C. Equipment Grounding Conductors
 - 1. Use only copper conductors for both insulated and bare grounding conductors in direct contact with earth, concrete, masonry, crushed stone, and similar materials.
 - 2. Underground Grounding Conductors: Bury at least 24 inches below grade, or 6 inches below the official frost line, whichever is greater, or when crossing a duct bank, bury 12 inches above duct bank.
- D. Connections
 - 1. General: Make connections so galvanic action or electrolysis possibility is minimized. Select connectors, connection hardware, conductors, and connection methods so metals in direct contact will be galvanically compatible. Provide electrical bonding plates, connectors, terminals, lugs and clamps as recommended by the manufacturers for indicated applications. Provide electrical insulating tape, heat shrinkable insulating tubing, welding materials, and bonding straps as recommended by the manufacturers for types of service indicated.
 - a. Use electroplated or hot-tin-coated materials to ensure high conductivity and to make contact points closer to order of galvanic series.
 - b. Make connections with clean, bare metal at points of contact.
 - c. Make aluminum-to-steel connections with stainless-steel separators and mechanical clamps.

- d. Make aluminum-to-galvanized steel connections with tin-plated copper jumpers and mechanical clamps.
 - e. Coat and seal connections having dissimilar metals with inert material to prevent future penetration of moisture to contact surfaces.
2. Compression Fittings: Permanent compression-type fittings may be used for the following:
 - a. Connecting conductors together.
 - b. Connecting conductors to ground rods
 3. Tighten screws and bolts for grounding and bonding connectors and terminals according to manufacturer's published torque-tightening values. If manufacturer's torque values are not indicated, use those specified in UL 486A/B.
 4. Compression-Type Connections: Use hydraulic compression tools to provide correct circumferential pressure for compression connectors. Use tools and dies recommended by connector manufacturer. Provide embossing die code or other standard method to make a visible indication that a connector has been adequately compressed on grounding conductor.
 5. Moisture Protection: If insulated grounding conductors are connected to ground rods or grounding buses, insulate entire area of connection and seal against moisture penetration of insulation and cable.
- E. Field Quality Control
1. Testing: Perform the following field quality-control testing:
 - a. Test completed grounding system at each location. Measure ground resistance not less than two full days after the last trace of precipitation, and without the soil being moistened by any means other than natural drainage or seepage and without chemical treatment or other artificial means of reducing natural ground resistance. Perform tests by the fall-of-potential method according to IEEE 81.
 - b. Provide drawings locating each ground rod and ground rod assembly and other grounding electrodes, identify each by letter in alphabetical order, and key to the record of tests and observations. Include the number of rods driven and their depth at each location and include observations of weather and other phenomena that may affect test results. Describe measures taken to improve test results.
 - c. Perform point-to-point megohmmeter tests between the ground rod and all cable shields, splice cases, locate wires, and racking hardware to determine the resistance.
 - d. Investigate point-to-point resistance values that exceed 0.5 ohms.
 - 1) Check for loose connections.
 - 2) Check for absent or broken connections.
 - 3) Check for poor quality welds.
 - 4) Consider other reasons.
 - e. Excessive Grounding Electrode Resistance: If measured resistance to earth ground value exceeds specified values, add grounding electrodes and additional conductors as required to obtain the specified value.

3.9 GRADING AND PLANTING

- A. Restore surface features, including vegetation, at areas disturbed by Work of this Section. Reestablish original grades, unless otherwise indicated. If sod has been removed, replace it as soon as possible after backfilling is completed. Restore areas disturbed by trenching, storing of dirt, cable laying, and other activities to their original condition. Include application of topsoil,

fertilizer, lime, seed, sod, sprig, and mulch. Maintain restored surfaces. Restore disturbed paving as indicated.

3.10 INSTALLATION ACCEPTANCE

- A. Prior to final acceptance of the duct bank and associated structures, pull an aluminum or wooden test mandrel through the duct to prove joint integrity and to verify ducts have not been deformed. Provide mandrel equal to 80 percent fill of the duct internal diameter.
- B. Test duct bank, manhole and handhole grounding to ensure electrical continuity of grounding and bonding connections. Measure and report ground resistance as specified above. Correct any deficiencies and retest as specified above.
- C. Clean internal surfaces of manholes (including sumps) and handholes and remove foreign materials.
- D. Acquire written approval from the Owner prior to backfilling any duct banks or covering manholes / hand holes
- E. Provide Record Drawings indicating the exact pathway of the Telecommunications Duct bank include elevation changes and the location of all manholes/handholes. Label all manholes MH-xx and handholes HH-xx, coordinating exact labeling scheme with Owner.

END OF SECTION 27 05 43

SECTION 27 10 00 - STRUCTURED CABLING SYSTEM

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Install Owner furnished/Owner terminated horizontal Category 6A and coaxial cable from serving telecommunications equipment room to outlet locations. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Owner shall furnish, install, test, and label all horizontal cable connectors, patch panels, racks, and enclosures.
- C. Owner shall furnish and install all fiber, copper, and coax backbone cabling, connectors, and equipment.
- D. Owner shall furnish and install all cabling and connectors necessary for connection to campus internet, telephone, and television service.
- E. Specification sections 271000 through 271999, and Drawings numbered with prefixes TN, generally describe these systems, but the scope of the Structured Cabling System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Electronic Safety and Security Drawings and Specifications; and Addenda.
- F. This section includes additional requirements for the Structured Cabling (Telecommunications) System, which include the following:
 1. Quality Assurance requirements, including Contractor qualifications and advanced warranties

1.2 RELATED DOCUMENTS

- A. Division 27 Section "General Communications".
- B. Division 27 Section "Common Work Results for Communications".
- C. Requirements of this Section apply to all Sections 271000 through 271999.

1.3 STANDARDS

- A. The references to the following standards represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON):
 1. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
 2. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
 3. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure"
 4. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
 5. ANSI/BICSI/NECA 568 – "Standard for Installing Commercial Building Telecommunications Cabling"

1.4 GUIDELINES

- A. The references to the following guidelines represent the most current and up-to-date revisions or printing as of the issue of this document including all sections, parts and their addenda. The Contractor is responsible for following the correct revision or printing (UON)
 - 1. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
 - 2. BICSI Telecommunications Distribution Methods Manual (TDMM)

1.5 DEFINITIONS

- A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category 3/5e/6/6A copper cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc.
- B. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.6 QUALITY ASSURANCE

- A. Personnel Qualifications:
 - 1. Provide and maintain a BICSI Registered RCDD in good standing on staff as a full-time employee at all times. This RCDD shall be familiar with the project and available to attend all scheduled project meetings when required by the Owner/Design Consultant.
 - 2. Provide and maintain a Project Manager whom is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times. This project manager shall attend all scheduled project meetings and be responsible for all Submittals.
 - 3. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Division shall, at a minimum, be a BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training certificate (of those identified as approved for this project) and approved by the Design Consultant.
 - 4. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
 - 5. Alternate qualifications may be considered if requested alternates are provided in accordance with the substitution section herein prior to bid.
- B. Contractor qualifications:
 - 1. Provide a list of projects (no less than 2) of similar size, scope and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.

1.7 ADVANCED STRUCTURED CABLING SYSTEM WARRANTY

- A. All components, including but not limited to, connectors, terminal blocks, cabling and all other components considered to be a part of what is commonly referred to as an end-to-end solution for all backbone and horizontal cabling systems, shall be warranted for a minimum period of 15 years from the date of installation against defects in materials, equipment and workmanship. This warranty shall also include the performance of these systems. This warranty shall include transmission requirements as specified in applicable ANSI/TIA/IEC/ISO standards for each cable

system specified. This warranty shall also include all current and future applications designed for and becomes available under warranty for each cable system.

1. Warranty shall be guaranteed by a reputable manufacturer such as:

a. CommScope Inc.

- B. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
- C. Perform the remedial work promptly, upon written notice from the Architect or Owner.
- D. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.8 WORK INCLUDED

- A. Provide labor, materials, and accessories required to install Owner-provided horizontal cabling as called for in the Contract Documents and in accordance with applicable codes and regulations. Labor, materials or accessories not specifically called for in the Contract Documents, but required to provide complete, operating infrastructure systems shall be provided without additional cost to the Owner. The work includes, but is not necessarily limited to, the following:
 - 1. Installation of horizontal cabling between the Telecommunications rooms and the outlets.
 - 2. All physical cable management hardware including, but not limited to: "J-hooks" in accessible ceiling areas, cable trays, conduits, ladder-type cable racks within telecommunication rooms and "D-rings" on backboards and equipment racks/cabinets/frames.
 - 3. A Grounding/Bonding System, as described in these construction documents.
 - 4. Preparation and submission of shop drawings, testing reports, as-built drawings, and cabling documentation as described below.
- B. Termination and testing of cabling shall be provided by Owner.

1.9 COORDINATION

- A. The locations of cable termination fields, outlets, patch panels, equipment racks and other equipment indicated on the Drawings are approximately correct, but they are understood to be subject to such revision as may be found necessary or desirable at the time the work is installed in consequence of increase or reduction of the number of outlets, or in order to meet field conditions, or to coordinate with modular requirements of ceilings, or to simplify the work, or for other legitimate causes.
- B. Exercise particular caution with reference to the location of outlets, patch panels, control panels, switches, etc., and have precise and definite locations accepted by the Architect before proceeding with the installation.
- C. The Drawings show only the general run of raceways and approximate locations of outlets. Any significant changes in location of outlets, cabinets, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Modifications shall be made at no additional cost to the Owner.
- D. Verify with the Architect the exact location and mounting height of outlets and equipment not dimensionally located on the Drawings.
- E. Outlet/cable tags in the form of alpha/numeric characters are used where shown to indicate the outlet and cable designation numbers in cable termination fields (terminal blocks and/or patch

panels. and in the printed and computer readable cabling schedules. Where sample outlet/cable-numbering information is not indicated, request clarification from the Architect.

- F. The drawings generally do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Provide the correct cable type and quantity as required by the indicated outlets, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI/TIA-568.
- G. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - 1. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - 2. Provide offsets, transitions and changes in direction of conduit as required to maintain proper headroom and pitch on sloping lines.

1.10 SUBMITTALS

- A. Refer to requirements in Division 27 Section "General Communications Requirements". At a minimum, include the following items:
 - 1. "Pre-bid" Phase
 - a. Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid)
 - b. Alternate personnel credentials to be reviewed for approval
 - 2. "Bid" Phase
 - a. Bid Response Forms
 - b. Personnel Qualifications / Credentials - Supplemental to Division 1 requirements submit the following documents to indicate the required personnel qualifications per the quality assurance section of this section:
 - 1) Member of staff required to be RCDD
 - a) A copy of their valid RCDD certificate, RCDD number, and BICSI member number shall be provided with bidding documents.
 - 2) On-site project manager
 - a) A copy of their valid BICSI Certified Technician certificate and BICSI member number shall be provided with bidding documents.
 - 3) Other personnel physically installing any portion of the Communications infrastructure
 - a) A copy of their valid BICSI Commercial Installer certificate and BICSI member number shall be provided with bidding documents
 - b) An alternate certification may be considered by the Design Consultant for approval, which shall be completely at the Design Consultant's discretion.
 - c) If the contractor chooses to submit an alternate certification from one of the conditionally approved vendor list as an acceptable alternate for a BICSI Commercial Installer, the following shall be included:

- i) A valid copy of each certification with the person's name and member number including the manufacturer's logo
 - ii) A document provided by the manufacturer describing what specific subjects the certification covers, period of time spent doing course work required to gain certification, exam topics, and the requirements needed to maintain the certification.
 - 4) Contractor Qualifications (Previous project references)
 - 5) Voluntary Bid Alternates
- 3. "Pre-construction" Phase
 - a. Warranty information
 - 1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and terms/conditions
 - 2) Proof that Contractor is certified with the Advanced System Warranty manufacturer
 - b. Resubmit Contractor and Personnel Qualification, update if necessary
 - c. A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Order shall match that as in these specifications.
 - d. Manufacturers' cut-sheets, in same order as typed list and in these specifications.
 - 1) At a minimum all cut-sheets shall contain the following:
 - a) Cross-reference to the specification section and/or drawings for which the product is to be reviewed for compliance and acceptance
 - b) Every product cut-sheet submitted for review shall contain the manufacturers' name and logo
 - c) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp, or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
 - d) For cut-sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
 - e) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
 - e. Shop Drawings
 - f. And as required by individual sections in this Division
- 4. Phase four - "Project Completion"
 - a. Preliminary Project Completion submittal requirements:
 - 1) To be submitted:
 - a) After all horizontal cabling has been installed.
 - b) In conjunction with the Substantial Completion Review request.
 - i) Design Consultant requires a minimum of 1 weeks] notice to schedule the on-site Substantial Completion Review.

- ii) Substantial Completion Review shall be a minimum of 1 weeks before Substantial Completion, or earlier if the Project Schedule requires it, to allow for major Punch List items to be address by Contractor.
- 2) Submittal shall include:
 - a) Scanned Work Site Prints that include horizontal
- b. Final Project Completion submittal requirements:
 - 1) Advanced Structured Cabling System Warranty Certificate. Warranty terms and conditions shall contain the following:
 - a) Length of warranty period
 - b) Applications covered (future and present)
 - c) Single manufacturer responsible for fulfilling warranty
 - d) Who is covered
 - e) What is covered
 - f) All disclaimers, limitations, etc.
 - g) What, if anything, is not covered
 - 2) Product Information
 - a) Product List (Bill of Materials) – a typed list of products (in order of these specifications), in Excel or CSV file format, indicating:
 - i) Product Type (as identified in these specifications)
 - ii) Manufacturer
 - iii) Model Number
 - iv) Quantity installed
 - v) Serial Number (if applicable)
 - vi) Manufacturer Warranty date (if longer than 1 year)
 - b) Manufacturer Cut Sheets / Specification Sheets
 - c) Operation and Maintenance Manuals – manufacturer’s installation, service, and maintenance instructions.
 - d) Warranty certificates (for products not covered by the Advanced System Warranty)
 - i) If products require registration, register on the Owner’s behalf.
 - 3) As Built Drawings
 - a) At the completion of the project, incorporate changes to the Structured Cabling System noted on the jobsite work prints onto a set of as built Drawings. These changes shall be done electronically in AutoCAD and saved to PDF format.
 - b) Include date and installing contractor’s logo and contact information in the title block.
 - c) Mark each sheet "As Built Drawing".
 - d) Drawings shall include:

- i) Corrected items from Substantial Completion Review punch list.
 - ii) Routing of cable/conduit/cable tray and location of any firestopping systems and pull boxes.
 - iii) Project RCDD's stamp, which indicates that the project has been installed in compliance with industry standards and the contract documents.
- B. All submittals for Division 271000 through 271999 (Structured Cabling System) work at each phase shall be submitted together and in one package. "Piecemeal" submissions will not be reviewed. It is permissible to combine 270500 Common Work Results submittals with that of the Structured Cabling System.
- C. For each room or area of the building containing Structured Cabling System infrastructure and equipment, submit the following as part of the shop-drawings and as-built drawings:
 1. Floor plans, at not less than 1/8" scale, showing routing of Communications conduits, cable trays, and wireways, including surface-mounted raceways and pullboxes. Also show the routing of bundles of cables supported by "J-hooks", or similar means, if and where such installation practices are allowed by the Contract Documents.
 2. Riser diagrams showing types, quantities and schematic routing of all Communications backbone pathways, cabling and the TBB and BCT.
 3. Enlarged plan views and elevation layout drawings for the Telecommunications Entrance Facility Room, Telecommunications Rooms and all other designated Telecommunications Equipment Rooms indicating the equipment in the exact location in which it is intended to be installed. These plans shall be of a scale not less than 1/4 inch = 1'-0". They shall be prepared in the following manner:
 - a. Indicate the physical boundaries of the space including door swings and ceiling heights and ceiling types (as applicable).
 - b. Illustrate all Communications equipment proposed to be contained therein. The Drawings shall be prepared utilizing the dimensions contained in the individual equipment submittals. Indicate code and manufacturer's required clearances.
 - c. Illustrate all other equipment therein such as conduits, detectors, lighting fixtures, ducts, registers, pull boxes, wireways, structural elements, etc.
 - d. Indicate the operating weight of each piece of equipment.
 - e. Indicate dimensions to confirm compliance with code-required clearances.
 - f. Indicate maximum normal allowable operating temperature for each piece of equipment (as per each respective manufacturer's recommendation). (Note: This requirement applies to active Communications equipment such as LAN hubs, routers, amplifiers, radio transmitters/receivers, PBX or key telephone equipment, etc., if installed under this work.)
 - g. Equipment removal routes for individual equipment items with plan dimensions exceeding 24" by 36" or height exceeding 84".
- D. The Communications Equipment room layout submittals and the related Structured Cabling System submittals shall be submitted concurrently. Failure to submit concurrently may result in the immediate return of the submittal marked REVISE AND RESUBMIT.

PART 2 - PRODUCTS

2.1 HORIZONTAL CABLING

- A. Category 6A and coaxial cable shall be furnished by owner and installed by contractor.
- B. Owner shall furnish, install, test, and label all Category 6A and coaxial connectors and faceplates.

2.2 BACKBONE CABLING INSIDE BUILDING

- A. Owner shall furnish and install all fiber, copper, and coaxial backbone cabling and connectors.

2.3 CAMPUS UTILITY CABLING

- A. Owner shall furnish and install all fiber, copper, and coaxial cables and connectors to provide connection to campus services.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.

3.2 IDENTIFICATION / LABELING

- A. General
 - 1. The administration of the Telecommunications infrastructure includes:
 - a. Schedules (or other records (printed and/or in computer data base form) to document information about the individual components and the relationships between them.
 - b. Plans or drawings to assist with visualizing the physical and/or logical locations of the components.
 - 2. Provide labels on all applicable items installed under this work and to provide all related records and drawings so that the Owner will be able to administer the Telecommunications infrastructure.
 - a. All required fire stopping systems.
 - b. All pathways (e.g., inner duct, cable racking, conduit, etc.) installed under this work.
 - 1) All interior pathways including cable trays and conduits shall be striped, traced, colored, or marked.
 - c. Provision of a database that records appropriate information regarding all cabling, terminations, frames, racks, etc. installed under this work.
 - d. In general, the label, plate or tag is to be provided and installed by whoever installed the item that is being labeled.
 - e. Refer to individual Telecommunications specification sections (Division 27) and to the Telecommunications drawings for additional information on labeling requirements.

3.3 TEST REPORTS FOR THE STRUCTURED CABLING SYSTEM

- A. General cable testing
 - 1. Pre-installation testing:
 - a. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.

- b. Where post-manufacturer test data has been provided by the manufacturer on the reel, box or shipping carton: submit copies to the Owner prior to installing cables.
- c. Mark reels or boxes as tested/inspected and submit associated test results to Owner/Design Consultant.
- d. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.

B. Acceptance

1. The Owner and Design Consultant reserve the right to observe the conduct of any or all portions of the testing process.

3.4 SUBSTANTIAL COMPLETION REVIEW

A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:

1. The complete build-out of all Communications Rooms, cleaned of dust and debris.
2. Installation of all backbone and horizontal cabling.
3. The installation and labeling of all firestopping systems required for Telecommunications cabling and outlets. If firestopping was provided by a separate contractor (per Division 27 "Common Work Results for Communications"), ensure all firestopping systems are installed and labeled.
4. The installation, labeling, and testing of the Telecommunications Grounding and Bonding System.
5. Update jobsite Work Prints with all individual port / cable IDs, which shall correspond to the cable IDs in the Test Results.
 - a. These shall then be scanned to PDF (minimum resolution of 150 dpi) to be included in the Preliminary Project Completion documentation outlined in the Part 1 Submittal requirements earlier in this section.

B. Request in writing a review for Substantial Completion. Refer to Part 1 Submittal requirements earlier in this section for required notice and Preliminary Project Completion documentation that shall be included with this request.

C. State in the written request that the Contractor has complied with the requirements for Substantial Completion for the (Telecommunications) Structured Cabling System.

D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.

E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.

F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.

3.5 SPECIAL TOOLS

A. Delivery to Owner's representative 2 complete sets (UON) of all special tools and small equipment items needed for proper operation, adjustment and maintenance of cabling and equipment installed under this work. All tools to be new and still in manufacturers packaging. The cost for these tools is to be included within the bid price for this work.

- B. The terms “special tools” and “small equipment items” is meant to include such items as punch down tools, connector assembly tools, etc. with each individual item having a retail replacement cost not exceeding five hundred dollars (\$500.00). It is NOT meant to include common hand tools such as standard screwdrivers, pliers, wrenches, etc.

END OF SECTION

SECTION 27 11 00 - TELECOMMUNICATIONS EQUIPMENT ROOM FITTINGS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Section includes fittings that are within the physical walls of the communications equipment rooms to support the Telecommunications System. Fittings include but are not limited to:
 - 1. Grounding & Bonding
 - 2. Plywood Backboard
 - 3. Ladder Rack
- B. Section does not specify fittings such as cables, cable terminations, termination blocks, and patch panels for structured cable system (SCS). These components are provided by the Owner.
- C. Section does not specify fittings for audio video system(s). These components are specified in the Division 27 Section "Audio Video Systems".

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Follow all applicable codes, references, and standards listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System".
- B. Division 26 Section "Grounding and Bonding for Electrical Systems".

1.3 DEFINITIONS

- A. Communications Equipment Room – This CSI MasterFormat™ term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).
- B. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article 770 "Optical Fiber Cables and Raceways" and Article 800 "Communications Circuits" of NFPA 70 "National Electrical Code".
- C. Communications Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19" or 23" inches.
- D. Communications Rack – A floor or wall mount unit without side panels. Racks can be 2-post or 4-post. Communications equipment is supported by mounting rails separated at 19" or 23" inches.
- E. Communications Frame - A floor or wall mount unit without side panels. Communications termination blocks are the only communications devices mounted to the unit.
- F. Communications Enclosure – A floor or wall mount unit enclosed with side panels. Communications equipment is not supported by mounting rails separated by 19" or 23" inches. This definition shall encompass BICSI Telecommunications Distribution Methods Manual term for Telecommunications Enclosure (TE).
- G. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- H. Grounding Equilizer (GE) – The conductor that interconnects elements of the telecommunications grounding infrastructure.

- I. Telecommunications Bonding Backbone (TBB) – A conductor that interconnects the telecommunications main grounding busbar (TMGB) to the telecommunications grounding busbar.
- J. Telecommunications Main Grounding Busbar (TMGB) – A busbar placed in a convenient and accessible location and bonded by means of the bonding conductor for telecommunications, to the building service equipment (power) ground.

1.4 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Sections “General Communications Requirements” and “Structured Cabling System”.

QUALITY ASSURANCE

- B. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.
- C. Communications equipment room fittings shall be listed by a NRTL.

PART 2 - PARTS AND MATERIALS

2.1 ANSI/TIA-607-COMPLIANT TELECOMMUNICATIONS GROUNDING AND BONDING SYSTEM

- A. General
 - 1. Provide a complete functioning telecommunications grounding and bonding system, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary for the system to be in compliance with the ANSI/TIA-607 Standard “Generic Telecommunications Bonding and Grounding for Customer Premises”. Major components include:
 - a. TMGB in the Main Telecommunications Room and TGBs in all remaining Telecommunication Rooms and Spaces.
 - b. BCT connecting the TMGB to the main Electrical Service Ground.
 - c. TBB connecting the TMGB to all TGBs.
 - d. All equipment and pathway grounding and bonding connections as identified on the drawings, recommended by manufacturers of equipment installed under this section, and stipulated in the referenced standard.
 - 2. Component Manufacturers:
 - a. Chatsworth
 - b. Cooper B-Line
 - c. Erico
 - d. Harger
 - e. Hoffman
 - f. Panduit
 - 3. Conductor Manufacturers
 - a. Shall be from the list of Component Manufacturers; or

- b. Shall be from the list of Manufacturers in Division 26 Section "Low-Voltage Electrical Power Conductors and Cables".
- B. Telecommunications Main Ground Bar (TMGB)
 - 1. Specifications
 - a. All busbars shall have a clear cover installed to protect connections
 - b. Cover shall be:
 - 1) Plexiglass or plastic
 - 2) Cover shall be printed with 3/8" lettering "TMGB" (or "TGB") using appropriate labels.
 - 3) Of the same manufacturer as the ground bar
 - c. A predrilled Electrolytically plated copper busbar provided with holes for use with standard sized lugs; hole patterns shall be in TIA/BICSI style.
 - d. Have minimum dimensions of 1/4 inch thick x 4 inches wide x 20 inches long.
 - e. Provide enough length for all connections with 25% growth.
 - f. Provided with insulators to electrically isolate busbar from mounting surface.
 - g. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
 - 2. Manufacturer shall be
 - a. Harger TGBIP14420TMGB
 - b. Chatsworth 40153-020
 - c. Or equivalent from Component Manufacturer
- C. Telecommunications Ground Bar (TGB)
 - 1. Specifications
 - a. Be a predrilled Electrolytically plated copper busbar provided with holes for use with standard sized lugs
 - b. Have minimum dimensions of 1/4 inch thick x 2 inches wide x 12 inches long
 - c. Provided with insulators to electrically isolate busbar from mounting surface
 - d. Provided with a minimum of 2-inches clearance from wall or other mounting surfaces for access.
 - 2. Manufacturer shall be
 - a. Harger TGBI14212TGB
 - b. Chatsworth # 13622-012
 - c. Or equivalent from Component Manufacturer
- D. Ground Wire for TBB
 - 1. Specifications
 - a. All grounding and bonding connectors shall be listed by a Nationally Recognized Testing Laboratory (NRTL) as required by the NEC.

- b. All grounding and bonding conductors shall be copper and may be insulated UON. When conductors are insulated, they shall be listed for the application (i.e. Plenum, riser, outside plant, etc.)
 - c. Ground Wire for TBB: Non-Insulated grounding wire with a minimum conductor size as indicated on drawings. Wire shall be UL listed.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name.
 - 2) Copper Conductor Gauge.
 - 3) UL listing.
 - e. Cable jacket shall be green with black lettering.
 - f. Sizing shall be per Part 3 of this section. All sections of TBB longer than 300 feet shall be 750 kcmil.
- E. Bonding Conductor (To main Electrical service ground) for Telecommunications (BCT): Insulated grounding wire [with a minimum copper conductor size equal to that of the TBB], with PVC insulation. Shall be UL listed.
- 1. Specifications
 - a. Shall be copper.
 - b. Insulated grounding wire with PVC insulation
 - c. A minimum copper conductor size equal to that of the largest TBB or other bonding conductor connected to the TMGB, UON.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name
 - 2) Copper Conductor Gauge
 - 3) NRTL listing information
 - e. Cable jacket shall be green with black lettering
 - f. A minimum conductor size as indicated on drawings
- F. Ground Wire (for connections within each Telecommunications Room and to Cable Tray)
- 1. Specifications
 - a. Shall be copper.
 - b. When not routed through plenum or other air-handling space: Insulated grounding wire with a minimum copper conductor size of number 6 AWG, with PVC insulation. Shall be UL listed.
 - c. When routed through plenum or other air-handling space: Non-Insulated grounding wire with a minimum copper conductor size of number 6 AWG. Shall be UL listed.
 - d. Cable jacket marking: Shall be legible and shall contain the following information:
 - 1) Manufacturer's name.
 - 2) Copper Conductor Gauge.
 - 3) UL listing.
 - e. Cable jacket shall be green with black lettering.

G. Connectors / Connections

1. Specifications

- a. All connectors and connections shall utilize products that are Listed by a NRTL such as UL.
- b. All connectors shall have twin clamping elements for cable; two holes for attachment to grounding bar, etc.

2. Compression Lugs

a. Specifications

- 1) Shall be manufactured from electro-plated tinned copper for use with copper conductors.
- 2) Shall include inspection port.
- 3) On center dimension between holes (O.C. Dim. B/T Holes) shall be 0.625" ("A" Pattern) or 1" ("C" Pattern)

b. Manufacturer shall be:

- 1) Harger GECLB Series
- 2) Or Approved Equivalent

3. Conductor to conductor connection

a. Specifications

- 1) All connections between conductor and the joining or mating of cables to connectors shall be done by exothermic weld or irreversible compression connector.

b. Manufacturer – Exothermic Weld

- 1) Erico CADWELD
- 2) Harger Ultraweld
- 3) Or Approved Equivalent

c. Manufacturer – Irreversible Compression connector

- 1) Burndy HYGROUND
- 2) Or Approved Equivalent

4. Connector for conduit to cable

a. Specifications

- 1) All continuous conduits (except entrance conduits) which extend into the Telecommunications Room shall be fitted with a pipe clamp or conduit bonding clamp connected to the TMGB/TGB.

b. Manufacturer shall be:

- 1) For 1" diameter and larger conduits – Harger series CPC electro tin-plated pipe clamp
- 2) For less than 1" diameter conduits – Harger TBGC4SCS electro tin-plated conduit bonding clamps
- 3) Or Approved Equivalent

5. Connector for conductor to cable tray
 - a. Specifications
 - 1) For metallic cable trays that extend to the Telecommunications Room.
 - b. Manufacturer shall be:
 - 1) Harger electro tin-plated cable tray bonding clamps – TBCTC
 - 2) Or Approved Equivalent

H. Insulated Grounding Bushings

1. Specifications
 - a. All communications entrance conduits that extend into the Telecommunications Room shall be fitted with an Insulated Grounding Bushing.
 - b. Shall be UL Listed for copper conductors.
 - c. Shall include lug for easy connection of conductor to TMGB/TGB.
2. Manufacturer shall be:
 - a. O-Z/Gedney IBC-L
 - b. Or Approved Equivalent

2.2 PLYWOOD BACKBOARD

- A. 4' x 8' sheets of 3/4" thick (minimum) fire-retardant plywood shall be painted white with fire-retardant paint.

2.3 TELECOMMUNICATIONS LADDER RACK

- A. Ladder Rack (Cable Runway)
 1. Color: black
 2. Rung Spacing: 9"
 3. Width: 12"
 4. UL Listed as an equipment grounding conductor
 5. Provide ladder rack components such as e-bend, outside radius bend, and corner bracket for a complete system meeting drawings and manufacturer instructions.
 6. Provide ladder rack supports such as wall angle support kit, triangular support bracket, center support kit, threaded rod, I-beam clamp, threaded ceiling kit, cabinet elevation kit, foot kit, rack mounting plate, rack elevation kit for a complete system meeting drawings and manufacturer instructions.
 7. Provide ladder rack accessories such as cross member radius drop, end caps, and dividers for a complete system meeting drawings and manufacturer instructions.
 8. The following manufacturers are Conditionally Approved:
 - a. B-Line
 - b. Chatsworth Products
 - c. nVent/Hoffman
 - d. Middle Atlantic
 - e. Or connectivity manufacturer carrying structured cabling warranty

- f. Or Approved Substitution (submitted and accepted in the “pre-bid” phase)

2.4 TELECOMMUNICATIONS RACK AND CONNECTIVITY

- A. Owner will furnish and install all telecommunications racks and rack mounted equipment.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer’s instructions.

3.2 GROUNDING AND BONDING INSTALLATION

- A. General:

1. Install all other ground conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination except as shown on the Drawings and/or specified herein. Where splices are necessary, the number of splices should be a minimum and they shall be accessible and located in Telecommunications rooms (spaces). Joined segments of a TBB shall be connected using exothermic welding, irreversible compression-type connectors, or equivalent. All joints shall be adequately supported and protected from damage. “Daisy chaining” of Telecommunications ground bus bars back to the TMGB will not be accepted unless specifically indicated on the Telecommunications drawings or specified herein
2. Unless otherwise noted, all ground wires shall be routed through the Telecommunications cable management pathways so as to achieve a “coupled bonding conductor” effect
3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
4. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet (1 meter) in length, the conductors shall be bonded to each end of the conduit using a grounding bushing or a No. 6 AWG conductor, minimum.
5. The Bonding Conductor for Telecommunications (BCT), each Telecommunications bonding backbone (TBB) conductor, and each grounding equalizer (GE), shall be green or marked with a distinctive green color
 - a. Marking with a distinctive green color Shall be done at a minimum of every 1 foot (0.3 meter) by appropriate methods
 - b. Indicate proposed and actual routing of these conductors on overall floor plans in both the pre-construction Shop Drawings and Record Drawings, respectively.
6. Follow additional installation requirements from NECA/BICSI 607-2011 “Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings”.

- B. Required Grounding Connections:

1. Provide and install one individual ground wire from each equipment rack/cabinet/frame (installed under this work) to the TGB in the room. Each conductor is to be “home run”; do not “daisy chain” the connections, except as may be indicated on the drawings.
2. Provide and install one individual ground wire from the raised floor system (if applicable) to the TMGB. Conductor is to be “home run”; do not “daisy chain” the connections, except as may be indicated on the drawings.

3. Provide and install one individual ground wire from the overhead and vertical ladder racking (installed under this work) to the TGB in the room. All sections of ladder rack shall be securely connected together; otherwise, provide ground wire from each section of ladder rack.
4. Where structural steel is available for connection install one individual ground wire to the nearest structural steel for connection.
5. Provide and install all grounding connections as required by Telecommunications set of drawings.

C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.

D. Cable Identification:

1. Label both ends of each ground conductor within 6 inches (152.4 mm) of a connector terminal or splice. Label the grounding conductors as shown on the Drawings or specified herein. All labels shall include the following in addition to specific labeling requirements for each conductor.

**IF THIS CONNECTOR OR CABLE IS
LOOSE OR MUST BE REMOVED,
PLEASE CALL THE BUILDING
TELECOMMUNICATIONS
MANAGER**

E. Quantities of Ground Wires (Conductors)

1. Location and placement of grounding and bonding wires and components shall be as shown on the Drawings or defined herein.
2. Quantities of ground wires, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a grounding and bonding system that meets the intent of these Specifications and the relevant codes.

F. Sizing of Ground Wires (Conductors)

Subject to the applicable electrical code and the reference standards and guidelines, the BCT, TBB, GE conductors (if applicable), and conductors to serving electrical panels and building steel shall be sized per the following table (Table 1 from ANSI/TIA-607):

Linear Length (ft)	AWG Size
less than 13	6
14-20	4
21-26	3

27-33	2
34-41	1
42-52	1/0
53-66	2/0
67-84	3/0
85-105	4/0
106-125	250 kcmil
126-150	300 kcmil
151-175	350 kcmil
176-250	500 kcmil
251-300	600 kcmil
Greater than 301	750 kcmil

G. Testing

1. As a minimum test, as described below, all metallic wires and cables installed under these Specifications.
2. Test the grounding conductor and the terminal connectors for total resistance between the equipment item being grounded and the main telecommunications grounding point in the room. This resistance Shall be less than 0.10 Ohm.
3. Recommended test equipment (obtain approval of Owner/ Design Consultant prior to using substitute test equipment):
 - a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.

H. Acceptance

1. Upon receipt of the Contractor's documentation of cable testing, the Owner/ Design Consultant will review/observe the installation and randomly request tests of the cables/wires installed. Once the testing has been completed and the Owner/ Design Consultant is satisfied that all work is in accordance with the Contract Documents, the Owner will notify the Contractor in writing.

I. Record Drawings

1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

3.3 CABLE LADDER RACKING

- A. Installation and configuration shall conform to the requirements of the ANSI/TIA Standards 568C & 569, NFPA 70 (National Electrical Code), NEMA VE2, and applicable local codes.
- B. Install cable ladder racking level and plumb according to manufacturer's written instructions, Coordination Drawings, original design, and referenced standards.
- C. Install cable ladder racking where indicated in the drawings and as required by these Specifications
- D. Corner clamp brackets shall be used to join sections of cable ladder rack that are perpendicular to each other.
- E. Cable ladder rack stringers shall be attached to plywood backboards with angle brackets and "J" bolts.
- F. End supports and stringer junction brackets shall be used to attach vertical cable ladder segments to the floor.

- G. Stringer junction brackets shall be used to attach end to end horizontal cable ladder rack segments.
- H. Open ended stringer segments shall be closed with corner clamps and end bars.
- I. Mounting plates and "J" bolts shall be used to attach the cable ladder racking to the relay racks or equipment cabinets.
- J. Runway should be supported every 5 feet on center with 1/2 inch diameter threaded rod with slotted hanger clamps, or applicable support brackets or attachments. All wall brackets shall be attached to plywood backboard.
- K. A support shall also be placed within 24 in. on each side of any connection to a fitting.

3.4 QUANTITIES OF RACK/CABINET AND DISTRIBUTION FRAME EQUIPMENT AND COMPONENTS

- A. Location and placement of communications equipment room fittings shall be as shown on the Drawings or defined in these specifications and schedules.
- B. Quantities and sizes of communications equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.

END OF SECTION

SECTION 27 15 00 - COMMUNICATIONS HORIZONTAL CABLING

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Install Owner-furnished horizontal (work area) telecommunications cabling system as shown on the TN sheets and in accordance with these Contract Documents. Owner shall terminate and test cables.
- B. This section specifies installation requirements the following:
 - 1. Horizontal Copper Cable

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions, requirements, and recommendations in Division 27 Section "General Communications Requirements"
- B. Refer to Division 27 Section "Common Work Results for Communications" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Refer to Division 27 Section "Structured Cabling System" for Advanced System Warranty information and other requirements.
- D. Refer to Division 27 Section "Telecommunications Equipment Room Fittings" for telecommunications equipment racks, patch panels, wall-blocks, surge suppressors, and other equipment room requirements.
- E. Category 6A and fiber cabling and connectivity for Audio Video Systems (as required by the TA drawings) are specified in Division 27 Section "Telecommunications Requirements for Audio Video Systems".

1.3 CODES, STANDARDS, AND GUIDELINES

- A. In addition to all applicable codes, standards, and guidelines listed in Division 27 Sections "General Communications Requirements" and "Structured Cabling System", follow the most recent editions of the following:
 - 1. NFPA 70 (NEC) – "National Electrical Code" (NEC)
 - 2. IEEE NESC - "National Electrical Safety Code"
 - 3. ANSI/BICSI 005 – "Electronic Safety and Security System Design and Implementation Best Practices"
 - 4. ANSI/NECA/BICSI-607 – "Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings"
 - 5. ANSI/TIA-568 – "Commercial Building Telecommunications Cabling Standard Set"
 - 6. ANSI/TIA-569 – "Commercial Building Standard for Telecommunications Pathways and Spaces"
 - 7. ANSI/TIA-607 – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
 - 8. ANSI/TIA-606 – "Administration Standard for Commercial Telecommunications Infrastructure"
 - 9. BICSI – "Telecommunications Distribution Methods Manual"

10. BICSI – “Information Technology Systems Installation Methods Manual”
11. IEEE 142 – “Recommended Practice for Grounding of Industrial and Commercial Power Systems” (Green Book)
12. IEEE 1100 – “Recommended Practice for Powering and Grounding Electronic Equipment” (Emerald Book)
1. TIA-526 – “Standard Test Procedures for Fiber Optic Systems”
13. TIA-TSB-140 – “Additional Guidelines for Field-Testing Length, Loss and Polarity of Optical Fiber Cabling Systems”

1.4 DEFINITIONS

- A. Advanced System Warranty – refer to Division 27 Section “Structured Cabling System”.
- B. Communications Equipment Room - This CSI MasterFormat term shall apply to spaces specifically designed to maintain communications equipment. This definition shall encompass ANSI/TIA-569 terms for Entrance Room, Common Equipment Room (CER), and Common Telecommunications Room (CTR). This definition also shall encompass BICSI Telecommunications Distribution Methods Manual terms for Telecommunications Room (TR), Telecommunications Enclosure (TE), Equipment Room (ER), and Entrance Facility (EF).
- C. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.
- D. Horizontal Cabling
 1. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - a. Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
 - b. Bridged taps and splices shall not be installed in the horizontal cabling
 - c. Splitters shall not be installed as part of the optical fiber cabling
 2. A work area is approximately 100 sqft (9.3 sqm), and includes the components that extend from the telecommunications outlet/connectors to the station equipment.
 3. The maximum allowable horizontal cable length is 295 feet (90 meter). This maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) to the workstation equipment. The maximum allowable length does not include an allowance for the length of 16 feet (4.88 meter) in the horizontal cross-connect.
- E. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed copper Category and fiber optic cable terminated onto a patch panel or outlet.

1.5 QUALITY ASSURANCE

- A. As a minimum, the person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.

1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 27 Section “General Communications Requirements”

- B. The following submittals are due at the “pre-bid” phase submission
 - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Engineer. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- C. The following submittals are due at the “pre-construction” phase submission
 - 1. Shop Drawings
 - a. Submit for review scaled layout drawings showing the routing of all cabling, and the locations where terminal blocks, patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), furniture feed points, and fiber optic termination panels are to be installed.
 - b. Shall show the number of horizontal cables served by each room
 - c. Each individual outlet on the drawings shall have proposed outlet identification indicated.
 - d. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same shop drawing.
 - 2. Testing
 - a. Qualifications: Identity and qualifications of the personnel who will perform the testing as required above in the Quality Assurance paragraph.
 - b. Submit all physical characteristics needed for appropriate testing setup and verification. I.e. Nominal velocity of propagation (NVP) for each and every cable type. This parameter shall be identified and submitted for review. Such submittals for all parameters shall be from printed manufacturers’ cut-sheets or other manufacturers’ printed material.
 - c. Submit the proposed schedule for performing testing at least 2 weeks prior to the start of testing.
 - 3. Sample warranty information as indicated herein and elsewhere in this Division.
- D. The following submittals are due at the “Project Completion” phase submission
 - 1. As-built Drawings
 - a. Submit scaled layout drawings showing the routing of all cabling, locations of Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), and furniture feed points, have been installed.
 - b. Shall show the number of horizontal cables served by each.
 - c. Unless otherwise required by these specifications, it is permissible to show different cabling systems (voice, data, CATV, A/V) on the same As-built drawing.
 - 2. After approval by the Owner, submit the test results in computer readable copy in CD, DVD or mutually acceptable format by the Contractor and Owner.
 - 3. Advanced Structured Cabling System Warranty Certificate

1.7 WARRANTIES

- A. Provide manufacturer warranties as required in Division 27 Section “Structured Cabling System”.

PART 2 - PRODUCTS AND MATERIALS

2.1 HORIZONTAL (WORK AREA) COPPER CABLE

- A. All horizontal copper cable will be furnished by the Owner and installed by the Contractor.

2.2 FACEPLATES FOR COPPER CONNECTIVITY

- A. All faceplates will be furnished and installed by the Owner.

2.3 COPPER CONNECTIVITY

- A. All modular jacks and faceplate inserts will be furnished and installed by Owner.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.

3.2 CABLE INSTALLATION

- A. General
 1. Place all horizontal cabling in accordance with these specifications, on the Drawings, and as indicated on any cable schedules
 2. Install each cable as an uninterrupted conductor section between the designated termination points, unless otherwise directed by the cable installation specifications.
 - a. There shall be no splices or mechanical couplers installed between the cable points of origin and termination except as shown on the Drawings and/or specified herein.
 - b. There shall be no Bridged taps (multiple appearances of the same cable pairs at several distribution points) installed.
 - 1) No horizontal cables shall exceed the allowed maximum distance of 295 feet (90 meters) by ANSI/TIA-568.
 3. Unless otherwise noted, all cables shall be routed through the building cable tray/conduit/surface-mounted raceway system. Refer to the electrical drawings for the layout of the conduits. Refer to the Telecommunications drawings for layout of cable tray.
 - a. All horizontal cables shall be plenum (CMP, MPP, OFNP, or OFCP) rated. UON
 - b. Horizontal cables installed in "wet" locations as defined by the NEC or in these construction documents (such as conduits embedded or routed below a ground floor slab) shall be suitable for installation in such environments and follow the installation requirements for outside plant cables as specified herein.
 4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
 5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb (90.72 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.

6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
 7. Comply with all referenced standards and guidelines.
 8. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
 9. Where distance allows all horizontal cables shall be provided with slack/service loops at each end of the cable, one at the work area outlet and one at the Telecommunications room/enclosure. Each slack/service loop shall be:
 - a. A minimum of 8 feet (2.44 meter) in length, UNO
 - b. Configured in a loosely formed figure eight configuration (i.e. not coiled)
 10. Prior to using any cable pulling lubricants provide the Engineer with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
- B. Outside plant cable installation: for cables placed in "wet locations" or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
1. Unlisted cables shall transition to an indoor rated cable within 50 feet (15.24 meter) of the entrance point as required the NEC.
 - a. This 50 feet (15.24 meter) allowed by code is only to allow termination as close as practicable to the entrance point. Terminate all outdoor only (unlisted) cables at the closest point of entrance and transition to an indoor rated cable to extend to additional Telecommunications rooms (spaces)
 2. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
 3. Where specifically allowed by these construction documents cable jackets rated for dual use by a NRTL, such as an indoor/outdoor rated cable may be used.
 - a. These cables may be installed in locations within the building in which the cable jacket is appropriately rated to meet all applicable building codes.
 4. Rigid metallic conduit shall be used to route outdoor (unlisted) cabling to within 50 feet (15.24 meter) of the transition point to indoor rated cabling in accordance with the NEC.
- C. Horizontal (work area) Cables:
1. From the appropriate Telecommunications room, provide each work area outlet, the types and quantities of horizontal cables as described in the applicable system specification sections. Cables will leave the Telecommunications room via cable tray, conduit/sleeve or floor duct. Each cable will be terminated except for pay phone and elevator machine room junction box locations.
 2. Install all horizontal cables in accordance with Division 27 Section "Common Work Results for Communications" and as indicated on the drawings.

3.3 CABLE & WIRE INSTALLATION

- A. General:

1. Place all station cabling in accordance with these specifications, and as indicated on the cable schedules and the Drawings.
- B. Station Cables:
1. Install station cabling as detailed in the horizontal cable placement schedules and the Drawings. The typical configuration for outlets shall be two unshielded twisted pair (UTP) cables of 4-pairs each, unless otherwise noted on the drawings or the Horizontal Cable Placement Schedules.
- C. Cables located in “wet” locations
1. Provide all required entrance protection in accordance with Division 27 “Communications Equipment Room Fittings”.
 2. Follow the requirements for installing outside plant rated cable as specified in Division 27 Section “Communications Horizontal Cabling”
 3. All cables routed to floor boxes in the slab shall route to a transition box within 50 feet (15.24 meter) of where the conduit emerges from the slab. Provide connecting hardware within an appropriately rated enclosure to allow a transition from outside plant cable to indoor rated cable. Indoor rated cable shall be rated as required by building code and as specified herein. Route indoor cables as indicated for horizontal cable distribution. Transition hardware shall meet or exceed the category performance of the highest rated cable being terminated.
 - a. Cables from multiple different floor boxes may be routed to a single, appropriately sized, transition enclosure.
- D. Elevator Phone Cables:
1. Install elevator phone cables to support communications to each individual elevator cab. These cables will be run from each elevator’s respective elevator equipment room to the nearest Telecommunications room as shown on the Drawings. Leave 15 feet (4.47 m) of coiled slack in the elevator equipment room junction box for eventual termination by the elevator contractor.

3.4 CONNECTOR INSTALLATION

- A. Owner will furnish and install all cable connectors.

3.5 FLOORBOX LOCATIONS

- A. Refer to Division 27 “Common Work Results for Communications” for size, type, and specifications.
- B. For slab-on-grade floorbox locations, coordinate with the Common Work contractor to extend underground or in-slab conduit all of the way to the serving Telecommunications Room. If that is not practical, coordinate with Common Work contractor on stub-up location and overhead enclosure size/location to transition OSP (wet-rated) cable to plenum-rated cable.
1. Note underground conduit routing and overhead transition point locations on pre-construction shop drawings and Record Drawings.

3.6 FACEPLATE INSTALLATION

- A. Owner will furnish and install all faceplates.

3.7 CABLE IDENTIFICATION

- A. Owner will furnish and install all cable identification.

3.8 CABLE TERMINATIONS

- A. Owner will terminate all horizontal cables.

3.9 CABLE TESTING

- A. Owner will perform all cable testing.

3.10 ACCEPTANCE

- A. The Owner and Design Consultant reserves the right to observe the conduct of any or all portions of the installation process.
- B. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found.

END OF SECTION

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SECTION 27 41 00 - AUDIO VIDEO SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. These specifications and the associated TA series drawings describe the audio-video (AV) systems (hereafter referred to as the "Technical System") requirements to be furnished and installed as a portion of the project scope of work.
- B. System is intended for practice and crowd noise simulation
- C. Work includes all such work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Communications, Fire Alarm and Electronic Safety and Security Drawings and Specifications; and Addenda.
- D. Work under this section of the specifications includes all labor, equipment, and installation as required to provide a complete technical system in compliance with the contract documents.
- E. Employ the services of a qualified structural engineer to review all overhead mounting and suspension details of the technical system equipment. All mounting and suspension schemes indicated on the drawings are shown for concept only. Submit shop drawings stamped by a structural engineer of all details and weights for review by the project's Architect, Structural Engineer, and Design Consultant.
- F. The work in this section shall be coordinated with other work to determine installation scope for conduit, outlet boxes, junction boxes, pull boxes, terminal cabinets, 120-volt AC power circuits, and insulated ground cables required for the technical system.
 - 1. Provide related low-voltage "on/off" AC power control system wiring, low-voltage "on/off" control switches, and certain AC power/ground requirements internal to the equipment racks as specifically noted herein and/or on the drawings.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
 - 1. Division 27 Section "General Communications Requirements"
 - 2. Division 27 Section "Common Work Results for Communications"
- B. All Category and fiber optic cabling and terminations shall adhere to the Division 27 Section "Structured Cabling System".
- C. This section is a parent section to all sections numbered 274101 thru 274199. Requirements found in this section shall apply to all child sections unless otherwise noted.
 - 1. Exception: Division 27 "Television Distribution Systems" is a stand-alone section.

1.3 EXAMINATION OF SITE

- A. This project is a new facility.
- B. Prior to submitting a bid personally examine the site of the proposed work and verify the conditions which involve this work. Perfect
- C. By the act of submitting a bid, the contractor will be deemed to have made reasonable allowances for site examinations, site conditions, and included all costs in his proposal. Failure to verify these conditions will not be considered a basis for the granting of additional compensation.

1.4 MATERIAL AND WORKMANSHIP

- A. All equipment shall be new and in proper operating condition. All workmanship shall be of the finest quality by experienced installation technicians.
- B. Contact the Architect, in writing, regarding the selection of colors for all exposed equipment.
- C. In addition to a complete set of the system project drawings and specifications, maintain at the job site a complete set of manufacturer's original operation, instruction, installation, and service manuals for each equipment item, for reference.

1.5 ORDINANCE AND CODES

- A. Comply with all applicable national and local codes and ordinances and obtain all required permits.
- B. Contractor shall be responsible for any and all violations within the scope of this work.

1.6 DEFINITIONS

- A. Structured Cabling System – the physical infrastructure installed to support information technology/transport for voice and data applications, commonly referred to as a Telecommunications System. This includes, but is not limited to: Category cabling, terminations/blocks, modules, faceplates, etc., and optical fiber cabling, terminations, modules, etc
- B. Suspension System – A unique assembly of rated hardware elements and accessories required for overhead installation (and attachment to building structure) of loudspeakers and other technical system components. Elements of a suspension system may include: wire rope, shackles, eyebolts, chain, beam clamps, strut channel, etc.

1.7 QUALITY ASSURANCE

- A. Contractor General Qualifications:
 - 1. Compliance with the requirements of Division 1.
 - 2. Licensed to perform work of this type in the project jurisdiction.
 - 3. At least five (5) years of verifiable direct experience with the devices, equipment and systems of the type and scope specified herein.
 - 4. Prior successful experience of projects of similar size, scope and type as outlined in the Construction Documents.
 - 5. Active membership in the National Systems Contractors Association (NSCA).
 - 6. Active membership in The Audiovisual and Integrated Experience Association (AVIXA).
 - a. AVIXA APEX certification.
 - 7. Fully staffed and equipped maintenance and repair facility.
 - 8. Factory-authorized dealer for the major components specified.
- B. Contractor Personnel Qualifications:
 - 1. Skilled workers thoroughly trained and experienced in the necessary crafts and completely familiar with the specified requirements and the methods needed for proper performance of the work in this section. The workers shall have at least three (3) years direct experience in similar work, evidence of which shall be verified in writing with appropriate references.
 - 2. Supervisor with at least five (5) years direct experience in similar work. The supervisor shall be present for and in responsible charge of all work in the fabrication shop and on the project site during all phases of the installation and testing of the system(s). To assure continuity,

this supervisor shall be the same individual throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene. This person shall act as the Technical System Project manager and shall attend all scheduled project meetings.

- a. Minimum of one full-time staff member who has attended technical system design and installation courses taught by Syn-Aud-Con in the past 10 years.
 - b. Minimum of one AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.
 - c. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with and is factory-certified on the most recent version of the selected Digital Signal Processor (DSP) software and technology. This individual shall be responsible for the implementation of the DSP system including software. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
 - d. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with network-based AV transport and is factory-certified on the most recent version of the selected AV transport technology. The individual shall hold a current manufacturer's certification (i.e., Crestron DMC-E). This individual shall be responsible for the implementation and preliminary testing of the AV transport system. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
 - e. Minimum of one full-time staff member who has a minimum of three (3) years direct experience and is a factory certified Master Level Programmer on the most recent version of the AV control system software and technology. This individual shall be the same throughout the execution of the work unless illness or loss of personnel intervenes. A factory authorized independent programmer (i.e., Crestron Master CAIP) will also be accepted, providing the programmer meets the criteria identified in this paragraph.
- C. Provide additional information as required for review by the Owner's Representative, Architect, and Design Consultant to aid in proving acceptability.

1.8 SUBMITTALS

- A. Refer to requirements in Division 27 Section "General Communications Requirements".
- B. Include the following items specifically as it relates to AV:
 1. Submittal #1: AV System Product Data (Pre-Construction). A separate product data submittal is required for each specification section, i.e., 274100, 274116, etc.
 - a. Equipment List (1A)
 - b. Manufacturers' cut sheets (1B)
 - c. Product Substitutions (1C)
 - d. Project Implementation Schedule (1D)
 2. Submittal #2: AV System Shop Drawings (Pre-Construction)
 - a. AV Pathways, Devices, and Cabling (2A) – Follow requirements of Division 27 Section "Common Work Results for Communications". Indicate locations of all devices and equipment.
 - b. Signal Flow Shop Drawings (2B) – Any generic diagrams found within the Construction Documents shall be drawn to specific requirements. Alterations from basis of design

- found within the Construction Documents shall be reflected and identified. Include wire numbering scheme.
- c. AV Control System (2C) - AV control system panel/screen layouts suitable for the Owner's Representative to understand the operation and flow (submitted no less than five months prior to system first use).
 - d. DSP Signal Flow (2D) - DSP signal flow configuration (submitted no less than three months prior to system first use).
3. Submittal #3: AV System Fabrication Drawings (Pre-Construction)
- a. Structural Details (3A)
 - 1) No Suspended device shall be installed prior to the final approval of Structural Detail Submittals by the Consultant.
 - 2) For Suspended equipment provide detailed, dimensioned drawings of each Suspension hardware assembly. Also indicate location relative to structure, location relative to other component(s) (Technical System or otherwise), configuration of suspended components, attachment to structure, suspension method, and calculations.
 - a) Calculations shall include weights of Technical System equipment including suspension hardware, and details of all suspension hardware including: manufacturer(s), part number(s) and pertinent technical information (i.e., Working Load Limit) of each part including nuts, bolts, and other accessories. All weight bearing hardware must be traceable, load rated, and domestically manufactured. All welds must be certified.
 - 3) Prior to submission, these drawings must be approved and signed/sealed by a structural engineer licensed for the location of the project. The following guidelines are applicable:
 - a) Contractors participating in the Suspension of Technical System components shall conform to industry best practice standards as set forth in:
 - i) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14); and
 - ii) ANSI E1.6-2 -2013 (Entertainment Technology – Design, Inspection, and Maintenance of Electric Chain Hoists for the Entertainment Industry); and
 - iii) ANSI E1.6-3- 2012 (Selection and Use of Serially Manufactured Chain Hoists in the Entertainment Industry).
 - b) All Suspended loudspeakers shall conform to ANSI E1.8-2012 (Entertainment Technology—Loudspeaker Enclosures Intended for Overhead Suspension—Classification, Manufacture and Structural Testing).
 - b. Equipment Rack Shop Drawings (3B) - Equipment rack front elevation for each rack showing equipment, panel layout, and electrical circuiting.
 - c. Panel, Patch Panel, and Plate Shop Drawings (3C) - All panel, patch panel, and plate layouts indicating locations of connectors, engraving, nomenclature, panel material, and finish. Include Structured Cabling Work required by the technical system.
4. Submittal #4: AV System Test Results (Prior to Substantial Completion)

- a. Preliminary Testing Documentation Package (4A) – Provide preliminary results of system testing as described in Part 3 of this section for review prior to final acceptance. Include final results with Closeout Documentation.
5. Project Closeout
 - a. Refer to Division 27 Section “General Communications Requirements” and the Record Drawings and Operation and Maintenance Data sub-sections in Part 3 of this section for requirements.
6. Refer to child sections for additional requirements.

1.9 SUBSTITUTIONS

- A. Refer to Division 27 Section “General Communications Requirements”.

1.10 ELECTRONIC FILE SHARING

- A. Refer to Division 27 Section “General Communications Requirements” for information on obtaining electronic versions of the construction drawings.

1.11 BASE BID AND ALTERNATES

- A. In addition to the Base Bid, provide prices for designated Alternates, as defined below and as further described in the specifications and on the drawings. Alternates shall be as described herein and on the drawings. Any work not designated as an Alternate shall be provided in the Base Bid.
- B. Any and all Alternates that are not accepted (i.e., not installed) shall include provisions for future installation of these Alternates. Typical provisions include engraving and installation for all panel-mounted receptacles reflecting the complete system, all wiring installed in conduit (except where conduit remains empty) with suitable identification (noted on the working drawings for inclusion with the record drawings), patch panel wiring and labeling, and appropriate rack space (including blank panels for Alternate equipment not installed).
- C. The Owner’s Representative reserves the right to: reject all bids; reject all Alternates; accept any Alternates in any order or combination; and determine the low Bidder on the basis of the sum of the Base Bid and accepted Alternates.
- D. ADD Alternate No. 3: Provide broadcast truck compound relocation as indicated on sheets TA002 and TA703.
- E. ADD Alternate No. 4: Provide supplemental loudspeakers as indicated on sheet TA201 and TA611.
 1. Provide practice field sideline fill loudspeakers and related scope (loudspeaker cabling, amplification, mounting hardware, labor, etc.) to provide a complete solution as indicated on TA series drawings and Division 27 Specifications.

1.12 PROTECTION OF WORK

- A. Protect all work, materials and equipment from damage due to any cause. Provide for the safety and new condition of the equipment and materials until final acceptance by the Owner’s Representative. Replace all damaged or defective materials and/or equipment as directed by the Architect or Design Consultant.
- B. Equipment racks, cabling racks, junction boxes, termination boxes, and other exposed equipment shall be kept covered and protected from airborne contaminants. Clean all debris from the equipment room(s)/location(s) and control areas, and clean all equipment and the interior rack floor, prior to system final acceptance activities.

1.13 TEMPORARY TECHNICAL SYSTEM

- A. Provide and operate a temporary technical system of reasonably equivalent function as determined by the Design Consultant if the work in this section, as a failure of the contractor, is incomplete or found not in conformance with the contract documents. The temporary system shall remain in use until acceptance of the permanent system.

1.14 WARRANTY

- A. Warrant all work executed under this contract, including all in-shop and onsite material, parts and labor, for a period of twelve months after the date of final acceptance.
 - 1. Existing or any other Owner-furnished equipment shall not be included in this warranty.
 - 2. For equipment that has an advertised manufacturer's warranty longer than 12 months, include end date of warranty period.
- B. The warranty services are limited to normal business hours unless additional agreements are made between the Owner's Representative and the contractor.
- C. Warranty work relating to technically complex equipment and/or programming such as for codecs, digital signal processing, control systems, and video projectors shall be performed by a factory authorized technician.
- D. Damage to the system resultant from improper use or adjustment by others, negligence, acts of nature, or other causes which are beyond the contractor's control shall be excluded from the warranty.
- E. Visit the job two weeks prior to the end of the warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.
- F. Update Record Drawings and Operation and Maintenance Data to reflect work done during Warranty period and provide the updates to the Owner's Representative and Design Consultant.
- G. Refer to General Conditions for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Unless otherwise designated, provide all of one type of equipment from one manufacturer; for example, microphones of one type by one manufacturer, data switches of one type by one manufacturer, cabling of one type by one manufacturer, or loudspeakers of one type by one manufacturer.
- B. Equipment and wiring shown on the drawings represents the basis of design. Ensure similar or better performance is achieved by the use of equipment other than that shown.
- C. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.
- D. All equipment shall be new and of professional quality.
- E. Some items listed in these specifications are custom-made products. Ensure when pricing and ordering equipment that the exact part number called out is used. If there is a discrepancy, contact the Design Consultant for clarification.
- F. Each software programmable device furnished (i.e. Digital Signal Processor, control system, etc.) shall include most recent software and appropriate computer interface (wired cable or wireless). Cable, software, source (uncompiled) code and all related aspects of all software-controlled

equipment shall become the property of the Owner and will be furnished as a portion of the Operation & Maintenance (O&M) Data manuals (see Operation & Maintenance Manuals near the end of Part 3).

- G. The quantities of each item of portable or mobile equipment (and other portable or loose accessories), as well as those items associated with Alternates, are indicated in parenthesis. Such equipment is intended to be shared between rooms having technical systems, except where noted for use in one specific room.

2.2 ETHERNET SWITCHES & ACCESSORIES

- A. Ethernet switches shall be as recommended by the manufacturer(s) of the connected technical system equipment. These devices shall also be coordinated with the Owner's Representative's IT department to maintain common products (where possible). Each shall be labeled as shown on the technical system drawings and as required to match the Owner's Representative's IT labeling standard.
- B. Contractor shall be responsible for the selection of product(s) that are approved for use with all systems connected to the switch(es). Products listed in this portion of the specifications are representative at the time of design – furnish the most recent approved product.
- C. Ethernet switches shall have IPv4 and IPv6 routing, multicast routing, advanced quality of service (QoS), and security features in hardware. Disabling of power saving and other blocking features shall be available for proper signal traffic.
- D. Ethernet switches shall be provided with all licensing requirements, product activation requirements, etc. for proper operation.
- E. Ethernet switches shall be configured for proper operation of the system. Configuration shall comply with Owner's network standards.
- F. Ethernet Switch – (##)(M)(P)(G)(R)(-L3)(-AVB): Ethernet switch with SFP uplink capabilities and the following characteristics required as shown on the signal flows.
1. Key to product identification: Example(**)(M)(P)(G)(R)(-L)(-AVB):
 - a. ** = minimum quantity of ports
 - b. (M) = managed (no symbol = unmanaged)
 - c. (P) = PoE (P+ = PoE+) (no symbol = non-PoE)
 - d. (*G) = 1 GB/s or 10 GB/s-capable ports as shown (no symbol = minimum 100 MB/s-capable ports)
 - e. (R) = rack mount (no symbol = optional if not included)
 - f. (-L) = minimum layer requirements (layer 2 or layer 3 enterprise level feature set)
 - g. (-AVB) = AVB certified (no symbol = AVB capability not required)
 2. Layer 3:
 - a. Cisco 2960XR Series; or
 - b. Extreme Networks Summit Series; or
 - c. HP 5120 Series; or
 - d. Verified equal
- G. PoE Injector, 1 port Power over Ethernet injector:
1. Crestron PWE-4803RU; or

2. D-Link DWL-P200; or
3. SonicWALL PoE Injector; or
4. Approved equal.

2.3 DATA PATCH PANELS & ACCESSORIES

- A. Data Patch Panels are acceptable for use in Ethernet, audio network, AVLAN, and digital multimedia network applications as required to provide a complete technical system.
- B. All Category and Fiber Optic cabling (of the acceptable applications listed above) entering a technical system rack shall be terminated to a Data Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Data Patch Panel unless shown otherwise.
- C. Data Patch Panels shall be labeled per specification part 3 of this section.
- D. Category Cabling Patch Panels –
 1. Refer to Division 27 Section “Structured Cabling Systems” for product information and additional installation requirements.
- E. Fiber Optic Patch Panels & Enclosures –
 1. Refer to Division 27 Section “Structured Cabling Systems” for product information and additional installation requirements.
- F. Cable Management – 19” wide horizontal patch cable management system, 1 rack unit, with pass-through opening to allow patch cables access to rear of rack (one required per 24 port patch panel / switch):
 1. Chatsworth Velocity 13930-701
 2. Cooper B-Line RCM+ SB87019S1
 3. Panduit NetManager NMF1
 4. Or approved equal

2.4 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

- A. Touch screen control interfaces shall follow the guidelines outlined in the “Dashboard for Controls” documents created on behalf of AVIXA International. Reference the Design Guide, Design Reference, and Integrators Guide for this project. Documents are available for download on the AVIXA web site.
- B. Contractor shall be responsible for complete configuration of the control system features including touch screen layouts, colors, appearance, operation, and coordination with systems external to the Technical System.
- C. Participate in planning meeting(s) (web/phone) with Design Consultant and Owner’s Representative to review programming concepts and requirements before commencement of work.
- D. Panel layout and navigational flow concepts shall be developed during planning meeting(s) with Design Consultant and Owner’s Representative.
- E. Refer to submittal requirements for additional information.
- F. This specification describes the initial touch screen programming concepts and requirements. Account for four (4) distinct changes for revisions requested by the Owner’s Representative after the system is substantially complete.

- G. Touch screen and keypad overall user interfaces shall comply with the following minimum requirements:
1. A common theme shall be employed and used with consistency throughout the layouts. Theme shall be discussed with the Owner's Representative. The Owner's standard theme template shall be used if available.
 2. Where Owner logos or colors are used, Owner branding guidelines shall be followed. Trademarks shall be used appropriately. Official graphical representations (logos, word marks, logotypes, etc.) may not be altered. Owner colors shall utilize official and exact color (Pantone, CMYK, RGB, hex, etc.) as provided by the Owner, visual matching is not allowed. Content shall be obtained from an official and authorized source, e.g., the use of content from Google images is not appropriate. Owner branding is encouraged where appropriate; however, proper use and compliance remains the responsibility of the Contractor.
 3. The use of a password hierarchy shall be employed as directed by the Owner's Representative as they deem appropriate.
 4. Power ON/OFF sequence shall control all applicable devices. Sequence time shall be the required time for all controlled devices to cycle. Projector lamp warm-up and cool-down period shall be taken into account. Shutdown shall utilize two-step verification.
 5. Animated activity indicators (spinning ring, progress bar, etc.) shall be utilized to provide visual feedback while the system is processing tasks in the background. This will prohibit multiple button presses by the user and show feedback that the control system is processing the request. Relevant text shall be utilized where appropriate, e.g., "Please wait while the system shuts down."
 6. Source selection shall be available for all devices. Sources shall be laid out and grouped in a logical manner. A 'blank source' or 'image blanking' feature shall be utilized to result in no image being displayed.
 7. Button presses shall show instant visual feedback that they have been engaged and shall accurately reflect the response received from the device being controlled.
 8. Current system status shall be visible at all times and be consistent across all adjoined screens. Buttons shall show current status (engaged or disengaged) via color, illumination, outline, greyscale, etc. as relevant. Sliders and level indicators shall show current and true system status (i.e. show true level based on system feedback, not status based on last touch screen input) via color, knob location, percentage, etc. as relevant.
 9. All program source devices, such as Blu-ray players, shall have the control screens emulate the appearance and functionality of all operational controls of the handheld remote control or user interface furnished with each device. The furnished handheld remote control and control system shall be interoperable allowing either to be used simultaneously without causing any lockups, inconsistencies, or false control system visual status. The use of (properly vetted) manufacturer control system modules is recommended.
 10. Volume control of wired microphones, wireless microphones, and/or AV system program volume levels shall be discrete and shall be properly interfaced with the DSP (where applicable). The use of a master volume control is prohibited.
 11. Where applicable, show the current operation mode. For example, in the case where two rooms combine/separate, the word "Combined" or "Separated" shall be displayed on each applicable screen.

2.5 CABLE - BULK

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.

- B. Product must be procured from the original cable manufacturer.
- C. AWG wire sizes indicated herein or on the drawings are the minimum size conductors required. Larger size conductors (i.e., smaller AWG number) are permitted assuming no impact on the project will occur (such as the resulting need for larger or additional conduit, cable trays, chases, etc.) to accommodate such cable.
- D. Where cable is run exposed (such as in ceiling plenums, cable trays, chases, or below accessible floors):
 - 1. Verify which locations do and do not require plenum-rated cable.
 - 2. Furnish the appropriate cable type.
 - 3. Obtain written authorization from the Architect (or the Architect's designated Engineer) in this regard.
- E. Category cabling:
 - 1. Refer to Division 27 Section "Structured Cabling Systems" for product information and additional installation requirements.
- F. Fiber Optic cabling:
 - 1. Refer to Division 27 Section "Structured Cabling Systems" for product information and additional installation requirements.
- G. Twisted Pair – Shielded: Twisted pair, shielded 22 AWG cable; interior rated 2 conductor cable with drain wire suitable for microphone, line, or production intercom level circuits:
 - 1. Communications plenum rated cable (CMP) is suitable for use in all environments including environmental air plenums as defined per NEC Article 800.
 - a. The use of performance equivalent substituted cables of lesser type is permitted at the Contractor's discretion where allowable by NEC Article 800, local codes, and the connected equipment manufacturer's listed requirements.
 - b. Performance equivalence to the below specified products shall be determined by the cable manufacturer's listed product equivalents provided in tables and cut sheets.
 - 2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.
 - 3. 22 AWG/CMP: 22 AWG Communications Plenum rated bare copper conductor cable:
 - a. Belden 9451P or 6500FC; or
 - b. Clark Wire SPA22GSP; or
 - c. Gepco IP222AL or 61801HS; or
 - d. West Penn 25291B.
 - 4. 22 AWG/CMR: 22 AWG Communications Riser rated bare copper conductor cable:
 - a. Belden 8451 or 9451 or 5500FE; or
 - b. Clark Wire SPA22GS; or
 - c. Gepco IR222AL or 61801 or 61801EZ; or
 - d. West Penn 291 or 452.
- H. Twisted Pair – Unshielded: Twisted pair, 2-conductor interior installation loudspeaker cable:

1. Class 3 remote-control, signaling, and power-limited plenum rated cable (CL3P) is suitable for use in all environments including environmental air plenums as defined per NEC Article 725.
 - a. The use of performance equivalent substituted cables of lesser type is permitted at the Contractor's discretion where allowable by NEC Article 725, local codes, and the connected equipment manufacturer's listed requirements.
 - b. Performance equivalence to the below specified products shall be determined by the cable manufacturer's listed product equivalents provided in tables and cut-sheets.
 - c. Wire gauge shall not be reduced to gain a higher cable rating.
2. Tinned copper cables are required in locations subject to corrosion, such as natatoriums.
3. ** AWG/CL3P: As listed AWG Class 3 Plenum rated bare copper conductor cable:
 - a. Belden 1862A or 6200UE (16 AWG), 6300UE (18 AWG); or
 - b. Gepco IP122BA19 (12 AWG), IP142BA19 (14 AWG), IP162BA19 (16 AWG), IP182BA7 (18 AWG); or
 - c. West Penn 25210 (10 AWG), 25227B (12 AWG), 25226B (14 AWG), 25225B (16 AWG), 25224B (18 AWG).
4. ** AWG/CL2P: As listed AWG Class 2 Plenum rated bare copper conductor cable:
 - a. Belden 6T00UP (10 AWG), 1860A or 6000UE (12 AWG), 1861A or 6100UE (14 AWG), 1863A (18 AWG); or
 - b. Clark Wire CW1202P (12 AWG), CW1402P (14 AWG), CW1602P (16 AWG), CW1802P (18 AWG).
5. ** AWG/CL3R: As listed AWG Class 3 Riser rated bare copper conductor cable:
 - a. Belden 5000UE (12 AWG), 5100UE (14 AWG), 5200UE (16 AWG), 5300UE (18 AWG); or
 - b. Clark Wire CW1202HS (12 AWG), CW1402HS (14 AWG); or
 - c. Gepco IR122BA19 (12 AWG), IR142BA19 (14 AWG), IR162BA19 (16 AWG), IR182BA7 (18 AWG); or
 - d. West Penn 227 (12 AWG), 226 (14 AWG), 225 (16 AWG), 224 (18 AWG).
6. ** AWG/CL2R: As listed AWG Class 2 Riser rated bare copper conductor cable:
 - a. Clark Wire CW1202 (12 AWG), CW1402 (14 AWG), CW1602 (16 AWG), CW1802 (18 AWG).
7. ** AWG/CL3: As listed AWG Class 3 rated bare copper conductor cable:
 - a. Belden 1313A (10 AWG), 1311A (12 AWG), 1309A (14 AWG), 1307A (16 AWG); or
 - b. Gepco 122HBW (12 AWG), 142HBW (14 AWG).
8. ** AWG/CL2: As listed AWG Class 2 rated bare copper conductor cable:
 - a. Belden 5T00UP (10 AWG); or
 - b. West Penn HA210 (10 AWG).
- I. RG-59: Single 75-ohm coax, RG-59/U precision video cable:
 1. RG-59/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:

- a. Belden 1505A; or
 - b. Clark Wire CD7559; or
 - c. Gepco VPM2000; or
 - d. West Penn 819.
2. RG-59/P: Plenum rated cable:
 - a. Belden 1506A; or
 - b. Clark Wire CD7559P; or
 - c. Gepco VPM2000TS; or
 - d. West Penn 25819.
 3. RG-59/Flex: Non-plenum flexible cable, for use with portable cables, exposed, or other locations where cable movement can or does occur:
 - a. Belden 1505F; or
 - b. Clark Wire CD7559F; or
 - c. Gepco VHD2000M.
- J. RG-6: Single 75-ohm coax, RG-6/U precision video cable:
1. RG-6/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 1694A or Gepco VSD2001; or
 - b. Belden 1694wb (outdoor water block); or
 - c. Clark Wire CD7506; or
 - d. Clark Wire CD7506DB (direct burial, water block); or
 - e. West Penn 6350.
 2. RG-6/P: Plenum rated cable:
 - a. Belden 1695A; or
 - b. Clark Wire CD7506P; or
 - c. Gepco VSD2001TS; or
 - d. West Penn 256350.
- K. RG-11: Single 75-ohm coax, RG-11/U precision video cable:
1. RG-11/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7731A; or
 - b. Clark Wire CD7511; or
 - c. Gepco VHD1100; or
 - d. West Penn 1135.
 2. RG-11/P: Plenum rated cable:
 - a. Belden 7732A; or
 - b. Clark Wire CD7511P; or

- c. Gepco VHD1100TK.
- L. Television Distribution, coax:
 - 1. RG-59/TV-NP: Single 75-ohm coax, RG-59/U Television equipment room cable; Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 1505A; or
 - b. Clark Wire CD7559; or
 - c. Gepco VPM2000; or
 - d. West Penn 819.
 - 2. RG-59/TV-P: Single 75-ohm coax, RG-59/U Television equipment room cable; Plenum rated:
 - a. Belden 1506A; or
 - b. Clark Wire CD7559P; or
 - c. Gepco VPM2000TS; or
 - d. West Penn 25819.
 - 3. RG-6/TV-NP: Single 75-ohm coax, RG-6/U Television drop cable; Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7915A; or
 - b. Belden 5399B5; or
 - c. Clark Wire CV7506-CA; or
 - d. West Penn 841.
 - 4. RG-6/TV-P: Single 75-ohm coax, RG-6/U Television drop cable; Plenum rated:
 - a. Belden 6339Q8 (quad shield); or
 - b. Carol C3525 (quad shield); or
 - c. Clark Wire CV7506P-CA (dual shield); or
 - d. West Penn 25841 (dual shield); or
 - e. Carol C3525 (dual shield).
 - 5. RG-6/TV-DB: Single 75-ohm coax, RG-6/U Television drop cable; Suitable for direct burial:
 - a. Belden 1190A; or
 - b. West Penn 6310.
 - 6. RG-11/TV-NP: Single 75-ohm coax, RG-11/U Television distribution cable; Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 1523A; or
 - b. Carol 495027; or
 - c. Clark Wire CV7511-CA; or
 - d. West Penn 821.
 - 7. RG-11/TV-P: Single 75-ohm coax, RG-11/U Television distribution cable; Plenum rated:
 - a. Belden 1153A; or

- b. Carol 395029; or
 - c. Clark Wire CV7511P-CA; or
 - d. West Penn 25821.
8. RG-11/TV-DB: Single 75-ohm coax, RG-11/U Television distribution cable; Suitable for direct burial:
- a. Belden 1525A; or
 - b. Clark Wire CV7511DB-CA; or
 - c. West Penn 1110.
- M. RG-58: Single 50-ohm coax, RG-58/U radio frequency cable:
- 1. RG-58/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7806R; or
 - b. Clark Wire CV5058; or
 - c. West Penn 812.
 - 2. RG-58/P: Plenum rated cable:
 - a. Belden 82240 or 88240; or
 - b. Clark Wire CV5058P; or
 - c. West Penn 25812.
- N. RG-8: Single 50-ohm coax, RG-8X and RG-8/U radio frequency cable:
- 1. RG-8X/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 7808R or 9258; or
 - b. Clark Wire CV5008X; or
 - c. Gepco V5020; or
 - d. West Penn 807.
 - 2. RG-8X/P: Plenum rated cable:
 - a. West Penn 25810.
 - 3. RG-8/U/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 9913; or
 - b. Clark Wire RF50LL; or
 - c. West Penn 810.
 - 4. RG-8/U/P: Plenum rated cable:
 - a. Belden 89913; or
 - b. Clark Wire RF50LLP; or
 - c. West Penn 25812.
- O. RG-213: Single 50-ohm coax, RG-213/U radio frequency cable:

1. RG-213/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 8267; or
 - b. Clark Wire CV50213.
- P. Control cable, power and control in one jacket, one unshielded 18 WG pair, one shielded 22 AWG pair:
 1. Control cable - NP, not plenum rated:
 - a. Belden 1502R or Gepco 18/22AXL; or
 - b. Clark Wire ULK2218; or
 - c. Crestron CRESNET-NP; or
 - d. West Penn 77350.
 2. Control cable - P, plenum rated:
 - a. Belden 1502P or Gepco 18/22AXLP; or
 - b. Clark Wire ULK2218P; or
 - c. Crestron CRESNET-P; or
 - d. West Penn D25350.
- Q. RS-232: Low capacitance computer cable for EIA RS-232/422, 24 AWG, 4-conductor, shielded, minimum conductor-to-conductor capacitance: 22pF/ft, PVC jacket:
 1. RS-232/NP: Non-plenum cable installed in conduit, equipment racks, or other non-plenum spaces:
 - a. Belden 8102; or
 - b. Clark Wire SMP2404.
 2. RS-232/P: Plenum rated cable:
 - a. Belden 88102; or
 - b. Clark Wire SMP2404P.

2.6 CABLES – FACTORY TERMINATED – INSTALLED

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this subsection does not indicate a requirement for use.
- B. Factory terminated cable assemblies specified in this subsection are only permitted for use within racks or between devices external to racks. Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Not permitted for use in conduit unless specifically noted as such.
- C. Factory terminated cable assemblies shall be the minimum length needed to accomplish the connection. Portable cable assemblies are specified in Division 27 Section “Audio Video Systems Equipment” and are required to be furnished in addition to those required for system installation.
- D. All cable assemblies must be factory tested and certified.
- E. Category cabling:
 1. Refer to Division 27 Section “Structured Cabling Systems” for product information and additional installation requirements.

- F. Fiber Optic cabling:
 - 1. Refer to Division 27 Section "Structured Cabling Systems" for product information and additional installation requirements.
- G. DisplayPort, version 1.1a or higher, Acceptable lengths: 1'-25':
 - 1. Clark Wire DP Series (3', 6', 10', 15'); or
 - 2. Comprehensive DisplayPort Standard Series (3', 6', 10', 15', 25'); or
 - 3. Extron DisplayPort M-M Series (3', 6', 12', 25'); or
 - 4. Approved Equal.
- H. DVI, Dual Link DVI-D cable, Acceptable lengths: 1'-16':
 - 1. Clark Wire DVID Series (3', 6', 10', 16'); or
 - 2. Comprehensive Pro AV/IT Series (3', 6', 10', 15'); or
 - 3. Extron DVID DL Pro Series (3', 6', 12'); or
 - 4. West Penn CN-E08 Series (6', 10', 15'); or
 - 5. Approved Equal.
- I. DVI-Flex, Flexible Single Link DVI-D cable, Acceptable lengths: 1'-16':
 - 1. Comprehensive MicroFlex Low Profile Series (1.5', 3', 6', 10', 15'); or
 - 2. Extron DVID SL Ultra Series (1.5', 3', 6', 9', 12'); or
 - 3. Approved Equal.
- J. HDMI Locking Cable, version 1.4 or higher compliant, locking connectors, male HDMI to male HDMI, Acceptable lengths: 1'-25':
 - 1. Belden HD-800 Series (2', 4', 8', 25'); or
 - 2. Clark Wire HDMI-L Series (3', 6', 10', 16'); or
 - 3. Perfect Path 800 Series (2', 4', 8', 16', 25'); or
 - 4. Approved Equal.
- K. HDMI Fiber Optic Cable, version 1.4 or higher compliant, male HDMI to male HDMI, Acceptable lengths: 25'-328':
 - 1. Celerity UFO Series (35', 40', 50', 60', 80', 100', 160', 200', 300'); or
 - 2. Liberty DL-HDM-M-***M Series (8m, 10m, 15m, 23m, 30m, 50m, 60m, 100m); or
 - 3. Cables To Go RapidRun Optical Series (25', 35', 50', 65', 80', 100', 125', 150', 175', 200'); or
 - 4. Approved Equal.
- L. USB, Type B male (device = square) to Type A male (computer = flat) or Type A male to Type A male USB 2.0 compliant, Acceptable lengths: 1'-25':
 - 1. Comprehensive; or
 - 2. Extron; or
 - 3. Approved Equal.
- M. Video Cable BNC, RG-59 BNC to BNC, 75 ohm, Acceptable lengths: 1'-25':

1. Canare VAC Series (3', 5', 25'); or
2. Comprehensive Pro AV/IT Series (3', 6', 10', 25'); or
3. Hosa BNC-59-1 Series (3', 5', 25'); or
4. Whirlwind VID BNC3 Series (5', 25'); or
5. Approved Equal.

2.7 CONNECTORS

- A. The products in this section have been approved for use in the project as necessary to facilitate a complete and working system. Inclusion in this section does not indicate a requirement for use.
- B. All XLR receptacles located outdoors, in boxes that are located outdoors, in natatoriums, or in areas where moisture or other corrosive materials are present shall have gold plated contact pins.
- C. XLR Cable Connector, cable mounted connector for line-level, microphone level, and intercom circuits:
 1. Amphenol AC series; or
 2. Neutrik X-series; or
 3. Switchcraft E Series Q-G.
- D. XLR Panel Connector, panel mounted audio connector for line-level, microphone level, and intercom circuits, color shall match plate color where possible:
 1. Amphenol AC "DZ" series; or
 2. Neutrik D-Series; or
 3. Switchcraft standard AAA Series Q-G with metal handle.
- E. XLR Combo Connector, female XLR and 1/4" TRS receptacle in one chassis-mount connector:
 1. Neutrik NCJ6FI-S.
- F. 1/4" TRS Cable Connector, three-conductor (Tip Ring Sleeve) connector with a metal barrel and solder lugs:
 1. Amphenol TS3PN; or
 2. Canare F-16; or
 3. Neutrik NP3C; or
 4. Switchcraft 267.
- G. 1/4" TS Cable Connector, two-conductor (Tip Sleeve) connector with a metal barrel and solder lugs:
 1. Amphenol TM2PN; or
 2. Canare F-15 plug; or
 3. Neutrik NP2C plugs; or
 4. Switchcraft 250.
- H. 1/4" TRS Panel Connector, three-conductor (Tip Ring Sleeve) connector with the sleeve contact isolated from the panel or plate to which it is mounted:
 1. Neutrik NJ3FP6C; or
 2. Switchcraft E112BL.

- I. 1/8" TRS Cable Connector, 1/8" (3.5mm) three-conductor mini-plugs which have a metal barrel and solder lugs:
 - 1. Amphenol KS3P; or
 - 2. Canare F-12; or
 - 3. Neutrik NTP3RC; or
 - 4. Switchcraft 35HDNN plug.
- J. Locking LS Cable Connector, twist-lock cable mount male loudspeaker connector, minimum 2-two conductors. Coordinate connector with associated intended panel mount connector, including those on loudspeakers:
 - 1. Amphenol SP-2-FN (two conductor); or
 - 2. Neutrik speakON NL2FC (two conductor); or
 - 3. Amphenol SP-4-FN (four conductor); or
 - 4. Neutrik speakON NL4FC (four conductor); or
 - 5. Neutrik speakON NL8FC (eight conductor).
- K. Locking LS Panel Receptacle, twist-lock chassis mount female loudspeaker connector, minimum two conductors. Coordinate receptacle with associated intended cable connector:
 - 1. Amphenol SP-2-MD (two conductor); or
 - 2. Neutrik speakON NL2MP (two conductor); or
 - 3. Amphenol SP-4-MD (four conductor); or
 - 4. Neutrik speakON NL4MP. Male connector (four conductor); or
 - 5. Neutrik speakON NL8MPR-BAG (eight conductor)
- L. RJ45 Panel (Faceplate) Connector-6, data connector rated for shielded Category 6 cable:
 - 1. Neutrik etherCON NE8FDY-C6* with SCDX cover
*Division 27 "Structured Cabling Systems" Contractor shall terminate cable onto etherCON connector installed in custom faceplate.
- M. BNC Cable Connector, 75-ohm BNC, compression fitting for coaxial cable furnished:
 - 1. Liberty CM-RG-BNC series; or
 - 2. West Penn CN-CS-BNC and CN-FS-BNC series.
- N. BNC Panel Connector, 75-ohm BNC, pass-through, D-style mounting:
 - 1. Neutrik NBB75DFI; or
 - 2. Approved Equal.
- O. Terminator, RF or SDI terminator plug:
 - 1. Extron T-BNC series; or
 - 2. Pomona 3840 series; or
 - 3. Trompeter TNA series.
- P. Terminal Block Terminations
 - 1. Utilize as applicable and only as allowed per Part 3.

2. Acceptable mounting methods include:
 - a. For small quantities in AV Closets: Mount DIN rail within rear of AV equipment rack. Utilize as preferred method wherever feasible and provide a compatible DIN rail rack mount kit.
 - b. For large quantities in AV Closets: Mount DIN rail(s) to plywood backing on wall. Utilize wall mounting DIN rail brackets.
 - 1) Microphone level cable shall be mounted within an enclosure.
 - c. For field locations: Provide a minimum NEMA 1 rated enclosure and locate DIN rail(s) within enclosure. Ensure enclosure is properly labeled and identified on as-builts.
3. Captive Screw Terminal Block: modular terminal blocks for mounting on DIN rails:
 - a. Entrelec (TE) Screw Clamp series; or
 - b. Legrand Viking 3 series; or
 - c. Approved equal.
4. Terminal Block DIN Mounting Rails: DIN rails for mounting of terminal blocks:
 - a. Crestron DIN-EN series; or
 - b. Hoffman DIN Rail LMK series; or
 - c. Middle Atlantic FWD-DIN1H; or
 - d. Approved equal.

2.8 EQUIPMENT RACKS

- A. Furnish complete equipment racks including all top, bottom, and sides as necessary.
- B. Furnish all necessary accessories including ganging hardware, blank plates (to fill all unoccupied space), vent panels (as applicable), shelves, security covers, mounting screws, trim kits, lacing bars, cable management, leveling feet, casters, etc. to provide a complete solution which complies with "best practice" guidelines.
 1. Full-solution accessories are not detailed in this specification. They shall be provided as needed and shall be approved by the manufacturer for use with the intended rack series (i.e. Middle Atlantic casters must be used with a Middle Atlantic rack).
- C. Furnish all required components for a complete thermal management solution within each location to ensure enclosure interior temperature does not exceed manufacturer's recommended operating temperatures.
 1. Rack fans shall be quiet, such as the Middle Atlantic QFAN.
 2. Thermostatic fan control shall be utilized where available.
- D. Furnish all required components for a complete rack ground isolation solution.
 1. Racks shall be isolated from the floor by the use of isolated leveling feet (such as Middle Atlantic LF-ISO) or an isolation pad/system (such as Middle Atlantic ISO-1).
- E. Equipment racks and all associated blank panels located in equipment rooms shall be factory finished semi-gloss black. Equipment racks and associated blank panels located in control booths or other visible locations shall be factory-finished color as selected by the Architect.
- F. Furnish locking storage drawers, hinged security covers, and racks with locking doors all keyed alike. Furnish four keys total.

- G. Equipment rack specification indicates the system basis of design. Verify equipment layout, rack size, and number of equipment racks required for equipment furnished. "***" in part number denotes rack height.
- H. Floor Rack:
 - 1. Open Sides – XD, open-rack style with open sides, rear locking door, minimum 44RU height, minimum 32" extra deep. Furnish one side panel at each end of each row of equipment racks:
 - a. Lowell LGR-4432; or
 - b. Middle Atlantic Products BGR-4532; or
 - c. Middle Atlantic Products WRK-44-32; or
 - d. Chief NG1F4433.
 - 2. SA – XD, stand alone floor rack, rear locking door, minimum 44RU height, minimum 32" extra deep:
 - a. Lowell LER-4432; or
 - b. Middle Atlantic Products BGR-45SA-32; or
 - c. Middle Atlantic Products WRK-44SA-32.

2.9 EQUIPMENT RACK ACCESSORIES

- A. The following equipment rack accessories shall be provided as indicated on the rack elevations or within this section.
- B. Equipment rack accessories located in equipment rooms shall be factory finished semi-gloss black. Equipment rack accessories located in control booths or other visible locations shall be factory-finished color as selected by the Architect.
- C. Logo rack panel, single vertical rack space, labeled with contact information for the contractor and Design Consultant. Panel specified is custom and already has the information for the Design Consultant; the contractor shall coordinate their logo/information with the panel manufacturer (shop drawing required). One required to be installed at the top of each bank of equipment racks:
 - 1. Liberty AV Solutions model HEI-RHIM-TEMPLATE.
- D. Storage drawer, specification indicates the system basis of design. "***" in part number denotes (RU) height as indicated in rack elevations.
 - 1. Locking rack drawer keyed to match rack rear door, approximately 16" deep, color to match adjacent rack-mounting panels:
 - a. Atlas Sound SD**-14 with optional SD-LOCK installed; or
 - b. Middle Atlantic D**-LK; or
 - c. Chief SDR**-L.
 - 2. Rack drawer, approximately 16" deep, color to match adjacent rack-mounting panels:
 - a. Atlas Sound SD**-14; or
 - b. Middle Atlantic D**; or
 - c. Chief SDR**-.
- E. Rack Shelf:

1. 1RU, utility rack shelf, 3.5" high, approximately 10" deep, color to match adjacent rack-mounting panels:
 - a. Atlas Sound SH1-10; or
 - b. Lowell 1556-USV110; or
 - c. Middle Atlantic UTR1.
 2. 2RU, utility rack shelf, 3.5" high, approximately 16" deep, color to match adjacent rack-mounting panels:
 - a. Atlas Sound SH2-15; or
 - b. Lowell 1556-USV110; or
 - c. Middle Atlantic U2.
 3. Pull-out shelf, requires rear rack rails, approximately 1.75" high (1RU), color to match equipment rack:
 - a. Atlas Sound VTD1-16; or
 - b. Lowell 1191-SLS; or
 - c. Middle Atlantic SS.
- F. Display rack mount, VESA mount for rack mounting a display, 3RU mount, provide one per display indicated in an equipment rack:
1. Middle Atlantic RM-LCD-PNLK.
- G. Gooseneck Lamp – LED – Rack, rack-mount, 1RU, dual LED, 12" gooseneck:
1. Littlite Raklite RL-10-D-LED with included power supply; or
 2. Approved equal.

2.10 AC POWER

- A. General
1. A complete AC power connection solution for each equipment rack and cabinet is required.
 2. Provide spare NEMA 5-15R or 5-20R outlets (single duplex receptacle) for temporary equipment (beyond that required for connected equipment, rack fan, etc.). These outlets shall be fed from an un-switched "Normal" power circuit.
 - a. For racks 16 RU or less: two spare outlets (minimum)
 - b. For racks greater than 16 RU: four spare outlets (minimum)
 3. All power strips shall maintain integrity of system grounding requirements.
 4. All equipment shall be connected such that maximum rated performance can be obtained without exceeding the AC circuit load capacity.
 5. Coordinate with Electrical drawings and Division 26 specifications. Where outlets are provided under this section as a portion of power strips or power distribution units, receptacle types and colors shall match the supplied AC power circuit.
 6. Comply with all NEC requirements, including separation of loads classified as Life Safety from Normal loads via an independent Vertical / Horizontal Power Strip, PDU, and/or UPS.
- B. Uninterruptable Power Supply Requirements

1. UPS shall be provided in quantities as indicated on signal flows and/or rack elevations, and as described for components and equipment within this Section and associated Subsections.
 2. A UPS connected to a Normal power load shall be provided with enough battery capacity to bridge short duration loss of power and brownout events. The intent is to protect and prolong the life of sensitive processor based equipment, reduce power cycle time upon restoration of Normal power, and/or allow the User time to safely shut down components.
 3. A UPS connected to Emergency (NEC Article 700), Legally Required Standby (NEC Article 701), or Optional Standby (NEC Article 702) AC power circuits shall be provided with enough battery capacity to bridge the maximum operation load of the connected equipment during the time from loss of Normal power to load handover to the electrical standby power system (typically generator startup time).
 4. Each UPS with an ethernet port shall be connected to the network. The Contractor shall configure the UPS (using additional software where required) per direction from the Owner's Representative. Configuration shall include, but not be limited to:
 - a. Remote access and diagnostics
 - b. Automated reporting for non-normal events (such as battery condition or power interruption)
- C. PS/V: Vertical Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum fourteen NEMA 5-15R outlets, mount to rear of rack interior (furnish where provided electrical receptacle quantities do not meet system requirements):
1. APC AP7530 with 40170-6INCH L5-20P adaptor; or
 2. Eaton EPBZ97; or
 3. Middle Atlantic PD-2420SC-NS; or
 4. Tripp Lite PDUV20 with included L5-20P adaptor; or
 5. Approved equal.
- D. PS/H: Horizontal Power Strip, single 120V 20A circuit, NEMA 5-20P plug input, minimum eight rear-facing NEMA 5-15R outlets, single rack space (furnish where provided electrical receptacle quantities do not meet system requirements):
1. APC AP9563; or
 2. Eaton EPBZ85; or
 3. Middle Atlantic PD-920R-NS; or
 4. Tripp Lite PDU 1220; or
 5. Approved equal.
- E. PDU/V: Vertical Power Distribution Unit, capable of multiple circuits and outlets, configured for circuit quantity, voltage, and amperage provided to rack; mount to rear of rack interior (furnish in coordination with provided electrical power):
1. Juice Goose PD Series; or
 2. Middle Atlantic MPR Series; or
 3. Middle Atlantic PDW Series; or
 4. Approved equal.
- F. UPS:

1. 1RU: Uninterruptable Power Supply, single rack space chassis, line interactive, surge suppression, 120V 20A circuit, minimum 750VA load, plug input, minimum four rear-facing NEMA 5-15R outlets:
 - a. APC Smart-UPS SUA750RM1U; or
 - b. Eaton 5P750R; or
 - c. Middle Atlantic UPS-S1000R; or
 - d. Tripp Lite SmartPro SMART750RM1U; or
 - e. Approved equal.
2. 2RU: Uninterruptable Power Supply, two rack space chassis, line interactive, surge suppression, 120V 20A circuit, minimum 1950VA load, plug input, minimum eight rear-facing NEMA 5-15R outlets:
 - a. APC Smart-UPS SMT2200RMUS; or
 - b. Eaton 5P2200RT; or
 - c. Middle Atlantic UPS-2200R-8IP; or
 - d. Tripp Lite SmartPro SM2200RMXL2UP; or
 - e. Approved equal.
3. 2RU/30: Uninterruptable Power Supply, two rack space chassis, line interactive, surge suppression, 120V 30A circuit, minimum 2880VA load, plug input, minimum four rear-facing NEMA 5-15R and two rear-facing NEMA 5-20R outlets:
 - a. APC Smart-UPS SMT3000RMUS; or
 - b. Eaton 5P3000RT; or
 - c. Middle Atlantic UPS-OL3000R; or
 - d. Tripp Lite SmartPro SMART3000RMXL2U; or
 - e. Approved equal.
4. 3RU: Uninterruptable Power Supply, three rack space chassis, line interactive, surge suppression, 120/208V 3PH 5W 30A circuit, minimum 6000VA load, locking plug input, minimum four rear-facing NEMA 5-20R outlets:
 - a. APC Smart-UPS RT 6000 VA RM 208V to 208/120V; or
 - b. Approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION, GENERAL

- A. Install in accordance with manufacturer's instructions.

3.2 PREPARATION

- A. Coordinate locations and sizes of junction boxes, outlets, and conduit with the work of other trades. Field verify compliance with the construction documents.
- B. Carefully inspect areas where equipment will be installed. Notify the Architect of any conditions that would adversely affect the installation and subsequent operation of the system.

1. Repeat inspection on a regular basis to ensure ongoing work by other trades does not pose a conflict to Contractor's pending work.

3.3 INSTALLATION

A. General

1. Contractor shall demonstrate a reasonable standard of care. Installation shall be rendered in a workmanlike manner observing direction set forth herein as well as industry standard best practices.
2. In addition to any spare cabling shown on drawings, utilize industry best practice to pull additional spare cabling in conduit where logical. Neatly bundle a usable length of cable at each end of each spare circuit. All spare circuits shall be labeled and noted on the field drawings for inclusion into the record drawings.
3. Install any floor-mounted receptacles so that release buttons (for both receptacles and cable connectors) are easily accessible when cable connectors are installed.
4. Blank panels and/or vent panels shall be installed in unused rack spaces. Ensure that air flow within the rack is maintained (i.e. cool air can enter the rack and hot air can exit the rack).
5. Equipment racks and other exposed equipment shall be kept covered and protected from airborne contaminants. Clean all equipment racks and the interior rack floor, prior to system final acceptance activities.
6. For racks installed in credenzas, fasten carpet tiles or low friction sliders to the bottom of the rack to protect the finish of the furniture.
7. Where the design location requires products, materials, or equipment to be visible to the public, manufacturers logos shall be removed if possible. Unless otherwise directed, neatly remove or logos.
8. AC power switches located on the front panel of equipment mounted in racks shall be covered by a security cover or utilize front panel lockout features. Exclusions from this list are items requiring user interface such as tuners and wireless microphone receivers.
9. Furnish all equipment with factory finish where possible using the standard available factory color(s) as selected by the Architect. Notify the Architect regarding color options of relevant equipment prior to ordering equipment from each manufacturer.

B. Suspended Systems

1. General

- a. Contractor shall provide Suspension system, including connection to structure, for all suspended components including but not limited to: loudspeakers, video projectors, flat panel displays, televisions, projection screens, etc.
- b. Suspension system design shall be created by the Contractor and include fully dimensioned detail documentation stamped by a structural engineer licensed in the location of the project per submittal requirements in Part 1 of this document.
- c. Contractor shall include a safety cable or other backup support mechanism.
- d. Suspension systems and installation shall conform to industry best practice standards as set forth in:
 - 1) "Basic Principles for Suspending Loudspeaker Systems" (JBL Professional Technical Note Volume 1, Number 14)

- e. Coordinate with General Contractor any supplemental building structure necessary to facilitate the approved suspension design.
 - f. Field verify conditions for compliance with the approved suspension plan prior to installation, placement of equipment orders, or material fabrication. Coordinate with other trades as necessary.
2. Loudspeakers
- a. Install loudspeakers so there are no obstructions to loudspeakers' coverage pattern.
 - b. Loudspeakers shall be installed such that they do not produce or cause mechanical rattles in the surrounding structure. There shall be no audible vibration or noise caused by improper mechanical installation or defective components.
 - c. Paint loudspeaker and/or grille assembly (at discretion of Architect or Design Consultant) color as selected by the Architect. Use primer per manufacturer's recommendations. Do not paint loudspeaker cones or high frequency diaphragms. Materials and labor provided by Contractor.
 - d. Provide access to loudspeakers during installation, testing, and final acceptance activities to allow for modifications to location or installation. Access includes all necessary resources required to obtain direct physical contact to loudspeakers (front and rear), including: scaffolding, motorized lift, etc.
 - e. Provide ability to reorient loudspeakers in all axes (yaw, pitch, and/or roll) if so requested by Design Consultant during system final acceptance activities.
 - 1) Do not perform final suspension connections prior to final acceptance by the Design Consultant including: permanent cable swage, elimination of wire rope service loop, etc.
- C. Video
- 1. Coordinate structural backing required for wall mounted flat panel displays/televisions prior to the installation of drywall or other wall materials.
- D. Grounding
- 1. Comply with NEC and BICSI grounding requirements.
 - 2. Each equipment rack within a row of racks and each row of racks within a room shall be electrically bonded to each other. Bonding shall be via copper ground bus. Any bolts shall fasten to unpainted sheet metal.
- E. Equipment Power Control
- 1. Low-voltage "ON/OFF" control of system equipment shall be provided via the control system.
 - 2. Operation of the following components is required, at a minimum:
 - a. Power amplifiers as indicated in Part 2 requirements
 - b. UPS connected devices where components do not require power under system shutdown
 - c. Components equipped with power state control
 - 3. Make all low-voltage connections as required to provide a complete and working control system.
 - 4. Refer to drawings for additional low-voltage sequencing system requirements.
 - 5. Refer to electrical drawings for AC power information.

6. Coordinate with Electrical Contractor as necessary to verify proper circuit assignment and sequencing order.

3.4 RACK BUILDING, CABLE MANAGEMENT AND TERMINATION

- A. Employ techniques to fulfill AVIXA F502.01:2019 "Rack Building for Audiovisual Systems" as a minimum standard with the additional requirements as described in this paragraph.
 1. Reference below for additional requirements and stipulations related to zip tie utilization.
- B. General
 1. Do not violate the minimum cable bend radius as specified by the cable manufacturer.
 2. Dress cables so terminations are free from stress due to gravity acting on the cabling. Use cable supports as required depending on the size and stiffness of the cable.
 3. Terminate cables with sufficient service loop to allow at least two re-terminations without having to open a cable bundle or pathway.
 4. All circuits, including various audio signal levels, shall be separated according to function. Where audio and video circuits are installed in conduit or other raceway, separate conduits are required for the various circuit functions.
 5. Where circuits are exposed in the equipment racks or large junction or pull boxes, circuits shall be bundled according to function. Refer to "Conduit/Circuit Group Divisions" and "Conduit Routing and Separation" schedules for additional information.
 6. All solder connections shall be made with soldering iron and rosin core solder. All solder connections shall be checked for "cold" solder joints.
 7. If equipment is removed or replaced for service, ensure the proper cable termination points are apparent when the equipment is re-installed.
 8. Use Velcro tie wraps (hook and loop) for all category, coaxial, or fiber cables and additionally as practical for other types of cables. Do not use zip ties on any category, coaxial, or fiber cables and limit use where possible otherwise.
 9. Do not tighten cable wraps so the cable is deformed. Zip ties should never be used in locations prone to damage due to cable sagging.
- C. Equipment Racks
 1. Utilize Velcro cable wraps (hook and loop) for dressing cables within the rack(s). Cable wraps shall be hand tightened and spaced at various inconsistent distance intervals. The use of zip ties is not allowed inside equipment racks.
 2. Install rack-mounted equipment manufactured without IEC removable power cords so the power cords are dressed using removable fasteners such as Velcro and there are no obstructions to the item being pulled out from the front of the rack. Avoid coiled or bundled cable loops.
 3. For rack-mounted equipment manufactured with IEC removable power cords, provide power cord assemblies of the minimum length needed to accomplish connection to the PDU. Avoid excess power cabling including coiled or bundled cable.
 4. Factory terminated cable assemblies are only permitted for use within racks, between devices external to racks, as portable equipment, or for use in conduit as specifically noted as follows: Permitted for rack inter-connect when racks are in close proximity (same room) and may pass thru conduit if necessary in this situation. Cable assemblies shall be the minimum length needed to accomplish the connection.

5. Install rack equipment to enable repair or replacement without hindrance. If there are obstructions prohibiting the disconnection of terminations on the back side of the technical equipment, there must be sufficient cabling to permit the equipment to be pulled from the front allowing for easy disconnection and reconnection.

D. Paralleling and Extension Connections

1. Circuits shall not be joined by butt-splice, solder-splice, wire nut, or similar.
2. Circuits requiring parallel connection as indicated on signal flows shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
 - a. Approved connections include DIN mounted terminal blocks as specified in Part 2.
 - b. Field splicing techniques such as wire nuts, "twist and solder", etc. are not allowed.
 - c. Any circuit requiring parallel connection shall be permanently labelled on every cable as defined herein.
 - d. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.
3. Circuits requiring extension (non-data) due to field conditions such as excessive conduit bends, etc., shall be extended via approved termination in an appropriately sized junction box and shall conform to the following guidelines:
 - a. Extension of circuits is to be avoided if at all possible.
 - b. Contact the Design Consultant via documented project communication. Inform the Design Consultant of the circumstances regarding the desired extension. Contractor and Design Consultant will coordinate to determine the most appropriate course of action.
 - c. Approved connections include DIN mounted terminal blocks as specified in Part 2.
 - d. Any circuit requiring extension shall be permanently labelled on every cable as defined herein.
 - e. Care must be taken to maintain appropriate protection and shielding of circuits in order to maintain a fully functional system.
4. Document each parallel connection and extension on the field drawings and transfer same to the final record drawings.

E. Telecommunications Cabling

1. Refer to Division 27 Section "Structured Cabling Systems" for all work associated with data-related cabling including Category and Fiber Optic cabling.
2. All data-related cabling entering a rack shall be terminated to a Data Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Data Patch Panel.
3. All Fiber Optic cabling entering a rack shall be terminated to a Fiber Patch Panel. Rack inter- and intra-connect cabling utilizing factory-terminated cable assemblies are not required to pass thru a Fiber Patch Panel.

F. Microphone/Line Level Audio

1. Audio circuit termination shall observe the methods set forth in "Sound System Interconnection" RaneNote 110, © 2011 by Rane Corporation. This reference document may be obtained at: <https://www.ranecommercial.com/legacy/library.html>

2. Key methods include, but are not limited to the following:
 - a. All audio circuits shall be balanced two-wire circuits, with a separate grounding shield conductor, unless noted otherwise. All circuits shall have either the red or white wires as the "high" or "+" side of the line and connect to pin 2 of microphone-type XLR audio connectors and the tip of 3-conductor phone connectors. The black wire of the two-wire circuit shall be the "low" or "-" side of the line and connect to pin 3 of microphone connectors and the ring of 3-conductor phone connectors. The shield conductor shall connect to pin 1 of microphone connectors or to the sleeve of phone connectors.
 - b. Shield conductors shall be connected at each end of each wire to the pin 1 of each XLR, shield connection for each electronic device, etc. No shield wires shall be left unconnected except where noted on the drawings, nor shall any shield come in contact with conduit, pull boxes, or other building steel. Audio line-level circuit shield wires shall be grounded to rack sheet metal only via rack-mounted equipment. Shields shall be electrically isolated in multi-conductor cables. Shields for audio line-level circuits connected to audio transformers shall be connected to transformer electro-static shields and case ground.
 - c. In the case of an unbalanced source feeding into a balanced input and the cable run is short (i.e. less than fifteen feet), connect the signal connection of the unbalanced connector to the "high" side of the balanced input. Connect the "ground" connection of the unbalanced line to the "low" side of the balanced connector. Connect the cable shield to the shield connection of the balanced input but do not connect it to the unbalanced connector. If the cable run is longer than fifteen feet, balance the line at the unbalanced source using specified balancing devices.
 - d. In the case of a balanced source feeding into an unbalanced input and the cable run is short (i.e. less than fifteen feet), connect the "high" side of the balanced output to the signal input of the unbalanced connection. Connect the "shield" of the balanced connection to the "ground" of the unbalanced connection. Leave the "low" side of the balanced output floating.

G. Loudspeaker Level Audio

1. Loudspeakers in the same acoustic space shall all be wired to produce consistent polarity with a mono input signal. They shall also be polarized such that a positive acoustic pressure on a microphone results in a positive acoustic pressure at all loudspeakers.

H. Video

1. Compression fittings shall be used for all BNC and F connector terminations.
2. Terminate all unused RF and SDI outputs with impedance matching terminators.
3. Neatly dress all cables behind a flat panel display/television. Cables and connections should not be visible from the viewing locations. Power cables for displays shall not be bundled with signal cables nor visible.
4. For fixed projector or pole mounted flat panel display installations, signal cables shall be routed within the mounted pipe. Signal cables shall not be tied to the outside of the pipe. Provide cabling of appropriate distance to minimize excess cable at device. Bundle excess cable above the ceiling, not at the device.

3.5 LABELING

- A. Adhere to AVIXA F501.01:2015 "Cable Labeling for Audiovisual Systems" as a minimum standard with additional requirements as described in this paragraph.
- B. Refer to Division 27 Section "Structured Cabling Systems" for all labeling requirements associated with data-related cabling including Category and Fiber Optic cabling.

- C. Develop and utilize a consistent numbering scheme across the entire project. Utilize system names and building references where applicable, such as the rack number or rack room in a distributed system. All labels for input/output plates and control panels shall be consistent with the final room numbering for the facility.
- D. Adhere to the labeling standard across all platforms, including within the DSP programming.
- E. Refer to general notes, the signal flows, and panel and plate details for expected labeling scheme of system equipment and components. Comply with any specific color coding as described.
- F. All equipment in equipment racks shall be labeled front and rear for ease of identification. Labels shall be of a contrasting color with that of equipment color to promote visibility.
- G. Install permanent labeling on the front of each equipment rack in a row of racks identifying the rack designation (number).
- H. Within each rack and at other remote locations for technical system equipment, label all associated AC power receptacles reflecting the appropriate circuit breaker. Ensure that the circuit breakers are labeled as to the rack or remote equipment location.
- I. Document the labeling standard for inclusion in the Operation and Maintenance Data.
- J. Document all labels for the Record Drawings.
- K. Pre-approved labelling systems include:
 - 1. Brother P-touch EDGE with HGeS2***PK labels; or
 - 2. Brady Equipment Identification Labels.

3.6 SYSTEM CONFIGURATION

- A. Coordination
 - 1. Coordinate and take responsibility for the approval of all system configuration components as described in this paragraph.
 - 2. Coordinate all aspects of the technical system network, including configuration and connection with to the Owner's LAN. Utilize Owner's designated configuration style, standards, and security requirements.
- B. Software
 - 1. Furnish, install, and configure the most recent approved, non-beta, software for each device or system.
 - 2. Provide software as identified in other areas of these specifications or on the drawings.
 - 3. Provide software not specifically identified but required to allow for system operation and/or to allow for more efficient system configuration, setup, and operation.
- C. Firmware
 - 1. Ensure the firmware for each device is the most recent manufacturer approved version and is installed and operational.
- D. Operating Systems
 - 1. Gain approval of the operating system version and type from the Owner's IT representative and associated equipment manufacturer(s).
 - 2. Ensure the operating system for each device is the most recent, installed, and fully operational.
 - 3. Ensure the latest security patches are installed.

- E. Network Configuration
 - 1. All technical system devices with an Ethernet port shall be connected to the associated network.
 - 2. Secure the entire network, documenting all passwords. Comply with the Owner's IT representative's requirements with respect to password selection and network security implementation.
- F. Network Documentation
 - 1. Document the IP and MAC addresses of all IP capable equipment for inclusion with the Operation & Maintenance Manuals.

3.7 CONTRACTOR'S TESTING, ADJUSTMENT, AND SUBMITTAL REQUIREMENTS

- A. At the completion of the installation, perform the following tests on the system to ensure proper installation and operation. The technical system shall be fully tested with all equipment on site, installed, connected, and fully operational.
- B. Adhere to ANSI/Infocomm 10:2013 "Audiovisual Systems Performance Verification" as a minimum standard with additional requirements as described in this paragraph.
- C. The Contractor shall submit the results of all tests prior to on-site system review by the Design Consultant. Where available, provide documentation obtained directly from the test equipment. Other acceptable documentation includes screen captures, photos, and spreadsheets.
- D. General
 - 1. Utilize the technical support services offered by the manufacturers of the various technical system components to ensure optimum performance.
 - 2. All test equipment used for these tests shall be on site during the system final acceptance activities should verification of submitted measurements be required.
 - 3. Ensure that all equipment is on the jobsite and fully operational. This includes portable (not installed) items and other loose equipment. Remove all devices from shipping or packaging containers, ready for use, and place in equipment storage cabinet.
 - 4. The functional tests shall include operational tests of all program source equipment (record and playback), wireless microphone system, mixing console, system inputs and outputs, all patch panel receptacles, intercom system, video routing, video distribution, operational controls, AC power sequencing, operation of software, and all system electronics. Functional tests include examination for hum, buzz, hiss, ghosts, hum bars, oscillation, thumps, unintended reception of other signals such as AM or FM radio, TV, CB, ham radio, cell phones, or any other unwanted signals through the system.
 - 5. Ensure all inputs and outputs are wired to the appropriate devices per construction documents.
 - 6. Verify system startup and shutdown operates in the proper sequence.
 - a. System head end components shall be energized at the beginning of the startup sequence in an appropriate order to guarantee proper communication with associated devices.
 - b. Loudspeaker power amplifiers shall be energized at the end of the sequence in order to eliminate unwanted transients being reproduced through system loudspeakers.
 - c. System shutdown sequence shall be in reverse order.
 - 7. Where a system computer is furnished, load and configure all necessary control software. Examples include but are not limited to the following as applicable: wireless microphone

management, amplification management, projector/display management, audio console configuration/control, DSP configuration/management, and active loudspeaker management.

8. Where audio or video digital signal transport is required, ensure all network setup is complete including the installation and licensing of network management application software.

E. Required testing equipment

1. Certain systems/subsystems require testing and documentation via approved test equipment.
 - a. Systems requiring testing via approved devices will be identified below.
 - b. Required test devices will be listed in related sections.
 - c. Provide unified testing results of similar systems. Describe testing procedure including all test equipment used.
 - d. Provide original results from testing equipment (as applicable).
2. Failure to submit testing documentation conducted via approved devices will result in delayed final acceptance by the Design Consultant.
3. Contractors unable to provide required test equipment shall employ the services, at their own expense, of a certified subcontractor to assist in testing and documentation.

F. Audio System

1. Electronics
 - a. Test all system audio electronic components for uniform frequency response from input to power amplifier output:
 - 1) Supply pink noise to a single system input which engages most of the system electronics. For example, connect pink noise to a microphone receptacle on the stage for a Performing Arts facility.
 - 2) With all signal processing bypassed (equalization band pass filters, crossovers, dynamics, etc.), independently route the signal through audio console, DSP, and any other system processing components to an amplifier output.
 - 3) With speaker load disconnected, measure the signal response of the selected amplifier output (to obtain viable measurement results, ensure output level is set to match the ability of the measurement device to display accurate information. This can be accomplished via attenuation of signal or insertion of a speaker level to line level attenuator).
 - 4) Verify the measured response is uniform and matches the reference input signal within ± 1 dB from 30 Hz to 18 kHz.
 - 5) Required test equipment - Signal Generation:
 - a) Terrasonde/Sencore Audio-Toolbox; or
 - b) Japan Audio Society CD-1 test compact disc
 - c) NTI Minirator MR-PRO
 - 6) Required test equipment – Measurement Device:
 - a) Rational Acoustics SMAART system v7 or later; or
 - b) NTI Audio XL2 Analyzer; or

- c) Studio Six Digital Audio Tools RTA or FFT Module, with
 - i) Studio Six Digital iAudioInterface 2
 - b. Repeat measurement for each amplifier output channel.
- 2. Loudspeaker Impedance
 - a. Measure and record the impedance of all loudspeaker circuits at the output of each amplifier. During this process, also check each loudspeaker circuit for shorts to ground.
 - b. Required test equipment:
 - a) Dayton Audio DATS; or
 - b) NTI Minirator MR-PRO; or
 - c) Sennheiser ZP-3; or
 - d) Terrasonde/Sencore Audio Toolbox
 - 2) Unacceptable measurement devices for loudspeaker impedance include the following:
 - a) Digital Multimeter (DMM); or
 - b) TOA ZM-104; or
 - c) TOA ZM-104A
- 3. Loudspeaker Band Pass/Amplifier Assignment Confirmation
 - a. For full range loudspeakers, apply full spectrum pink noise at sufficient level in order to:
 - 1) Verify subjectively that each loudspeaker is emitting full spectrum signal (both woofer and tweeter/horn are operating)
 - 2) Confirm each loudspeaker is connected to the proper amplifier chassis and output channel.
 - 3) Verify proper phase of each loudspeaker.
 - 4) Required test equipment
 - a) Galaxy Audio CPTS Cricket Polarity Tester; or
 - b) NTI Audio MR-PRO generator with XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools Speaker Polarity Module; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic; or
 - d) Studio Six Digital Speaker Pop; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic
 - b. For loudspeakers with multiple band pass sections (bi-amp, tri-amp, etc.), apply appropriately band-limited pink noise at sufficient level to each device or band pass (i.e. high frequency section, mid frequency section, low frequency section):

- 1) Verify subjectively that each loudspeaker is emitting appropriately band-passed spectrum signal.
- 2) Confirm each band pass is connected to the proper amplifier chassis and output channel.
- 3) Verify phase of each band pass
- 4) Required test equipment
 - a) Galaxy Audio CPTS Cricket Polarity Tester; or
 - b) NTI Audio MR-PRO generator with XL2 Analyzer; or
 - c) Studio Six Digital Audio Tools Speaker Polarity Module; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic; or
 - d) Studio Six Digital Speaker Pop; with
 - i) Studio Six Digital iAudioInterface 2 and Type 1 or 2 Test microphone; or
 - ii) Studio Six Digital iPrecisionMic; or
 - iii) Studio Six Digital iTestMic
4. Loudspeaker Rattle
 - a. Verify each loudspeaker is connected to the respective power amplifier and test each loudspeaker throughout its usable frequency range using 1/3-octave bands of pink noise to ensure loudspeaker and related building systems do not rattle.
 - b. Required 1/3-octave band pink noise sources and test equipment include:
 - 1) Terrasonde/Sencore Audio-Toolbox; or
 - 2) Japan Audio Society CD-1 test compact disc
 - 3) NTI Minirator MR-PRO
5. Loudspeakers Uniformity of Coverage
 - a. Perform audio system verification per ANSI/AVIXA 1M-2009 for all loudspeakers. Document per guidelines set forth in the standard.
6. Loudspeakers Equalization
 - a. Perform sound system equalization to optimize system performance for the intended uses.
 - b. Every loudspeaker shall be equalized.
 - c. Required test equipment:
 - 1) Calibrated Type 1 or Type 2 microphones shall be used
 - 2) Studio Six Digital Audio Tools for the classrooms, meeting rooms, conference rooms gymnasium, lobby; with
 - a) Studio Six Digital iPrecisionMic; or
 - b) Studio Six Digital iTestMic; or
 - 3) SmartLive (most current non-beta version) with SmartLive approved:

- a) Appropriate laptop
- b) Microphone interface
- 4) EASRA (most current non-beta version) with EASRA approved:
 - a) Appropriate laptop
 - b) Microphone interface
- 7. Microphone/Line Level
 - a. Verify that all microphone and line level cabling and connectors are installed with Pins 1, 2, and 3 wired properly and there are no shorts to ground. Ensure proper polarity.
 - b. Verify that all microphone connectors, extension cables, and microphones are wired properly and in polarity.
 - c. Required test equipment:
 - 1) Alphonson ACT-100 Remote Tester; or
 - 2) NTI Minirator MR-PRO with Cable Test Adapter
 - 3) A microphone is NOT an acceptable measurement device for cable tests.
- 8. Wireless Microphones
 - a. Setup and configure each wireless microphone system using the software provided by the manufacturer of the wireless microphone system. The following tasks are required:
 - 1) Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform an RF spectrum sweep.
 - 2) Perform frequency coordination with Owner. Take into account any existing wireless microphone system(s).
 - 3) Calculate spare RF channels (based on 5% of the total wireless system channels).
 - 4) Perform frequency assignment of all transmitters/receivers per the results of the frequency coordination and RF spectrum sweep.
 - 5) Verify all receivers are set to maximum line level audio output.
 - 6) Set all handheld wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
 - 7) Set all body pack wireless transmitter microphone sensitivity settings to allow high level voice output without AF over modulation. All transmitters should be set the same.
 - 8) Using subjective listening, adjust the body pack settings to match the audio level of the handheld transmitters.
 - 9) Walk the entire performance coverage area using speech as the program material to verify signal performance. Utilize wireless microphone management system if applicable, e.g., Shure Wireless Workbench, to perform a QOS test.
 - 10) Document wireless microphone frequency assignments including coordinated spare channels.
- 9. Production Intercom System

- a. Verify that all intercom level cabling is installed with pins 1, 2, and 3 wired properly and there are no shorts to ground. Ensure intercom system power supply is disconnected for these tests.
 - b. Required test equipment:
 - 1) Alphonson ACT-100 Remote Tester; or
 - 2) NTI Minirator MR-PRO with Cable Test Adapter
10. Assistive Listening System
- a. Setup and configure the assistive listening system. Verify proper input signal level.
 - b. Walk the entire coverage area using speech as the program material to verify signal performance.
 - c. Set all receivers to match the selected transmit channel(s).
- G. Video System
1. Verify that all coax video cables pass a DC continuity cable test and contain no electrical shorts. Required test equipment includes:
 - a. Fluke MicroScanner2; or
 - b. Test-Um CX200; or
 - c. Triplet 8-Way WireMaster Coax
 2. Verify that all coax video cables pass a frequency sweep test for the bandwidth of intended use. Required test equipment includes:
 - a. Tektronix RSA5000; or
 - b. Rhode & Schwarz FPC1500; or
 - c. Keysight Technology N9340B
 3. Verify that all video cabling intended for use in SDI signals are tested to allow system conformance with SMPTE 424M. Required test equipment includes:
 - a. Phabrix SxE; or
 - a. Harris VideoTek HD-Star; or
 - b. Quantum Data QD780C
 4. Verify that all video systems utilizing DVI cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP as applicable, correct color space and bit depth, and correct frame rate. Required test equipment includes:
 - a. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
 - b. Murideo Fresco Field Test Suite; or
 - c. Proton-LVDS Video Generator Analyzer; or
 - d. Purelink HDG 2.0
 5. Verify that all video systems utilizing HDMI or DisplayPort cabling are tested to confirm the signal path passes full system bandwidth, full system resolution, HDCP, correct color space and bit depth, correct frame rate, HDR signal and metadata as applicable, and audio as applicable. Required test equipment includes:
 - e. Hall Research PGA-VHD; or

- a. Murideo Fox & Hound A/V Testing and Troubleshooting Kit; or
 - b. Murideo Fresco Field Test Suite; or
 - f. Quantum Data QD780C; or
 - g. Purelink HDG 2.0; or
6. Setup and calibrate each visual display using current edition of Spears & Munsil High Definition Benchmark Disc. Perform calibration with environmental lighting set to level representative of the system while in use. Verify each source and variety of resolutions. For projector/screen combinations, the screen drop shall be set to maximize observation from all seats and the image shall fill the available space on the screen.
 7. Calibrate each video image using a repeatable, calibrated system. Provide documentation for each calibrated image. Results shall also become a part of the Operation/maintenance manuals. Required test equipment:
 - h. Datacolor Spyder5ELITE Display Calibration; or
 - a. SpectraCal CalMAN Ultimate software (most recent version) running on Contractor-provided laptop which exceeds the minimum requirements stipulated by SpectraCal.
 - 1) Supported Meters: as recommended by SpectraCal
 - 2) Supported Pattern Sources: as recommended by SpectraCal; or
 - i. X-Rite ColorMunki Display
- H. Control System
1. Verify performance of the Control System including the operation of all control features.
- I. Adjustment
1. Repair or replace any defects or malfunctions found prior to the commencement of final acceptance activities by the Design Consultant.
- J. Testing Documentation Submittal
1. Document the results of all tests and compile into a complete Testing Documentation submittal with the following items:
 - a. Results of the tests detailed herein; and
 - b. Documentation of changes to the systems as a result of any project Change Order, ASI, field directive, Owner Representative direction or the Testing and Adjustment process. Scans of current field set are acceptable for this submittal; and
 - c. Digital photographs or explanation of reasoning for failed test results due to reasons such as site conditions, constraints, equipment availability, equipment failure, direction required from design team or Owner's Representative, etc.; and
 - d. Written notice to the Design Consultant that the system(s) are ready for final acceptance.
 2. Include the final approved Testing Documentation package in the Operation and Maintenance Data package.
 3. Modify the Record Drawings to include any changes as a result of the adjustment process.
- K. Contact the Design Consultant should problems or concerns arise during the testing activities.
- L. Transmit the Testing Documentation submittal to the Design Consultant in a timely fashion to allow the Consultant appropriate time for review and comment prior to scheduling of final

acceptance. The Consultant cannot visit the site or begin the acceptance phase until the submittal has been approved.

- M. Should the Design Consultant be required to invest time performing some or all of the tests, the Contractor will compensate the Design Consultant for all associated costs.

3.8 FINAL ACCEPTANCE

- A. After completion of the system installation and after the preliminary tests and adjustments are complete, the contractor in conjunction with the Design Consultant shall perform on-site acceptance of the technical system. This process will include, but not be limited to the following, as applicable:
1. Random verification of contractor tests;
 2. System check-out;
 3. Tailoring of the technical system's frequency response to the facility's acoustical environment (where required);
 4. Observation of video system to verify proper image display;
 5. Function and operability of the control system.
- B. Provide the services of the designated supervisor and any other technicians who are familiar with the system, for approximately one ten-hour days. Additional time may be required due to Alternates accepted by the Owner's Representative, or due to Addenda or Change Orders (if any) which modify the scope of work. The supervisor shall provide personal assistance during these activities. This time period does not include time for correcting wiring errors, equipment malfunctions, or problems related to the installation of the technical system. This work could occur at any time day, night, weekends, or holidays without additional claims for expense.
- C. At the discretion of the Design Consultant, the Contractor shall participate in the control and adjustment of computer controlled systems including but not limited to the following systems: Main control (Crestron/AMX), DSP, wireless microphone, amplifier, active loudspeaker, etc.
- D. At the completion of the final acceptance period, the Contractor shall compile all system configuration settings (files) with copies as required for inclusion in the O&M Manuals described later in these specifications.
- E. In addition, provide the following: hand and power tools appropriate for the type of installation, ladders, lifts, and/or scaffolding as required to reach all high-mounted devices, spare wire and cable of the types used in the installation, selection of wiring fasteners used in the installation, complete set of the most recent reviewed shop drawings, complete set of all manufacturers' original installation/operation/maintenance manuals, and specific test equipment used during the preliminary testing activities.
- F. After the technical system is operational, the Contractor shall provide verbal instruction to designated Owner's Representative as to proper methods of system operation. Video record the instruction class and provide the recording in a usable digital format to the Owner's Representative.
- G. Provide operational assistance for the first major use of the completed system as directed by the Owner's Representative, including being present for: one prior rehearsal associated with the event (if applicable); a technical-check immediately prior to the event; and the event itself.

3.9 OPERATION AND MAINTENANCE DATA

- A. At the completion of the project, compile thorough copies of the Operation and Maintenance (O&M) Data per Division 27 Section "General Communications Requirements".

- B. O&M data shall be assembled according to rooms or areas as it relates to the project site. The intent is to allow the Owner's Representative to easily locate information relating to a specific system/room without having to spend an inordinate amount of time searching. Include complete information for each system/room – this may involve duplication of information.
- C. Include ANSI E1.47-2017 (Entertainment Technology – Recommended Guidelines for Entertainment Rigging System Inspections) within the O&M data.
- D. As applicable, save full digital version to the system computer.

END OF SECTION

SECTION 274116 - AUDIO VIDEO SYSTEMS EQUIPMENT

PART 1 - GENERAL

1.1 SUMMARY

- A. These specifications and the associated TA-series drawings describe the requirements for the sound and audio-video (AV) system (hereafter referred to as the "Technical System").
- B. Refer to Division 27 Section "Audio Video Systems" for additional information.

1.2 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section, as do the following:
 - 1. Division 27 Section "General Communications Requirements".
 - 2. Division 27 Section "Common Work Results for Communications".
 - 3. Division 27 "Audio Video Systems".
- B. All Category 5e/6 and fiber optic cabling and terminations shall adhere to the Division 27 Section "Structured Cabling System".

1.3 QUALITY ASSURANCE

- A. Refer to Division 27 "Audio Video Systems" for quality assurance requirements with the following modifications:
 - 1. Contractor General Qualifications:
 - a. Active membership in the National Systems Contractors Association (NSCA).
 - b. Active membership in InfoComm Audiovisual and Integrated Experience Association (AVIXA).
 - d. Authorized dealer for major components of Technical System. Major components include: loudspeakers, control systems, and Digital Signal Processors.
 - 2. Contractor Personnel Qualifications:
 - a. Minimum of one full-time staff member who has attended technical system engineering courses taught by Syn-Aud-Con in the past 10 years.
 - b. Minimum of one InfoComm AVIXA CTS-I (Certified Technology Specialist - Installation) systems technician.
 - c. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with and is factory-certified on the most recent version of the selected Digital Signal Processor (DSP) software and technology. This individual shall be responsible for the implementation of the DSP system including software. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.
 - d. Minimum of one full-time staff member who has a minimum of three (3) years direct experience with network based-AV transport and is factory-certified on the most recent version of the selected AV transport technology. The individual shall hold a current manufacturer's certification (i.e., Crestron DMC-E). This individual shall be responsible for the implementation and preliminary commissioning of the AV transport system. This individual shall be the same throughout the execution of the work unless illness, loss of personnel, or other reasonable circumstances intervene.

- e. Minimum of one full-time staff member who has a minimum of three (3) years direct experience and is a factory certified Master Level Programmer on the most recent version of the AV control system software and technology. This individual shall be the same throughout the execution of the work unless illness or loss of personnel intervenes. A factory authorized independent programmer (i.e., Crestron Master CAIP) will also be accepted, providing the programmer meets the criteria identified in this paragraph.

1.4 SUBMITTALS

- A. Refer to requirements in Division 27 Section “General Communications Requirements”.
- B. Refer to Division 27 Section “Audio Video Systems” for submittal requirements with the following alterations and additions:
 - 1. Pre-Construction
 - a. Schedule specific items include:
 - 1) Off-site: touch screen layouts, DSP configuration
 - 2) On-site under scope: rack installation, flat panel display/television installation, loudspeaker installation
 - 3) On-site other scope: completion and securable equipment room
 - b. Structural Details: specific to loudspeakers, flat screen monitors/televisions
 - c. Signal Flow Shop Drawings – One-line diagrams indicating full intended system configuration. Any generic diagrams found within the Construction Documents shall be drawn to specific requirements. Alterations from basis of design found within the Construction Documents shall be reflected and identified.
 - d. DSP Signal Flow - DSP signal flow configuration (submitted within at least three months sufficient review time prior to system first use).
 - e. Millwork Shop Drawings - Sound console and mobile cart millwork details, and related equipment and panel layout.
 - f. AV Control System - AV control system panel/screen layouts suitable for the Owner’s Representative to understand the operation and flow (submitted within at least five months sufficient review time prior to system first use).
 - 2. Project Completion
 - a. Refer to Division 27 Section “General Communications Requirements” and the Operation and Maintenance Data section in Part 3 of this section for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Refer to Division 27 Section “Audio Video Systems” for general product requirements.
- B. All major components of technical system equipment shall be provided and installed by a qualified contractor as outlined in Part 1 of this section.
- C. All electronic audio devices shall have electronic or transformer balanced inputs and outputs except for specific program source equipment and specific mixing console inputs and/or outputs. If an electronic device specified or furnished has an unbalanced input and/or output,

make provisions to balance said input/output (i.e., active signal balancing device as approved) unless other arrangements have been agreed upon with the Design Consultant.

2.2 COMMON EQUIPMENT

- A. Refer to Division 27 Section "Audio Video Systems" for common equipment and components.

2.3 MICROPHONES – PORTABLE

- A. Microphone – Wired Dynamic: handheld microphone, dynamic, supercardioid. Furnish wired microphones from the same manufacturer as wireless microphones (two required):
 1. Shure BETA 58A with A58WS windscreen; or
 2. Sennheiser e945 with MZW 1 windscreen; or
 3. Approved equal.

2.4 MICROPHONE ACCESSORIES – PORTABLE

- A. Microphone Stand – SB: microphone floor stand with solid base, black (two required):
 1. Atlas MS-20E (ebony); or
 2. K&M 260 (black); or
 3. QuikLok A-399 (black) with fully filled base; or
 4. Ultimate Pro-SB (stackable); or
 5. Approved equal.

2.5 WIRELESS MICROPHONE SYSTEMS

- A. Furnish complete UHF diversity wireless microphone system(s) including the following components (select components from one manufacturer listed below):
- B. Wireless Microphone Receiver: furnish single, dual, or quad channel models with rack mount kits as required to achieve the number of receiver channels as shown on the drawings:
 1. Sennheiser EM 500 G3 single channel receiver with included GA3 rack adapter; or
 2. Shure ULXD4 (single channel), or ULXD4D (dual channel), or ULXD4Q (four channel) digital wireless receiver with encryption capability (encryption must be off when one receiver shares more than one transmitter) with included rack mount kit; or
 3. Approved equal.
- C. Wireless Beltpack Transmitter: furnish beltpack transmitter with headworn microphone (two required):
 1. Sennheiser SK 500 G3 beltpack transmitter with headworn microphone as specified elsewhere; or
 2. Shure ULXD1 with headworn microphone as specified elsewhere; or
 3. Approved equal.
- D. Wireless Handheld Transmitter – Dynamic (two required):
 1. Sennheiser SKM 500-935 G3 handheld microphone transmitter with included MZQ 1 clip and MZW 1 windscreen; or
 2. Shure ULXD2 with RPW118 (Beta 58A) head, 95T9279 microphone clip (included), and A58WS windscreen; or
 3. Approved equal.

- E. Wireless Remote Antenna - Diversity: integrated Dipole and LPDA antenna array, 470 – 698 MHz, forward gain, polarization offset:
 - 1. RF Venue Diversity Fin; or
 - 2. Approved equal
- F. Wireless Remote Antenna – Directional: outdoor rated antenna array, 470 – 608 MHz, forward gain, circular polarization:
 - 1. Winegard Flatwave Air Amplified Outdoor Antenna or
 - 2. Approved equal
- G. Wireless rechargeable battery system – main position: including batteries, chargers, and power supplies to charge all transmitters simultaneously. Label each battery using a logical scheme so batteries can be tracked as they are shuffled among transmitters. Document labels into a spreadsheet which will become a portion of the Operation & Maintenance manuals described in Part 3 of these specifications. Secure chargers to base of drawer using Velcro™ (one rechargeable battery and associated charging slot required for each transmitter furnished):
 - 1. Sennheiser BA2015G2 battery, LA215 dual charger station with NT3-120 power supply, LA2 handheld microphone charging adapter; or
 - 2. Shure SB900A battery, SBC200-US dual charger with power supply, SBC200 dual charger expansion, SBC800-US Eight Battery Charging Station; or
 - 3. Approved equal.
- H. Each receiver shall be connected via Ethernet to the computer. Furnish the most recent configuration software, install on the computer, and configure each receiver and transmitter for optimum operation. Test each and all receiver/transmitters to ensure no problems arise.
- I. Where remote 1/4 wavelength antennas are used, and mounting conditions allow, mount each antenna on a standard metal wall plate to serve as a ground plane.
- J. Provide all connections and components necessary for proper operation of the wireless systems described above.
- K. Coordinate the selection of transmitter/receiver frequencies to be free of interference from outside sources or interference between wireless systems. Select the frequency from an unused channel between (470 - 698 MHz) per FCC regulations Part 74, subpart H.
- L. Label each receiver/transmitter combination as noted on the drawings. See Labeling and Placards section in this specification for additional labeling requirements.

2.6 PROGRAM SOURCE EQUIPMENT

- A. Some of the program source equipment specified is consumer-grade equipment. Upon award of a contract, endeavor to procure these items as soon as possible to avoid delays caused by searching for discontinued product(s).
- B. Rack-mount kit for equipment that requires rack mounting but is not provided with rack mount ears or optional rack mount kit:
 - 1. Lowell RMK series; or
 - 2. Middle Atlantic Products RSH series; or
 - 3. Approved equal.

- C. For each portable item of program source equipment, furnish one set of input/output cables (6-foot minimum length) and adapters (as required) to allow connection to technical system inputs/outputs.
- D. Audio Network Recorder: plays mp3, WMA, WAV, MPEG-4 files from USB or network connections, single rack space, balanced outputs, RS-232 control, Dante Network Audio:
 - 1. JoeCo BBR64-Dante; or
 - 2. Approved equal
- E. USB Drive: 2TB HDD, USB 3.0, Shock, rain and pressure resistance. Minimum read/write speed 130MB/s
 - 1. LaCie Rugged Mini, or
 - 2. Western Digital G-DRIVE Armor ATD, or
 - 3. Approved equal
- F. Network Audio Player, AM/FM Tuner, Internet radio, USB playback, 1RU with rack-mount ears, digital display, balanced and unbalanced stereo analog outputs, IR handheld remote control, RS-232 control:
 - 1. Denon DN-350UI; or
 - 2. Approved equal.
- G. Analog – Dante Audio Interface 3x2: 2-gang Decora style wallplate with (4) XLR-F inputs, (2) phenix line level outputs, Dante Audio Network:
 - 1. Attero Tech unDX4I-B (color approval required) with optional matching cover plate; or
 - 2. Approved equal
- H. Network Audio – 4x2 multi I/O with BT -2G WP: 2-gang Decora style wallplate with 1/8" and dual RCA inputs, 1/2" line level outputs, bluetooth, Dante Audio Network:
 - 1. unD6IO-BT (color approval required) with optional matching cover plate; or
 - 2. Approved equal.
- I. Digital Signage Media Player: simultaneous 2160P and 1080P decoding, 2160P or 1080P playback, supports looping video displays, remote content update via network connection, RSS feed playback, UDP command support, Ethernet control, PoE, dual 1080p decode, IP streaming server, Touch, USB interactivity, live TV support and input:
 - 1. BrightSign XD234; or
 - 2. Approved equal.

2.7 DIGITAL SIGNAL PROCESSING (DSP)

- A. The AC power cord of the DSP shall be connected to a rack-mount uninterruptible power supply (UPS). Refer to the AC Power section for specific models. The UPS shall be connected to an unswitched (unsequenced) AC power circuit.
- B. The Design Consultant has assembled preliminary schematics for the DSP to determine the needed equipment and processing power required for the project. After award of the contract, contact the Design Consultant for a copy of the files. Embellish the software to represent the final product for the client and submit as a shop drawing.
- C. Create all schematics for the DSP and submit as a shop drawing.

- D. Provide one computer with mouse and system features as recommended and approved by the manufacturer of the DSP system for use during commissioning.
 - 1. If a computer is provided under this specification section for use as a system operation and configuration device, DSP software should be loaded and computer should be operational during system commissioning.
 - 2. Furnish a wireless 802.11n router and laptop computer configured to allow for wireless control of the DSP during system testing and commissioning if applicable to the facility. Retain ownership of the router and laptop computer.
- E. Password protection shall be included. One password shall be provided to allow operator access to select functions. Another password shall be provided for technical staff to access all aspects of the software.
- F. DSP programming of Fire Alarm connection
 - 1. General
 - a. Sound system operation in relation to fire alarm system is subject to NFPA, local building codes, and the local Authority Having Jurisdiction.
 - b. Sound system mute for fire alarm audible notification shall be provided for all assembly areas, locations with systems capable of prolonged operation in excess of 100dBA, and all facility background music systems.
 - c. Coordination is required with the fire alarm contractor and local AHJ.
 - 2. Sound system shunt initiation signal
 - a. Fire alarm system connection shall be via DSP contact closure in location as indicated on signal flows.
 - b. Upon fire alarm activation, and subsequent reception of shunt signal from the fire alarm system via normally open contact closure to the DSP, all sound system audio shall mute.
 - c. DSP shall be programmed to mute audio sources until the alarm is cleared, upon which normal operation shall resume. Activation of shunt signal may include General Alarm, keying of the fire alarm microphone, or initiation of preprogrammed severe weather (or the like) announcement.
 - d. DSP programming shall include clear visible status of alarm state for troubleshooting purposes.
- G. Furnish all components for a fully functioning digital signal processing system.
- H. DSP system basis of design is shown on the signal flows. Unterminated IO cards should be provided as indicated on the signal flows for future use or additional requirements.
- I. Substitutes to the basis of design will be considered if all features and functionality of the system requirements are met. IO requirements should meet or exceed the quantity of the basis of design. Processing requirements should meet or exceed the basis of design to ensure proper operation of the system. The following manufacturers are pre-approved substitutes to the basis of design found on the signal flows:
 - 1. BSS Soundweb London with:
 - a. The most recent London Architect software.

2.8 POWER AMPLIFIERS

- A. Power amplifiers in this section shall be by one manufacturer and operated in multi-channel mode to provide a minimum of two amplifier channels within one chassis unless noted otherwise.
- B. All power amplifiers shall have either electronic or transformer balanced inputs, and shall have either stepped input level attenuators or control via software.

Provide perforated metal security cover (type as specified herein) for each amplifier, to cover all front panel controls and AC power switches. Security cover shall not block air-flow for amplifier internal cooling system.

- C. All power amplifiers shall have standby/sleep mode functionality. This functionality should be implemented on a system wide scale to provide a fully controlled power sequencing system. Preferred solution is networked based; if amplifier does not have necessary features via network control, contact closure solution should be utilized. Contact closure solution shall utilize a control system for triggering power state.
 - 1. Upon system shutdown, power amplifiers shall enter standby/sleep mode per manufacturer's functionality.
- D. Power amplifiers are listed by series, with the basis of design model shown on the signal flows. Deviation from the basis of design to an approved substitute will be allowed as follows:
 - 1. Power rating for high impedance (70V) operation shall meet or exceed the basis of design load requirement on the channel. Load shall be calculated based on total power (addition of all loudspeaker tap values) as indicated on the signal flows.
 - 2. Power rating for low impedance operation shall meet or exceed the basis of design load requirement on the channel. Load shall be as indicated on the signal flows.
 - 3. Channel count per chassis should produce most efficient solution of maximum channels vs appropriate power rating.
 - a. Proposed substitute should take into account alterations of audio network requirements, as applicable. Alterations may include the need for additional network infrastructure, including network switches.
 - b. Proposed substitute should take into account alterations of audio system requirements, as applicable. Alterations may include the need for additional digital signal processing infrastructure.
 - c. Proposed substitute should take into account standby/sleep mode functionality. Alterations may include the need for additional network infrastructure or control system infrastructure.
 - d. Proposed substitute should take into account all other parameters, including but not limited to rack requirements and environmental considerations (AC power, thermal dissipation, etc.).
 - 4. Power Amplifier – Type (####)x/(#)N(A)(B)(C)(D)(E)(Q): power amplifier, high (70V) or low impedance operation switchable per output, network control, loudspeaker processing, audio network capabilities, with the following characteristics required as shown on signal flows:
 - 5. Crown DriveCore Install (DCI) Series
 - a. ####x, minimum power rating listed at 8-ohm load, also capable of providing high impedance (70V) operation
 - b. /#, number of channels per chassis

- c. N, network control capabilities
- d. A, AVB
- e. B, BLU-Link
- f. D, Dante

2.9 LOUDSPEAKERS – INSTALLED

- A. General loudspeaker requirements:
 - 1. Where visible, paint out or remove the manufacturer's logo on each loudspeaker.
 - 2. Loudspeaker, and related mounting bracket(s) where appropriate, color shall be as selected by the Architect from the available color selection offered from each loudspeaker manufacturer.
 - 3. For loudspeakers located outdoors or in a humid environment (such as natatoria):
 - a. Encapsulate all exposed loudspeaker wiring terminations in clear silicon type sealant or Star Brite Liquid Electrical Tape (800) 327-8583.
 - 4. Utilize the most recent manufacturer-recommended DSP settings if available.
- B. Loudspeaker C70-6", ceiling, six-inch loudspeaker, complete with enclosure, and integrated 70 volt transformer, switchable to 8 ohm:
 - 1. Community D6; or
 - 2. Martin Audio C6.8T; or
 - 3. Tannoy CMS 601 DC; or
 - 4. Approved equal.
- C. Loudspeaker SM/WR8-HL4x12"-96, surface mount, weather resistant, horn loaded full range loudspeaker, two eight-inch low frequency drivers, 90 x 60 dispersion, custom mounting condition as applicable:
 - 1. Danley SH-96; or
 - 2. Approved equal.
- D. Loudspeaker SM/WR8-HL2x8"-95, surface mount, weather resistant, horn loaded full range loudspeaker, two eight-inch low frequency drivers, 95 x 55 dispersion, custom mounting condition as applicable:
 - 1. Danley SH-95HO; or
 - 2. Approved equal.
- E. Loudspeaker HL/S4-1x18", horn loaded subwoofer, 4-ohm load, single eighteen-inch driver:
 - 1. Danley TH-118XL; or
 - 2. Approved equal.

2.10 ASSISTIVE LISTENING SYSTEM - FM 72MHZ

- A. The transmitter shall be installed in the audio equipment racks and the transmitting antenna shall be remotely mounted/suspended at the location shown on the drawings. The antenna shall be installed in a vertical orientation.
- B. Select interference-free frequencies corresponding to the following initial assignments, subject to revision (as approved) to avoid interference. Permanently and clearly label each receiver to match:

1. Transmitter channel A "Indoor Practice Field"
- C. The Assistive Listening System shall include all hardware as required to provide a fully functional system.
- D. ALS Transmitter 72MHz: assistive listening system transmitter, operates in the 72MHz band:
 1. Listen Technologies LT-800-072-1 with LA-326 rack mount kit; or
 2. Telex Soundmate ST-300 with RM-S rack mount kit; or
 3. Williams Sound PPA T45 with RPK 005 rack mount kit.
- E. ALS Dipole Antenna 72MHz: assistive listening system antenna, coax or dipole, tuned for operation in the 72MHz band:
 1. Listen Technologies LA-116 (coax) or LA-122 (telescoping dipole) or LA-123 (helical); or
 2. Telex Soundmate HGA-1 (coax); or
 3. Williams Sound ANT024 (telescoping dipole) or ANT034 (helical).
- F. ALS Receiver 1CH-72MHz: assistive listening system beltback style receiver, tuned for operation in the 72MHz band (four required):
 1. Listen Technologies LR-400-072 with LA-362 NiMH batteries or LR-4200-072 (iDSP) with LA-365 Li⁺ battery; or
 2. Telex Soundmate SR-400 with NiMH batteries; or
 3. Williams Sound PPA R38N with BAT 026-2 NiMH batteries.
- G. ALS Ear Speaker: assistive listening system single ear speaker (one required for each receiver furnished):
 1. Listen Technologies LA-401; or
 2. Telex Soundmate ES-1; or
 3. Williams Sound EAR 022.
- H. ALS Headphone: assistive listening system light-weight headphones (two required):
 1. Listen Technologies LA-402; or
 2. Telex Soundmate HED-2; or
 3. Williams Sound HED 021.
- I. ALS Neckloop: assistive listening system neck loop for use with T-coil equipped hearing aids (one required):
 1. Listen Technologies LA-166 or LA-430 (iDSP); or
 2. Telex Soundmate NL-4S; or
 3. Williams Sound NKL 001.
- J. ALS Charger: assistive listening system charging case (one charging slot required for each receiver furnished):
 1. Listen Technologies LA-317 4-Slot Charging/Carrying Case or LA-423 4-Port (iDSP) USB Charger; or
 2. Listen Technologies LA-321, 8-slot Charging/Carrying Case; or
 3. Listen Technologies LA-311 16-Slot or LA-380 12-Slot (iDSP) Charging/Carrying Case; or

4. Telex Soundmate BH-200, Charging Station for two receivers; or
 5. Williams Sound CHG 3512 PRO 12-Slot Charging/Carrying Case .
- K. ALS Signage: assistive listening system signage notifying occupants that the assistive listening system is available. Mount signage as directed by the Owner's Representative (one required for each entrance to each applicable room):
1. Listen Technologies LA-304; or
 2. Telex Soundmate WP-1; or
 3. Williams Sound IDP 008.

2.11 DISPLAY – PROFESSIONAL LCD FLAT PANEL

- A. LCD flat panels in this section shall be by one manufacturer, unless noted otherwise.
- B. All LCD flat panel displays specified in this section shall have the following features or options included, unless noted otherwise:
1. Display response time of 10ms or less
 2. LED backlighting
 3. VESA mounting compatible
 4. Viewing angle of 175° horizontal x 175° vertical (or greater)
- C. LCD flat panels are listed by series, with the basis of design model shown on the signal flows and related schedules. The minimum requirements for inputs, outputs, control connections and optional interfaces/accessories shall be as indicated on signal flow diagrams.
- D. Deviation from the basis of design to an approved substitute will be allowed as follows:
1. All audio, video, and control connections shown on signal flow (connectors shown on equipment block but unconnected are not required for substitution) shall meet or exceed the basis of design with respect to quantity, type, version, and supported protocols. This shall include the standard features of the display as well as any optional interfaces/accessories.
 - a. Example connections include but are not limited to TV tuner (NTSC, ATSC, and Clear QAM compatible), HDMI (HDCP compatible), DVI-D (HDCP compatible), SDI (SD, HD, 3G, Dual Link, 6G), Displayport (HDCP Compatible), HD15 RGB with 3.5mm audio, component with stereo audio, composite with stereo audio, multi-channel audio, RJ45 LAN, RJ45 HDBaseT, DB9 for RS232 control, and USB.
 2. Proposed substitute shall have an equivalent aspect ratio.
 3. Proposed substitute shall meet the capabilities of any built-in speakers.
 4. Proposed substitute shall have an equivalent brightness rating and backlighting technology (edge light, direct back light, etc.)
 5. Proposed substitute weight shall be considered with respect to the display mount. It shall be the responsibility of the contractor to confirm the mount is compatible with the substitute display.
 6. Proposed substitute mounting orientation capabilities (horizontal, vertical/portrait, etc.) shall meet or exceed basis of design.
 7. Proposed substitute manufacturer's warranty shall meet or exceed the basis of design.
- E. Equipment naming convention

1. "Product Type" – "Vertical Resolution" / "Nominal Diagonal Size (inches)"
2. Example: LCD Pro Display – 1080/52
 - a. Product Type: LCD Pro Display
 - b. Vertical Resolution: 1,080 pixels
 - c. Nominal Diagonal Screen Size: 52"

F. LCD flat panel displays shall be furnished by the owner and installed by the AV contractor.

2.12 FLAT PANEL DISPLAY MOUNTS

A. Refer to Division 27 Section "Audio Video Systems" for flat panel display mounts.

2.13 NETWORK AV TRANSPORT

A. Network based audio and video (and USB & control) transport products shall all be supplied from the same manufacturer throughout all systems to ensure cross-system compatibility and allow for full flexibility of the platform.

B. Network configuration requirements set forth by the manufacturer must be used for any network switches which will support these devices.

C. Decoder HDMI/CTL/USB/1G: single network stream input – single scaled HDMI output, chassis rack mountable with shelf, receives HDMI over network. Receives 4K, 60Hz, with 4:4:4 chroma subsampling video and AES67 audio within the distance limitations of the network it is connected to.

1. Extron NAV SD 101
2. Approved equal.

D. Encoder WP HDMI/CTL/USB/1G: single HDMI input – single HDMI output & network stream output, 3-Gang Decora-style wall plate, sends HDMI, ethernet, control, and USB over network. Transmits 4K, 60Hz, with 4:4:4 chroma subsampling video, AES67 audio, and 480 Mbps of USB (1.0, 2.0, or 3.0) data as host or device within the distance limitations of the network it is connected to.

1. Extron NAV E 201 D
2. Approved equal.

E. Network AV Manager: Manages up to 240 compatible endpoints, PoE powered, rack mountable, acts as central point for management, configuration, control, and updates of all network AV endpoints. Web-based UI, active directory support, 802.1X support.

1. Extron NAVigator with license tier required to support all endpoints
2. Approved equal.

2.14 CATV VIDEO DISTRIBUTION

A. CATV video transport products shall all be supplied from the same manufacturer throughout all systems to ensure cross-system compatibility and allow for full flexibility of the platform.

B. ATSC Tuner: UHD TV tuner – single HDMI, HD15, composite and component video output. Stereo RCA, SPDIF Coax and Optical audio output. DB9 RS-232 and RJ-45 10/100 Ethernet control

1. Contemporary Research 232-ATSC 4K HDTV Tuner, or
2. Approved equal.

2.15 A/V CONTROL SYSTEM – EQUIPMENT

- A. The AC power cord of the Control System Processor shall be connected to a rack-mount uninterruptible power supply (UPS). Refer to the AC Power section for specific models. The UPS shall be connected to an unswitched (unsequenced) AC power circuit.
- B. Control system equipment shall be furnished from one manufacturer only. Program the system to provide acceptable operation by the Design Consultant and/or Owner's Representative.
- C. Select equipment that can be fully controlled by the control system furnished.
- D. The drawings reflect a specific system manufacturer. If a different system manufacturer is furnished, shop drawings are required indicating proposed wiring configuration, control panel layouts, and equipment used. All of the features shown for the system on the drawings shall be maintained with the substitute system including coordination and costs related to back boxes, electrical, and other associated items.
- E. All systems shall be accessible remotely via the Owner's LAN as directed by the Owner's Representative.
- F. All control equipment necessary shall be furnished to provide a complete operating system, including but is not limited to the following components:
 - 1. Touch Screen - W10"
 - a. Extron TLP Pro 1022M
 - 2. Control System - Processor
 - a. Extron IPCP Pro 350

2.16 A/V CONTROL SYSTEM – GENERAL PROGRAMMING REQUIREMENTS

- A. Refer to Division 27 Section "Audio Video Systems" for general programming requirements with the following revisions and additions:
 - 1. No additional requirements.

2.17 CABLES – FACTORY TERMINATED – PORTABLE

- A. Factory terminated cable assemblies in this section are approved for portable use only.
- B. Portable cable assembly quantities are identified in parenthesis and are required to be furnished in addition to those required for system installation. Portable cable lengths are a minimum not to exceed the maximum acceptable length identified in the cable descriptions below. Where specific lengths are cited adjacent to quantities, these lengths are to be taken as ideal lengths. If a pre-approved model series is not offered in the specific length cited, then the cable length closest to the cited length shall be provided unless the difference is greater than twenty percent. In this case, contact the Consultant for direction.
- C. All cable assemblies must be factory tested and certified.
- D. Microphone Cable – Microphone cables shall be black with colored boot or ring on the male connector as a color code to identify length (colors as identified for each length below). Custom print "PROJECT NAME" and cover with clear heat shrink tubing approximately 6-inches from the male connector or use custom engraving on the male connector. Microphone cable part numbers are custom products.
- E. Microphone Cable – 25', twenty-five foot microphone extension cable (red) (two required):
 - 1. ProCo AQ-25M2F0PLM; or
 - 2. Whirlwind MKQ25-WSR-RED.

- F. Microphone Cable – 50', fifty foot microphone extension cable (blue) (two required):
 - 1. ProCo AQ-50M6F0PLM; or
 - 2. Whirlwind MKQ50-WSR-BLU.
- G. Microphone Cable – 100', one hundred foot microphone extension cable (white) (two required):
 - 1. ProCo AQ-100M9F0PLM; or
 - 2. Whirlwind MKQ100-WSR-WHI.

2.18 AUDIO INTERFACE EQUIPMENT – PORTABLE

- A. MP3 Balancing Adaptor – Mono XLRM 10', 1/8" audio to single XLRM with balancing transformer on XLR, 10' cable (one required):
 - 1. Proco IPATCH-10.

2.19 PORTABLE ACCESSORIES

- A. Work Light, clip-on work light (one required for each equipment rack furnished):
 - 1. Lowell RL-1A; or
 - 2. Middle Atlantic model WL-60; or
 - 3. Hardware store style with small (nominal 6-inch diameter) aluminum reflector, 60-watt "rough service" bulb, and 6-foot cord.

PART 3 - EXECUTION

3.1 COMMON REQUIREMENTS

- A. Refer to Division 27 Section "Audio Video Systems" for common requirements.

END OF SECTION 274116

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SECTION 28 00 10 - GENERAL ELECTRONIC SAFETY AND SECURITY REQUIREMENTS

PART 1 - GENERAL

1.1 DESCRIPTION OF WORK

- A. This Division requires providing complete functioning systems, and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. Division 28 of these Specifications, and Drawings numbered with prefixes TN, generally describe these systems, but the scope of the Electronic Safety & Security Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical and Telecommunications Drawings and Specifications; and Addenda.
- C. Drawings are graphic representations of the Work upon which the Contract is based. They show the materials and their relationship to one another, including sizes, shapes, locations, and connections. They also convey the scope of Work, indicating the intended general arrangement of the equipment, fixtures, outlets and cabling without showing all of the exact details as to elevations, offsets, and other installation requirements. Use the Drawings as a guide when laying out the Work and to verify that materials and equipment will fit into the designated spaces, and which, when installed per manufacturers' requirements, will ensure a complete, coordinated, satisfactory and properly operating system.
- D. Specifications, along with the device schedules located on drawing legend sheets, define the qualitative requirements for products, materials, and workmanship upon which the Contract is based.

1.2 ABBREVIATIONS

ADA	Americans with Disabilities Act
AFF	Above Finished Floor
AHJ	Authority Having Jurisdiction
ANSI	American National Standards Institute
ASTM	American Society for Testing and Materials
ETL	Electrical Testing Laboratories, Inc.
FCC	Federal Communications Commission
FM	Factory Mutual
IEEE	Institute of Electrical and Electronic Engineers
LED	Light Emitting Diode
NEC	National Electric Code
NESC	National Electrical Safety Code
NEMA	National Electrical Manufacturers Association
NFPA	National Fire Protection Association
NICET	National Institute for Certification in Engineering Technologies
NRTL	Nationally Recognized Testing Laboratory
OEM	Original Equipment Manufacturer
OFCI	Owner Furnished Contractor Installed
OSHA	Occupational Safety and Health Administration
UL	Underwriters Laboratories
UON	Unless Otherwise Noted

1.3 QUALITY ASSURANCE

- A. Execute all Work under this Division in a thorough and professional manner by competent and experienced workpersons duly trained to perform the Work specified.
- B. Qualifications – refer to individual Division 28 sections for specific Personnel and Contractor Qualifications.
- C. Install all Work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation.
- D. Unless indicated otherwise on the Drawings, provide all material and equipment new, of the best quality and design, free from defects and imperfections and with markings or a nameplate identifying the manufacturer and providing sufficient reference to establish quality, size and capacity. Provide all material and equipment of the same type from the same manufacturer.
- E. Unless specified otherwise, manufactured items of the same types specified within this Division shall have been installed and used, without modification, renovation, or repair for not less than one year prior to date of bidding for this Project.
- F. Comply with the current applicable codes, ordinances, and regulations of the authority or authorities having jurisdiction, the rules, regulations and requirements of the service providers serving the project and the Owner's insurance underwriter.
- G. Drawings, specifications, codes and standards are minimum requirements. Where requirements differ, the most stringent apply.
- H. Should any change in drawings or specifications be required to comply with governing regulations, notify and receive written approval from the Architect prior to submitting bid.
- I. All equipment and installations shall meet or exceed minimum requirements of ADA, ANSI, ASTM, IEEE, NEC, NEMA, NFPA, OSHA, UL, and the State Fire Marshall.
- J. Execute work in strict accordance with the best practices of the trades in a thorough, substantial, workmanlike manner by competent workmen. Provide a competent, experienced, full-time Project Manager who is authorized to make decisions on behalf of the Contractor.
- K. Warranty Requirements
 - 1. Refer to General Conditions for Warranties.
 - 2. Warrant each system and each element thereof against all defects due to faulty workmanship, design or material for a minimum period of 12 months from date of Substantial Completion, or longer where specific items are required to carry a longer warranty in these Construction Documents or a manufacturer's standard warranty exceeds the minimum. Remedy all defects, occurring within the warranty period(s), as stated in the General Conditions.
 - 3. Refer to individual Division 28 sections for additional warranty requirements, as certain components and systems will have warranty requirements that exceed 12 months.
 - 4. The above warranties shall include labor and material. Make repairs or replacements without any additional costs to the Owner.
 - 5. Schedule repairs with the Owner for times of the day, days of the week as specified by the Owner. No premiums shall be charged to the Owner for work requiring weekend or after "normal business hours" access.
 - 6. Perform the remedial work within 48 hours, upon written notice from the Architect or Owner, unless deferred by the Owner.

7. At the time of Substantial Completion, deliver to the Owner all warranties, in writing and properly executed, including term limits for warranties extending beyond the one year period, each warranty instrument being addressed to the Owner and stating the commencement date and term.

1.4 CODES, REFERENCES, AND STANDARDS

- A. Execute all Work in accordance with, and comply at a minimum with, National Fire Protection Association (NFPA) codes, state and local building codes, and all other applicable codes and ordinances in force, governing the particular class of Work involved, for performance, workmanship, equipment, and materials. Additionally, comply with rules and regulations of public utilities and municipal departments affected by connection of services. Where conflicts between various codes, ordinances, rules, and regulations exist, comply with the most stringent. Wherever requirements of these Specifications, Drawings, or both, exceed those of the above items, the requirements of these Specifications, Drawings, or both, shall govern. Code compliance, at a minimum, is mandatory. Construe nothing in these Construction Documents as permitting work not in compliance, at a minimum, with these codes.
- B. Bring all perceived conflicts between codes, ordinances, rules, regulations and these documents to the Architect's and Design Consultant's attention in sufficient time, prior to the opening of Bids, to prepare the Supplementary Drawings and Specifications Addenda required to resolve the conflict.
 1. If a conflict is not reported timely, prior to the opening of bids, resolve the conflict and provide the installation in accordance with the governing codes and to the satisfaction of the Architect and Design Consultant, without additional compensation. Contractor will be held responsible for any violation of the law.
- C. Obtain timely inspections by the constituted authorities having jurisdiction; and, upon final completion of the Work, obtain and deliver to the Owner executed final certificates of acceptance from these authorities having jurisdiction.
- D. All material, manufacturing methods, handling, dimensions, methods of installation and test procedures shall conform to industry standards, acts, and codes. Refer to individual sections for exact codes, references, and standards.

1.5 DEFINITIONS:

- A. Whenever used in these Specifications or Drawings, the following terms shall have the indicated meanings:
 1. AHJ - The local code and/or inspection agency (Authority) Having Jurisdiction over the Work.
 2. Approved - Labeled, listed, or both, by an NRTL, and acceptable to the AHJ over this project.
 3. As Directed - As directed by the Architect, or his representative.
 4. Concealed - Embedded in masonry or other construction, installed behind wall furring or within drywall partitions, or installed within hung ceilings.
 5. Conditionally Approved – The manufacturer has been found reputable by the design professional, but the design professional has not verified that the product offering by manufacturer meets to all specification requirements. Contractor shall adhere to submittal review process for final approval on products.
 6. Design Consultant - Where referenced in this Division, "Design Consultant" is the Design Professional for the Work under this Division, and is a Consultant to, and an authorized representative of, the Architect, as defined in the General and/or Supplementary Conditions.
 7. Furnish - "To supply and deliver to the project site, ready for unloading, unpacking, assembling, installing, and similar operations."

8. Furnished by Owner (or Owner-Furnished) or Furnished by Others: "An item furnished by the Owner or under other Divisions or Contracts, and installed under the requirements of this Division, complete, and ready for the intended use, including all items and services incidental to the Work necessary for proper installation and operation. Include the installation under the warranty required by this Division."
 9. Install - "To perform all operations at the project site, including, but not limited to, and as required: unloading, unpacking, assembling, erecting, placing, anchoring, applying, working to dimension, finishing, curing, protecting, cleaning, testing, commissioning, starting up and similar operations, complete, and ready for the intended use."
 10. NRTL - Nationally Recognized Testing Laboratory, as defined and listed by OSHA in 29 CFR 1910.7 (e.g., UL, ETL, CSA, etc.), and acceptable to the Authority having Jurisdiction (AHJ) over this project. Nationally Recognized Testing Laboratories and standards listed are used only to represent the characteristics required and are not intended to restrict the use of other NRTL's that are acceptable to the AHJ, and standards that meet the specified criteria.
 11. Provide - "To furnish and install complete, and ready for the intended use."
 12. Prime Contractor – a project's overall contractor responsible for all Divisions of Work, usually identified as a General Contractor or Construction Manager At Risk.
 13. Submit - Submit to Architect for review.
 14. Substitution: Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor. Substitutions include Value Engineering proposals.
 - a. Substitutions for Cause: Changes proposed by Contractor that are required due to changed Project conditions, such as unavailability of product, regulatory changes, or unavailability of required warranty terms.
 - b. Substitutions for Convenience: Changes proposed by Contractor or Owner that are not required in order to meet other Project requirements but may offer advantage to Contractor or Owner.
 15. Value Engineering: A systematic method to improve the "value" of goods and services by using an examination of function. Value, as defined, is the ratio of function to cost. Value can therefore be increased by either improving the function or reducing the cost. The goal of VE is to achieve the desired function at the lowest overall cost consistent with required performance.
 16. Wet Location - A location subject to saturation with water or other liquids. Pathways installed in wet locations do not protect cables from moisture such that cables installed in pathways within wet locations must be identified by their manufacturer for use in wet locations.
 - a. For example: Slab-on-grade construction where pathways are installed underground or in or under concrete slabs that are in direct or indirect contact with soil (e.g., sand and gravel with or without a moisture barrier) is considered a "wet location."
 17. (*) – Where appearing in product part or model numbers; shall represent wild card character to be filled in by the contractor to meet required specifications.
- B. The terms "approved equal", "equivalent", or "equal" are used synonymously and shall mean "accepted by, or acceptable to, the Design Consultant as equivalent to the item or manufacturer specified".
- C. The following definitions apply to excavation operations:

1. Sub-base: as used in this Section refers to the compacted soil layer used in pavement systems between the sub-grade and the pavement base course material.
2. Sub-grade: as used in this Section refers to the compacted soil immediately below the slab or pavement system.
3. Unauthorized excavation consists of removal of materials beyond indicated sub-grade elevations or dimensions without specific direction from the Architect.

1.6 COORDINATION

- A. Coordinate with other Divisions for Electronic Safety and Security work to be included but not listed in Division 28 or indicated on the Security or Fire Alarm Drawings.
- B. Visit the site and ascertain the conditions to be encountered in installing the Work under this Division, verify all dimensions and locations before purchasing equipment or commencing work, and make due provisions for same in the bid. Failure to comply with this requirement shall not be considered justification for omission, alteration, and incorrect or faulty installation of any of the Work under this Division or for additional compensation for any Work covered by this Division.
- C. Refer to Drawings and Divisions of the other trades and to relevant equipment drawings and shop drawings to determine the extent of clear spaces. Follow these drawings as closely as the actual construction and the work of other trades will permit.
- D. Maintain a project manager, as specified by the Quality Assurance sections of these specifications, on the jobsite at all times to coordinate this Work with other trades so that various components of the Division 28 systems are installed at the proper time, fits the available space, allows proper service access to all equipment, and meets all required codes and standards.
- E. Execute the Work in such a manner that the Work of the other trades will not be handicapped, hindered, or delayed at any time.
- F. Work of this Division shall progress according to the "Construction Schedule" as described in Division 1 and as approved by the Architect. Cooperate in establishing these schedules and perform the Work under this Division, in a timely manner in conformance with the construction schedule so as to ensure successful achievement of all schedule dates.
- G. Carefully check space requirements with other trades to insure that equipment can be installed in the spaces allotted.
- H. Refer to Coordination requirements in specific sections for additional information.
- I. Examine and compare the Contract Drawings and Specifications with the Drawings and specifications of other trades, and report any discrepancies between them to the Architect and obtain written instructions for changes necessary in the work. Install and coordinate the work in cooperation with other related trades. Before installation, make proper provisions to avoid interferences.
- J. Wherever the work is of sufficient complexity, prepare additional detail drawings to scale to coordinate the work with the work of other trades. Detailed work shall be clearly identified on the Drawings as to the area to which it applies. Submit these drawings to the Architect for review. At completion include a set of these drawings with each set of Record Drawings.
- K. Before commencing work, examine adjoining work on which this work is in any way affected and report conditions, which prevent performance of the work. Become thoroughly familiar with actual existing conditions to which connections shall be made or which shall be changed or altered.
- L. In cases of doubt as to the work intended, or in the event of need for explanation, request supplementary instructions from the Architect.

1.7 MEASUREMENTS AND LAYOUTS

- A. The Drawings are schematic in nature, but show the various components of the systems approximately to scale and attempt to indicate how they are to be integrated with other parts of the Work. Figured dimensions take precedence to scaled dimensions. Determine exact locations by job measurements, by checking the requirements of other trades, and by reviewing all Contract Documents. Correct, at no additional costs to the Owner, errors that could have been avoided by proper checking and inspection.

1.8 SUBMITTALS

- A. Refer to General Conditions for general submittal requirements in addition to requirements specified in this section. Refer to individual Division 28 Sections for additional submittal requirements. Unless otherwise noted, it is acceptable to submit electronic, PDF files.
- B. Submittals and shop drawings shall not contain the firm name, logo, seal, or signature of the Engineer. They shall not be copies of the work product of the Engineer. If the Contractor desires to use elements of such product, the license agreement for transfer of information obtained from the Engineer must be used.
- C. Separate submittals according to individual specification sections. Only resubmit those sections requested for resubmittal.
- D. Unless noted otherwise within each individual section, submittals shall be provided for approval in four distinct submittal stages:
 - 1. "Pre-bid" Submittal
 - a. Generally means submittals required no less than two weeks prior to the due date for the submission of bids, such as:
 - 1) Product substitutions, approved alternate or equivalent requests to be reviewed for approval (Prior to Bid).
 - 2) Alternate personnel credentials to be reviewed for approval
 - 2. "Bid" Submittal
 - a. Generally means submittals required at the time of the submission of bids, such as:
 - 1) Unit Pricing (if required by sections in this Division)
 - 2) Personnel Qualifications
 - 3) Contractor Qualifications
 - 4) Voluntary Bid Alternates
 - 3. "Pre-Construction" Submittal
 - a. Generally means submittals required after the award of the project to the winning bidder and prior to starting construction. At a minimum, Pre-Construction submittals shall include:
 - 1) The project name
 - 2) The submitted contractor's company name, the individual's name responsible for the submittal, and contact information for that individual
 - 3) The Prime Contractor's stamp, which shall certify that the stamped submittals have been check by the Prime Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
 - b. Submittals for this division shall be divided and titled in the following manner:

- 1) Division 28 Electronic Security Systems
- 2) Division 28 Fire Alarm Systems
- c. Submit the following items within 4 weeks after the notice to proceed:
 - 1) Division of Labor amongst sub-contractors. Include:
 - a) Information on each sub-contractor:
 - i) Company Name
 - ii) Address
 - iii) Name of project manager for this project, including:
 - (1) E-mail
 - (2) Telephone number
 - b) A detailed description or matrix identifying who is responsible for furnishing, installing, and verifying the following system components:
 - i) General requirements:
 - (1) Various system power, backup power, and grounding/bonding items.
 - (2) Various conduit and other common work items.
 - (3) Various low-voltage wires/cabling and terminations.
 - (4) Various structural and seismic items (including design)
 - ii) Individual Division 28 sections
 - 2) Updated Personnel and Contractor Qualifications (resubmit if there are no changes)
 - 3) Schedule - A Gantt chart or Milestone list that includes the following timetables:
 - a) Pre-Construction Submittals
 - i) Include time for resubmittals
 - ii) Unless otherwise stated elsewhere within these specifications, assume 1 week review time for the Prime Contractor and 2 weeks for the Architect/Division 28 Design Consultant for each submittal.
 - b) Material purchase/shipping schedules (to identify any long lead times for critical components)
 - c) Conduit Installation
 - d) Cabling Installation
 - e) Cabling termination and testing
 - f) Power and backup power availability
 - g) Equipment installation and testing
 - h) System startup and configuration
 - i) As-built drawings
 - j) Operation and Maintenance Manual submission, resubmission, and approval
 - k) Final Site Observation for Substantial Completion approval

- l) Owner Training sessions
 - m) Other items as required by individual sections in this Division
 - 4) Equipment List - A typed list, indexed by Specification section, of products specifically identified by part number (no wild card characters) within each specification section in this Division. Products are to be listed in the same order as in the specification. List is to include length of manufacturer warranty for each product.
 - 5) Data Sheets - Manufacturers' data-sheets:
 - a) At a minimum all product data-sheets shall contain the following:
 - i) The manufacturers' name and logo somewhere on the page
 - ii) All parts, pieces, and equipment submitted for review shall be identified specifically by stamp, or highlighted in such a manner that the product(s) being considered are clearly identifiable and distinguished from all other materials, parts or equipment that may be on the submittal.
 - iii) For data-sheets with accessories, additional parts, or derivations of the product being submitted all shall be clearly identified for the reviewer and acceptance.
 - iv) Sufficient detail for reviewer to identify all required information, such as size, weight, color, NRTL listings, approval or certification information, and other necessary identifying information to confirm product meets specifications.
 - b) Data-sheets are to be in the same sequential order as is presented within the specifications.
 - 6) Warranty Information – For warranties required by this specification and other Related Sections, submit warranty terms and conditions for each system or product. These shall contain the following:
 - a) Length of warranty period
 - b) What is covered
 - c) All disclaimers, limitations, etc.
 - d) What, if anything, is not covered
 - 7) Samples – refer to individual sections for exact sample requirements.
 - a) Samples requested shall be physical examples that represent materials, equipment or workmanship and establish standards by which the work will be judged. Contractor or Manufacturer is to cover return shipping if sample is to be returned.
 - 8) Shop Drawings – Refer to individual sections for exact Shop Drawing requirements.
 - d. And as required by individual sections in this Division
4. "Project Completion" Submittal
- a. Generally means, unless otherwise noted, submittals required to be submitted 2 weeks prior to Substantial Completion, for the Design Consultant to reference during the "Final Punch" Site Observation. Project Completion, aka "Close-out Documents" include the following:

- 1) Record Drawings
 - 2) Operation and Maintenance Manuals – refer to “Operations and Maintenance Data” section below.
 - 3) Owner training syllabus
 - 4) Recorded Owner Training
 - 5) Project test reports
 - 6) Cable Databases (as applicable)
 - 7) Warranty Certificate(s)
 - 8) And as required by individual sections within this Division
- E. Contractor shall notify the Architect and Design Consultant that the shop drawings have been posted. Contractor shall include the website, user name and password information needed to access the submittals. For submittals sent by e-mail, Contractor shall copy the Architect and Design Consultant’s designated representatives. Contractor shall allow the Design Consultant review time as specified above in the construction schedule. Contractor shall submit only the documents required to purchase the materials and/or equipment in the electronic submittal and shall clearly indicate the materials, performance criteria and accessories being proposed. General product catalog data not specifically noted to be part of the specified product will be rejected and returned without review.
- F. Identify each sheet of printed submittal pages (using arrows, highlighting, underlining or circling) to show applicable sizes, types, model numbers, ratings, capacities and options actually being proposed. Cross out or line-through non-applicable information. Note specified features such as materials or paint finish.
- G. Provide submittals in sufficient detail so as to demonstrate compliance with these Contract Documents and the design concept.
- H. Transmit submittals as early as required to support the project schedule. Allow two weeks Design Consultant review time, plus a duplication of this time for resubmittals, if required. Transmit submittals as soon as possible after Notice to Proceed and before construction starts.
- I. No part of the work shall be started in the shop or in the field until the shop drawings and /or samples for that portion of the work have been submitted and accepted.
- J. Before transmitting submittals and material lists, verify that the equipment submitted is compatible with and suitable for the intended use. Verify that the equipment will fit the available space and allow ample room for maintenance. If the size of equipment furnished makes necessary any change in location, or configuration, submit a shop drawing showing the proposed layout.
- K. The Contractor is not relieved of the responsibility for dimensions or errors that may be contained on submissions, or for deviations from the requirements of the Contract Documents. The noting of some errors but overlooking others does not grant the Contractor permission to proceed in error. Regardless of any information contained in the shop drawings, product data and samples, the Contract Documents govern the work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.
- L. Submittals shall contain the following information. Submittals not so identified will be returned to the Contractor without action:
1. The project name
 2. The applicable Specification Section
 3. The submittal date

4. The submitting contractor's company name and the project manager's name and contact information.
- M. The Contractor's stamp, which shall certify that the stamped drawings have been checked by the Contractor, comply with the Drawings and Specifications, and have been coordinated with other trades.
- N. Include dimensional data for roughing in and installation and technical data sufficient to verify that equipment meets the requirements of the Contract Documents. Include wiring, piping and service connection data.
- O. The Design Consultant's checking and subsequent acceptance of such submittals shall not relieve the Contractor from responsibility for deviations from Drawings or Specifications unless he has, in writing, called the Design Consultant's and Architect's attention to such deviations at the time of submission, and secured written acceptance; nor shall it relieve the Contractor from responsibility for errors in dimensions, details, sizes of members, or quantities; or for omissions of components or fittings; or for not coordinating items with actual building conditions and adjacent work.
- P. The work described in shop drawing submissions shall be carefully checked by all trades for clearances (including those required for maintenance and servicing), field conditions, maintenance of architectural conditions and coordination with other trades on the job. Each submitted shop drawing shall include a certification that related job conditions have been checked by the Contractor and each Subcontractor and that conflicts do not exist.
- Q. Maintain a complete set of reviewed and stamped shop drawings and product data on site.
- R. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed and will be returned to the Contractor for resubmittal.

1.9 ELECTRONIC DRAWING FILES

- A. AutoCAD
 1. In preparation of shop drawings or record drawings, Contractor may, at their option, obtain electronic drawing files in AutoCAD or DXF format from the Engineer for a shipping and handling fee of \$200 for a drawing set up to 12 sheets and \$15 per sheet for each additional sheet. Contact the Architect for Architect's written authorization. Contractor shall request and complete the Electronic File Release Agreement form from the Engineer. Send the form along with a check made payable to Henderson Engineers, Inc. Contractor shall indicate the desired shipping method and drawing format on the attached form. In addition to payment, Architect's written authorization and Engineer's release agreement form must be received before electronic drawing files will be sent.

1.10 SUBSTITUTIONS

- A. Refer to Bid documents, General and Supplementary Conditions for limitations and restrictions on substitutions in addition to requirements specified in this section.
- B. For products, materials, equipment, or systems for which this Division specifically identifies, the Contractor shall use it as the basis for their bid. However, if the Contractor feels a substitute is appropriate for consideration they may submit, as required in these documents prior to bid, for approval by the Design Consultant.
- C. Materials, products and equipment described in the Bidding Documents establish a standard of required function, performance, dimension, appearance and quality to be met by the proposed substitution.
- D. The base bid shall include only the products from manufacturers specifically named in the drawings and specifications.

- E. Request for Substitution:
1. Complete and send the Substitution Request Form attached at the end of this section for each material, product, equipment, or system that is proposed to be substituted.
 2. The burden of proof of the merit of the proposed substitution is upon the proposer.
 3. Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner the following:
 - a. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
 - b. Proposed substitution is consistent with the Contract Documents and will produce indicated results, including functional clearances, maintenance service, and sourcing of replacement parts.
 - c. Proposed substitution has received necessary approvals of authorities having jurisdiction.
 - d. Same warranty will be furnished for proposed substitution as for specified Work.
 - e. If accepted substitution fails to perform as required, Contractor shall replace substitute material or system with that originally specified and bear costs incurred thereby.
 - f. Coordination, installation and changes in the Work as necessary for accepted substitution will be complete in all respects.
- F. Substitution Consideration:
1. No substitutions will be considered unless the Substitution Request Form is completed and attached with the appropriate substitution documentation.
 2. No substitutions will be considered with receipt of Bids, unless the Architect and Design Consultant have received from the Bidder a written request for approval to bid a substitution at least ten calendar days prior to the date for receipt of Bids, and have approved the substitution request.
 3. Indicate revisions required to adapt substitutions including revisions by other trades. Substitutions that increase the cost of the work of related trades are not permitted.
 4. If the proposed substitution is approved prior to receipt of Bids, such approval will be stated in an Addendum. Bidders shall not rely upon approvals made in any other manner, including verbal. Acceptance of substitute equipment manufacturers does not relieve Contractor of the responsibility to provide equipment and materials which meet the performance as stated or implied in the Contract Documents.
 5. No substitutions will be considered after the Contract is awarded unless specifically provided in the Contract Documents.

1.11 OPERATION AND MAINTENANCE DATA

- A. Refer to General Conditions for Operation and Maintenance Data.
- B. Prior to Substantial Completion of the project, furnish to the Architect, for Design Consultant's review, and for the Owner's use, the following Division 28 items:
1. An electronic PDF file containing:
 - a. A parts list of all equipment installed
 - b. Equipment data-sheets for all equipment installed,
 - c. Summary of all settings and configurations for each piece of installed equipment

- d. Listing of all software and versions install
 - e. All software licensing information
 - f. Record Drawings completed in electronic format, updated from submitted Shop Drawings,
 - g. Manufacturer's service and maintenance data,
 - h. Warranty certificates
 - i. Include local contacts complete with address and telephone number, for equipment, apparatus, and system components furnished and installed under this Division of the specifications.
- C. Instruct the Owner's permanent personnel in the proper operation of, startup and shutdown procedures and maintenance of the equipment and components of the systems installed under this Division.
- D. Refer to individual sections in this Division for additional requirements.

1.12 APPROVED EQUIVALENTS

- A. For specific products, materials, equipment, or systems for which this Division specifically identifies the Contractor shall use as the basis for their bid. Where the term approved equivalent or equal is listed the contractor may submit documentation for review by the Design Consultant for approval. The Design Consultant's acceptance or rejection is final.

1.13 VOLUNTARY ALTERNATE BIDS

- A. Voluntary alternate bids will be accepted provided they are included in conjunction with a valid base bid or bid approved as an acceptable substitution by the Design Consultant.

1.14 SPARE PARTS

- A. Provide to the Owner the spare parts specified in the individual sections of this Division.
- B. Obtain the Owner's or Owner's representative's written acceptance when the specified spare parts for that section are delivered.

1.15 RECORD DRAWINGS

- A. Refer to General Conditions for Record Drawings in addition to requirements specified in this section.
- B. Maintain on a daily basis a set of jobsite work prints of the Issued for Construction Drawings, reflecting an accurate dimensional record of deviations between work shown on Drawings and that actually installed.
- 1. Record dimensions clearly and accurately to delineate the work as installed; suitably identify locations of all equipment by at least two dimensions to permanent structures.
 - 2. Pay particular attention to those items that require locating for servicing. This includes, but is not limited to, above-ceiling items such as:
 - a. Cable and conduit routing
 - b. Pullbox and junction box locations
- C. At the completion of the project, obtain reproducible electronic copies of the final Drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done electronically in [AutoCAD] [Revit] [Adobe PDF] and saved to PDF [and AutoCAD 2007 dwg] format. Mark each sheet "Record Drawing", along with the date, and deliver these Record Drawings to the Architect.

1. PDF versions of the drawings shall have searchable text. "Flattened" PDFs will not be acceptable.

1.16 DELIVERY, STORAGE AND HANDLING

- A. Refer to General Conditions for Delivery, Storage and Handling in addition to requirements specified herein.
- B. Deliver equipment and material to the job site in their original containers with labels intact, fully identified with manufacturer's name, make, model, model number, type, size, capacity and Underwriter's Laboratories, Inc. labels and other pertinent information necessary to identify the item.
- C. Deliver, receive, handle and store equipment and materials at the job site in the designated area and in such a manner as to prevent equipment and materials from damage and loss. Store equipment and materials delivered to the site on pallets and cover with waterproof, tear resistant tarp or plastic or as required to keep equipment and materials dry. Follow manufacturer's recommendations, and at all times, take every precaution to properly protect equipment and material from damage, including the erection of temporary shelters to adequately protect equipment and material stored at the Site. Equipment and/or material which becomes rusted or damaged shall be replaced or restored by the Contractor to a condition acceptable to the Architect and Design Consultant.
- D. Be responsible for the safe storage of tools, material and equipment.

1.17 PROJECT CONDITIONS

- A. Conditions Affecting Excavations: The following project conditions apply:
 1. Maintain and protect existing building services that transit the area affected by selective demolition.
 2. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by excavation operations.
- B. Site Information: Subsurface conditions were investigated during the design of the Project. Reports of these investigations are available for information only; data in the reports are not intended as representations or warranties of accuracy or continuity of conditions. The Owner will not be responsible for interpretations or conclusions drawn from this information.
- C. Use of explosives is not permitted.
- D. Environmental Conditions: Apply joint sealers under temperature and humidity conditions within the limits specified by the joint sealer manufacturer. Do not apply joint sealers to wet substrates.

PART 2 - PRODUCTS

2.1 EQUIPMENT AND MATERIALS

- A. Use only products listed for their intended use by a NRTL, except products for which no relevant standards exist.
- B. Where products are required to be NRTL listed, classified, approved or otherwise each individual item shall bear the NRTL mark by permanent means.
- C. Provide products and materials that are new, clean, free of defects, and free of damage and corrosion.

- D. Products and materials shall not contain asbestos, PCB, or any other material, which is considered hazardous by the Department of Environmental Protection or any other authority having jurisdiction.
- E. As directed by the Architect, replace materials of less than specified quality and relocate work incorrectly installed.
- F. Refer to individual sections for labeling requirements.
- G. Install materials and equipment with qualified trade people.
- H. Maintain uniformity of manufacturer for equipment used in similar applications and sizes.
- I. Follow manufacturer's instructions for installing, connecting, and adjusting equipment. Provide a copy of such instructions at the equipment during installation.
- J. Where factory testing of equipment is required to ascertain performance and attendance by the Owner's representative is required to witness such tests, associated travel costs and subsistence shall be paid for by the Contractor.
- K. Equipment capacities, ratings, etc., are scheduled or specified for job site operating conditions. Equipment sensitive to altitude shall be de-rated with the method of de-rating identified on the submittals.
- L. Enclosures for Electronic Safety and Security Infrastructure/equipment installed in mechanical equipment rooms shall be NEMA type 1 gasketed. Enclosures for Electronic Safety and Security Infrastructure/equipment installed outdoors shall be NEMA type 3R.
- M. If products and materials are specified or indicated on the drawings for a specific item or system, use those products or materials. If products and materials are not listed in either of the above, use first class products and materials, subject to approval of product data submittal.
- N. Ship and store all products and materials in a manner that will protect them from damage, weather and entry of debris. If items are damaged, do not install, but take immediate steps to obtain a replacement. Repairs of damaged goods will only be permitted with prior written permission of the Owner/Design Consultant.
- O. Part numbers and product codes in these specifications are correct as of the time of writing. Manufacturers may, however, change part numbers and product codes on short notice. In cases where part numbers or product codes differ from technical specifications for a particular product, provide products meeting the minimum technical specifications of the products in the specifications. Notify the Owner/Design Consultant of any product code and or part number changes on the material list submittal.

PART 3 - EXECUTION

3.1 FEES AND PERMITS

- A. Secure and Pay all required fees and obtain all required permits related to the Electronic Safety and Security Systems' installation.
- B. Pay royalties or fees in connection with the use of patented devices and systems.

3.2 CLEANING

- A. Avoid accumulation of debris, boxes, loose materials, crates, etc., resulting from the installation of this work. Remove from the premises each day all debris, boxes, etc., and keep the premises clean and free of dust and debris.

- B. Immediately prior to final inspection, make a final cleanup of dirt and refuse resulting from Work and assist in making the premises vacuum clean. Clean all material and equipment installed under this Division.
- C. Clean all fixtures and equipment at the completion of the project. Wipe clean exposed lighting fixture reflectors and trim pieces with a non-abrasive cloth just prior to occupancy.
- D. Remove dirt, dust, plaster, stains, and foreign matter from all surfaces.
- E. Touch up and restore damaged finishes to their original condition.
- F. All Electronic Safety and Security infrastructure and equipment shall be thoroughly vacuumed and wiped clean prior to startup and at the completion of the project. Equipment shall be opened for observation by the Architect as required.

3.3 DELIVERY, DRAYAGE AND HAULING

- A. Provide drayage, hauling, hoisting, shoring and placement in the building of equipment specified and be responsible for the timely delivery and installation of equipment as required by the construction schedule. If any item of equipment is received prior to the time that it is required, and provide proper storage and protection until the time it is required. Pay for all costs of demurrage or storage.
- B. If equipment is not delivered or installed at the project site in a timely manner as required by the project construction schedule, then Contractor shall be responsible for resulting disassembly, re-assembly, manufacturer's supervision, shoring, general construction modification, delays, overtime costs, etc. at no additional cost to the Owner.

3.4 EQUIPMENT AND MATERIAL PROTECTION

- A. Protect the work, equipment, and material of other trades from damage by work or workmen of this trade, and correct damaged caused without additional cost to the Owner.
- B. Take responsibility for work, materials, and equipment until finally inspected, tested and accepted. Protect work against theft, injury, or damage, and carefully store material and equipment received on site, which is not immediately installed. Close open ends of work with temporary covers or plugs during construction to prevent entry of obstructing material. Cover and protect equipment and materials from damage due to water, spray-on fireproofing, construction debris, etc. Store equipment to moisture damage in dry, heated spaces.
- C. Provide adequate means for fully protecting finished parts of materials and equipment against damage from whatever cause during the progress of the work until final acceptance. Protect materials and equipment in storage and during construction in such a manner that no finished surfaces will be damaged or marred, and moving parts are kept clean and dry. Do not install damaged items; take immediate steps to obtain replacement or repair.

3.5 CONNECTED PRODUCTS CYBER- SECURITY

- A. Software Requirements
 - 1. All firmware in products furnished or provided by the Contractor shall be the latest and most up-to-date provided by the manufacturer.
 - 2. All equipment requiring users to log on using a password shall be configured with user/site-specific passwords). No system/product default passwords shall be allowed. Coordinate user logins and passwords with Owner prior to system setup.
 - a. Passwords shall always be guarded and protected, including during construction phase of the project. Passwords shall not be written on or in any device, enclosure, or room where access could be obtained by others.

- b. Passwords shall be transmitted to owner, and Design Consultants via secure methods, obscuring or encrypting the document to be transmitted. This document shall be secured while stored for submission with the project(s) other submittals, including Shop Drawings and As-Built documentation.
 3. Refer to individual sections for additional software requirements.
- B. Network and Cybersecurity Requirements
1. For all Electronic Security Systems that have Contractor-provided equipment with an Ethernet/LAN port, Contractor shall coordinate with Owner's IT staff regarding Owner's network and cyber security requirements.
 2. The Contractor shall take positive measures to prevent the introduction of cybersecurity threats to the Owner's technology infrastructure and network. These measures shall include but are not limited to:
 - a. Coordinate with the manufacturer to ensure newly procured equipment does not have any cybersecurity notices, bulletins, or alerts. Provide a letter to the Design Consultant with the submittal documents for that Specification section confirming there are no active or known cyber threats.
 - b. Ensure all installers/technicians installing or configuring equipment are trained on the prevention of introduction of cyber threats to electronics.
 - c. The Contractor shall assess any cyber threats / vulnerabilities associated with the specified equipment, prior to procurement/installation. If cyberthreats are discovered, notify the Design Consultant within one Day. Provide the make and model of the associated equipment and the vulnerability.
 - d. Follow additional cybersecurity requirements and procedures as directed by the Owner's IT staff.
- C. Refer to individual sections for additional Networking and Cybersecurity Requirements.

3.6 ADJUSTING, ALIGNING AND TESTING

- A. Adjust, align and test all Electronic Safety and Security infrastructure and equipment furnished and/or installed under this Division.
- B. Check and test protective devices for specified and required application, and adjust as required.
- C. Verify that completed wiring system is free from short circuits, unintentional grounds, low insulation impedances, and unintentional open circuits.
- D. Notify the Architect immediately of all operational failures caused by defective material, labor or both.
- E. Refer to individual Sections for additional and specific requirements.

3.7 START-UP OF SYSTEMS

- A. Prior to start-up of Electronic Safety and Security systems, check all components and devices, to confirm compliance with manufacturers' recommended installation procedures.
- B. Demonstrate that all equipment and systems perform properly as designed per Drawings and Specifications.
- C. Refer to individual Sections for additional and specific requirements.

3.8 OPERATING INSTRUCTIONS

- A. Instruct Owner's operating and maintenance personnel in proper starting sequences, operation, shutdown, general maintenance and preventative maintenance procedures, including normal and emergency procedures.
- B. Refer to individual Sections for additional and specific requirements.

3.9 SUBSTANTIAL COMPLETION REVIEW

- A. Prior to requesting a site observation for "CERTIFICATION OF SUBSTANTIAL COMPLETION", complete the following items:
 - 1. Submit complete Operation and Maintenance Data.
 - 2. Submit complete Record Drawings.
 - 3. Perform all required training of Owner's personnel.
 - 4. Turn over all spares and extra materials to the Owner, along with a complete inventory of spares and extra materials being turned over.
 - 5. Perform start-up tests of all systems.
 - 6. Remove all temporary facilities from the site.
 - 7. Comply with all requirements for Substantial Completion in the Division 1 and General Conditions.
- B. Request in writing a review for Substantial Completion. Give the Architect at least seven (7) days notice prior to the review.
- C. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
- D. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
- E. If the Contractor requests a site visit for Substantial Completion review prior to completing the above-mentioned items, then provide reimbursement to the Architect and Design Consultant for time and expenses incurred for the visit.
- F. Upon completion of the review, the Architect and Design Consultant will prepare a "final list" of outstanding items to be completed or corrected for final acceptance.
- G. Omissions on the "final list" shall not relieve the Contractor from the requirements of the Contract Documents.
- H. Prior to requesting a final review, submit a copy of the final list of items to be completed or corrected. State in writing that each item has been completed, resolved for acceptance or the reason it has not been completed.

3.10 EARLY OCCUPANCY

- A. Failure to meet the Substantial Completion date can result in the Owner needing to take early occupancy. Complete the systems which are necessary to allow partial early occupancy of the building by original Substantial Completion date.
 - 1. Refer to individual sections for additional requirements.
- B. Verify and comply with requirements for temporary occupancy with the local Building and Fire Departments.

END OF SECTION

SUBSTITUTION REQUEST FORM

To Project Engineer: _____ Request # (GC Determined): _____

Project Name: _____

Project No/Phase: _____ Date: _____

Specification Title: _____

Section Number: _____ Page: _____ Article/Paragraph: _____

Proposed Substitution: _____

Manufacturer: _____ Model No.: _____

Address: _____ Phone: _____

History: New product 1-4 years old 5-10 years old More than 10 years old

Differences between proposed substitution and specified Work: _____

Point-by-point comparative data attached – REQUIRED BY ENGINEER
Comparative data may include but not be limited to performance, certifications, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements. Include all information necessary for an evaluation.

Supporting Data Attached: Drawings Product Data Samples
 Tests Reports Other: _____

Reason for not providing specified item: _____

Similar Installation:
Project: _____ Architect: _____

Address: _____ Owner: _____

_____ Date Installed: _____

Proposed substitution affects other parts of Work: No Yes; explain: _____

Substitution Certification Statement:

Unless stated otherwise in writing to the Engineer by the Contractor, Contractor warrants to the Engineer, Architect, and Owner that the:

- ▲ A. Proposed substitution has been fully investigated and determined to meet or exceed the specified Work in all respects.
- B. Proposed substitution is consistent with the Contract Documents and will produce indicated results.
- C. Proposed substitution does not affect dimensions and functional clearances.
- D. Proposed substitution has received necessary approvals of authorities having jurisdiction.
- E. Same warranty will be furnished for proposed substitution as for specified Work.
- F. Same maintenance service and source of replacement parts, as applicable, is available.
- G. Proposed substitution will not adversely affect other trades or delay construction schedule.
- H. Coordination, installation, and changes in the Work as necessary for accepted substitution will be complete in all respects.

Submitting Contractor Date Company

Manufacturer's Certification of Equal Quality:

I _____ represent the manufacturer of the Proposed Substitution item and hereby certify and warrant to Architect, Engineer, and Owner that the function and quality of the Proposed Substitution meets or exceeds the Specified Item.

Manufacturer's Representative Date Company

Engineer Review and Recommendation Section

Recommend Acceptance Yes No
Additional Comments: Attached None

Acceptance Section:

Contractor Acceptance Signature Date Company

Owner Acceptance Signature Date Company

Architect Acceptance Signature Date Company

Engineer Acceptance Signature Date Company

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SECTION 28 05 01 - COMMON WORK RESULTS FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. This Section includes general construction materials and methods, electronic security equipment coordination, and common Electronic Security Systems installation requirements as follows:
 - 1. Pathways
 - a. Conduit
 - b. Outlet Boxes
 - c. Pull Boxes
 - 2. Grounding and Bonding
 - 3. Firestopping Systems
 - 4. Access Panels
 - 5. Identification
- B. *Note* Refer to Division 28 Section "Common Work Results for Fire Alarm Systems" for common work requirements for fire alarm systems. This section specifies the common work requirements of all other Division 28 sections.

1.2 RELATED SECTIONS

- A. Except as modified by governing codes and by the Contract Documents, comply with the applicable provisions and recommendations in Division 28 Section "General Electronic Safety and Security Requirements"
- B. Firestopping requirements listed in this section are unique to Division 28 Work. Refer to Division 07 Section "Penetration Firestopping" for general and additional firestopping requirements.
- C. Refer to Division 26 for materials and methods for additional requirements for the following:
 - 1. Division 26 Section "Common Work Results for Electrical" for electrical systems coordination.
 - 2. Division 26 Section "Equipment Wiring Systems" for electrical systems coordination.
 - 3. Division 26 Section "Grounding and Bonding for electrical systems" for electrical systems coordination.
 - 4. Division 26 Section "Hangers and Supports for Electrical Systems" for electrical systems coordination.
 - 5. Division 26 Section "Raceways and Boxes for Electrical System" for electrical systems coordination.
 - 6. Division 26 Section "Cable Tray" electrical systems coordination.
 - 7. Division 26 Section "Underground Ducts and Raceways for Electrical Systems" for electrical systems coordination.

1.3 CODES, STANDARDS, AND GUIDELINES

- A. Follow all applicable codes, references, and standards listed in Division 28 Section "General Electronic Safety and Security Requirements".

- B. Follow all guidelines listed in Division 28 Section “General Electronic Safety and Security Requirements”.
- C. Follow the correct revision or printing (UON) of all applicable codes, references, standards, and guidelines.
- D. Follow the additional codes, references, standards and guidelines:
 - 1. Follow the additional codes, references, standards and guidelines:
 - a. For Telecommunications Infrastructure (Category 5e/6/6A and fiber optic cabling) required by this division:
 - 1) ANSI/TIA/EIA-569-C – “Commercial Building Standard for Telecommunications Pathways and Spaces”
 - b. For Firestopping installed by this division:
 - 1) ASTM E 814 and ANSI/UL1479 –“Fire Tests Through Penetration Firestops”
 - 2) ASTM E 84 and ANSI/UL 723 “Surface Burning Characteristics of Building Materials”
 - 3) ASTM E 119 and ANSI/UL 263 “Fire Tests of Building Construction Materials”

1.4 QUALITY ASSURANCE

- A. Install all Work in strict conformance with all manufacturers' requirements and recommendations, unless these Documents exceed those requirements. Install all equipment and materials in a neat and professional manner, aligned, leveled, and adjusted for satisfactory operation, in accordance with NECA guidelines.
- B. Firestopping Systems
 - 1. Firestopping material and systems shall be tested and listed by UL. All firestopping products shall bear this classification marking.
 - 2. Installation technicians shall be by qualified and trained personnel. Acceptable installer qualifications are as follows:
 - a. FM Research, approved in accordance with FM AS 4991.
 - b. Individuals who are trained and certified by the firestopping manufacturer. For Specified Technologies, all installers shall have current FIT Level 1 certification.

1.5 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Section “General Electronic Safety and Security Requirements”.
- B. The following submittals are due as part of the Pre-Bid Submittal:
 - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information. Be prepared to submit a sample should the Design Consultant request an evaluation.
- C. The following submittals are due at the Pre-Construction Submittal:
 - 1. Contractor Qualifications (for Firestopping Systems): Provide copies of training/certification as required in the Quality Assurance portion of this specification section.

2. Parts List: Provide a typed list indicating part name, manufacturer, part number, and color (if applicable) for products specifically identified herein by the exact and complete part number (no wild-card characters).
3. Submit manufacturers' cut sheets or catalog cut sheets of each of the pathways not specifically identified by its exact part number:
 - a. Cut sheets shall include the following information at a minimum:
 - 1) Manufacturers name and logo
 - 2) Size – including physical and loading dimensions
 - 3) Maximum span length
 - 4) Weight supported
 - 5) Type
 - 6) Fittings to be used
 - 7) Method of attachment to structure
 - 8) Firestop system assembly information for each system to be installed:
 - a) Documentation from UL catalog for each system proposed. This documentation shall include the following information:
 - i) Firestop manufacturer
 - ii) UL system number
 - iii) F, T, and L Ratings
 - iv) The complete description of the firestop system; To include what specific construction the system is intended to pass through such as a wall or floor assembly, the penetrating items allowed to pass through the opening in the wall or floor assembly, and the materials designed to prevent the spread of fire through the openings.
4. Shop Drawings:
 - a. Submit for review scaled layout drawings showing the size/routing of all pathways and the size/information/locations of all boxes, pullboxes, firestopping systems, and access panels.
 - 1) Each pathway shall be identified by type and size on the drawings.
 - a) Example #1: 4" EMT
 - b) Example #2: 2" IMC
 - 2) Each grounding conductor shall be identified by size (and insulation):
 - a) Example: #3/0 insulated ground
 - 3) Each firestop system shall be identified by Manufacturer and Product, as well as UL system number for that particular location.
 - a) Example #1 – Firestopping Sleeve: EZ-Path Series 22, UL System W-L-3255
 - b) Example #2 – Backbox in Fire-Rated Wall: Specseal Power Shield, UL System QCSN/CLIV.R14288
 - 4) Each pullbox and access panel shall be identified by size and height above finished floor.

- a) Pullbox Example: Pullbox 8" x 24" x 40" approximately 12' AFF.
- b. Include pathway systems (conduit, cable tray, auxiliary supports, etc.) and other common work on the same shop drawings for Division 28 "Electronic Security Systems".
 - 1) The following submittals are due at the Project Completion Submittal:
 - a) Record Drawings:
 - i) Based on the work prints kept on the jobsite and official changes to the Contract Documents (such as Change Orders, Architect's Supplemental Instructions, and Design Change Directives), create final drawings incorporating any minor and approved changes to the submitted Shop Drawings. Submit this set in accordance with the Record Drawings requirements of Division 28 Section "General Electronic Safety and Security Requirements".
 - b) Keys – Supply two copies of every key as required for pullboxes, junction boxes, and access panels.

1.6 DEFINITIONS

- A. Conditionally Approved - the manufacturer has been found reputable by the Design Consultant, but the Design Consultant has not verified that the product offering by manufacturer meets to all specification and project requirements. Contractor shall adhere to submittal review process for final approval on products.
- B. Conveniently Accessible – Capable of being reached from the floor or via the use of an 6 to 12 foot step ladder without crawling or climbing over or under obstacles such as piping, duct work, motors, transformers, pumps, etc.
- C. Firestopping System – Firestopping products that have been specifically tested and rated by a Nationally Recognized Testing Laboratory (NRTL), such as UL, to provide the required flame (F), fire and temperature (T), air and smoke (L), and water (W) containment for a given partition/penetration.
- D. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- E. IMC – Intermediate Metal Conduit
- F. Plenum – A compartment or chamber to which one or more air ducts are connected and that forms part of the air distribution system.
- G. Plenum-rated – A product that is listed by a NRTL as being suitable for installation into a plenum space.
- H. RMC – Rigid Metal Conduit
- I. Surface Metal Raceway – A metallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- J. Surface Nonmetallic Raceway – A nonmetallic raceway that is intended to be mounted to the surface of a structure, with associated couplings, connectors, boxes, and fittings for the installation of electrical conductors.
- K. UL – Underwriters Laboratory

1.7 COORDINATION

- A. Coordinate arrangement, mounting, and support of equipment:

1. To allow maximum possible headroom unless specific mounting heights that reduce headroom are indicated.
 2. To provide for ease of disconnecting the equipment with minimum interference to other installations.
 3. To allow right of way for piping, ducts, and other systems installed at required slopes and/or elevations.
 4. So connecting raceways, cables, and wireways will be clear of obstructions and of the working and access space of other equipment.
 5. Adjust location of conduits, terminal blocks, equipment, etc., to accommodate the work to prevent interferences, both anticipated and encountered. Determine the exact route and location of each conduit prior to fabrication.
 - a. Right-of-Way: Lines which pitch shall have the right-of-way over those which do not pitch. For example: condensate, steam, and plumbing drains normally have right-of-way. Lines whose elevations cannot be changed have right-of-way over lines whose elevations can be changed.
 - b. Provide offsets, transitions and changes in direction of conduit* as required to maintain proper headroom and pitch on sloping lines. *Refer to Part 3 of this section for stringent conduit bend requirements.
- B. Coordinate installation of required supporting devices and set sleeves in cast-in-place concrete, masonry walls, and other structural components as they are constructed.
- C. Coordinate location of access panels and doors for Division 28 equipment that are behind finished surfaces or otherwise concealed.
- D. Coordinate testing of electrical, mechanical, and architectural items, so equipment and systems that are functionally interdependent are tested to demonstrate successful interoperability.

PART 2 - PRODUCTS AND MATERIALS

2.1 PATHWAYS FOR ELECTRONIC SECURITY SYSTEMS

- A. General
1. Category 6A and fiber cabling and pathways between Equipment Rooms (shared Communications Rooms) and devices are by Division 27 and Owner.
 2. All other cabling serving Electronic Security System devices within the footprint of the building shall meet the following requirements (from device to Equipment Room):
 - a. Within concealed conduit from device to overhead ceiling space.
 - b. For areas above accessible ceilings, supported via J-hooks every 48"-60" back to nearest cable tray or serving Equipment Room. For inaccessible ceilings or ceilings exposed to structure, continue routing cable within conduit.
 3. Division 28 "Electronic Security Systems" Contractor is to indicate proposed pathway types/supports and routing on Division 281000 Shop Drawings.
- B. Conduit
1. Specifications
 - a. Refer to Electrical Division 26 for specific product and material information.

- 1) Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
 - b. Conduits routed within the building as connection to outside devices (exterior to the footprint of the building) shall be rigid metal (RMC) or intermediate metal conduit (IMC) at the point it enters the building, emerges from an exterior wall or ground floor slab to the final Equipment Room termination/transition point.
 - 1) If services enter a room or space such as a mechanical room, electrical room or other intermediate room due to convenience or proximity to the exterior and adequate space has not been provided within 50 feet for the equipment needed for transitioning these and future cables/services to an appropriately rated indoor cable then those conduits shall be continued uninterrupted (except for necessary pull boxes) to the final connection point or location where the transition point has been designated.
 - c. For interior devices (and devices on the face of exterior walls) Electrical metallic tubing (EMT) with compression connectors shall be used where concealed in walls, above ceiling, and exposed or concealed in equipment rooms.
 - d. Unless specifically identified on the Security drawings, flexible conduit shall not be used.
 - e. Conduits shall be dedicated to specific sub-systems (i.e. video cabling shall not be installed in any other sub-system conduit, such as access control, intrusion detection, fire alarm, etc.).
 - f. Provide conduit as indicated on the Drawings or required by this Specification.
 - 1) Minimum conduit size for all Category 6 cabling shall be: $\frac{3}{4}$ " inch for interior locations and 1" for exterior locations (such as devices at light poles and gates).
 - 2) Provide a polypropylene or monofilament plastic line with not less than 200-lb tensile strength in each conduit.
 - 3) Permanently mark or tag each conduit at the source and inside each pull box, identifying it based on specific subsystem (Access Control, Intrusion Detection, etc) and far-end destination. Each conduit that is stubbed into the ceiling space from an outlet box shall be permanently marked or tagged; refer to Labeling requirements in Section 3 – Execution.
- C. Outlet Boxes
1. The following manufacturers are Conditionally Approved, unless otherwise noted.
 - a. Emerson/Appleton
 - b. Hubbell/RACO
 - c. Randl Industries
 - d. Thomas & Betts/Steel City
 - e. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
 2. Specifications
 - a. Boxes shall either be square or rectangular, as noted on the drawings. Dimensions indicate minimum size.
 - b. For masonry (CMU) walls, backbox shall be 3-1/2 inches deep. Manufacturer shall be:
 - 1) Single gang – RACO 695R, no substitutes
 - 2) Double gang – RACO 696R, no substitutes

- c. For stud walls, backbox shall be 2-3/4 inches deep. Manufacturer shall be:
 - 1) Single gang – RACO 560 series, or equivalent from Conditionally approved manufacturer.
- d. Telecommunications Boxes for Security – for camera outlets shown on TN drawings:
 - 1) For stud walls: dual-gang outlet box shall be a minimum size of 4-11/16 inches width by 4-11/16 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension as needed for flush mounting. Depth shall match that of wall gypsum board(s).
 - a) Double gang – RACO 258/259 (Coordinate knock-out size with conduit size indicated on drawings), RANDL T-55017 or equivalent with appropriate
 - 2) For ceilings (flush or above accessible ceiling): plenum-rated, dual-gang outlet box shall be a minimum size of 4 inches width by 4 inches height by 2-1/8 inches depth, with a dual-gang or single-gang raised cover/extension ring as needed for flush mounting. Depth shall match thickness of gypsum ceiling board(s) or accessible ceiling panel (if applicable).
 - a) Double gang – RACO 239 or equivalent, with ceiling grid framing where installed in accessible ceiling.
- e. Junction Box – in accessible ceiling space above access controlled doors
 - 1) Minimum Size 6" x 6" x 4" deep, or as noted on drawings/details, with hinged cover
 - 2) NEMA 1 rating
 - 3) Manufacturer shall be Hoffman A6N64 (or larger) or equivalent from Conditionally approved manufacturer.
- f. Pull Boxes - for interior use only, mounted in Conveniently Accessible Locations.
 - 1) Specifications
 - a) NEMA 1
 - b) Refer to Execution section for sizing requirements.
 - 2) The following manufacturers are Conditionally Approved.
 - a) Hoffman
 - b) NEMA Enclosures
 - c) Wiegmann
 - d) Or Equivalent

2.2 GROUNDING AND BONDING

- A. Refer to drawings and Division 28 Section "Equipment Room Fittings for Electronic Security" for exact grounding and bonding requirements.

2.3 FIRESTOPPING SYSTEMS

- A. General
 - 1. The following manufacturers are Conditionally Approved.
 - a. 3M
 - b. Hilti
 - c. Specified Technologies, Inc

2. Division 28 "Electronic Security Systems" Contractor is to indicate proposed Firestopping locations that correspond to their proposed pathway and cable routing on Division 281000 Shop Drawings.
 3. Refer to Architecture / Life Safety plans for locations of fire- and smoke-rated walls.
- B. Zero-Maintenance Fire-Rated Pathway Device – for sleeves through a single penetration (wall or floor)
1. Specifications
 - a. Minimum performance requirements: Shall meet testing requirements of ASTM E-814 or U.L. 1479; Shall be installed in accordance with the NRTL. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 - b. Shall meet or exceed the ratings of the wall or floor that it penetrates.
 - c. Shall be a pre-fabricated and zero-maintenance solution which requires no action to activate the fire and smoke protective characteristics of the device.
 - d. Allows the installation and removal of cables without the need to remove or add any materials.
 - e. Used to seal penetrations of cables through fire rated partitions
 2. Manufacturer shall be:
 - a. EZ-Path family of products by Specified Technologies Inc.
 - b. SpeedSleeve series of products by Hilti
 - c. Or approved equivalent
- C. Firestopping for Backboxes in Fire-Rated Walls
1. Specifications
 - a. Used to seal backboxes in fire rated partitions.
 - b. Minimum performance requirements: Shall meet UL testing requirements of UL 263 and classified as Wall Opening Protective Material (QCSN or CLIV); Shall be installed in accordance with the NRTL. Shall meet or exceed the ratings of the wall or floor that it is located in.
 - c. Provide fire stop systems appropriate for the specific application and in accordance with manufacturer's instructions.
 2. Manufacturer shall be:
 - a. Specified Technologies Inc., SpecSeal Power Shield
 - b. Or approved equivalent
- D. Firestopping for Thru-Wall (or Floor) Conduit Penetrations and Other Applications
1. For fire-rated penetrations where the pathway extends beyond a single fire-rated partition, and other required firestopping applications not previously addressed in this specification.
 2. Specifications:
 - a. Shall be UL listed for the specific application; Shall meet or exceed the ratings of the wall or floor that it penetrates.
 3. Manufacturer shall be:

- a. Specified Technologies Inc.
- b. Or approved equivalent

2.4 ACCESS PANELS

- A. The following manufacturers are Conditionally Approved.
1. Activar/J.L Industries www.activarcpg.com
 2. Acudor Products www.acudor.com
 3. Alfab/Barco www.alfabinc.com
 4. Elmdor Products www.elmdorproducts.com
 5. Karp Associates, Inc. www.karpinc.com
 6. Milcor www.commercialproductsgroup.com
 7. Nystrom Building Products www.nystrom.com
 8. Williams Brothers www.wbdoors.com
 9. Wind-lock www.wind-lock.com
 10. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
- B. Specifications:
1. To be utilized for access to a Pull Box that is installed above an inaccessible ceiling (where a Pull Box is required to keep the number of bends in conduit to 180 degrees or less between pull points).
 2. Steel Access Panels and Frames: Factory-fabricated and assembled units, complete with attachment devices and fasteners ready for installation.
 3. Joints and seams: continuously welded steel, with welds ground smooth and flush with adjacent surfaces.
 4. Frames: 16-gauge steel, with a 1 inch (25.4 mm) wide exposed perimeter flange for units installed in unit masonry, pre-cast, or cast-in-place concrete, ceramic tile, or wood paneling:
 - a. For installation in masonry, concrete, ceramic tile, or wood paneling: 1-inch-wide-exposed perimeter flange and adjustable metal masonry anchors.
 - b. For gypsum wallboard or plaster: perforated flanges with wallboard bead.
 - c. For full-bed plaster applications: galvanized expanded metal lath and exposed casing bead, welded to perimeter of frame.
 5. Flush Panel Doors: 14-gauge sheet steel, with concealed spring hinges or concealed continuous piano hinge set to open 175 degrees; factory-applied prime paint.
 6. Fire-Rated Units: Insulated flush panel doors, with continuous piano hinge and self-closing mechanism.
- C. Locking Devices:
1. Wherever these are located in a publically accessible space and are less than 9' AFF, provide a lock.
 2. Lock shall be 5-pin or 5-disc type cylinder locks, individually keyed.
 3. Provide 2 keys.

- D. Indicate proposed size and locations on pre-construction shop drawings. No access panels shall be installed without Architect and Design Consultant approval.

2.5 FASTENINGS

- A. Except in equipment rooms, all exposed securing screws shall be stainless steel, center pin torx security screws. Security Fasteners: A maximum of two different sets of tools shall be required to operate security fasteners for Project. Provide stainless-steel security fasteners in stainless-steel materials.
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
1. Holo-Krome; a Danaher Corporation.
 2. Safety Socket Screw Corporation.
 3. Tamper-Pruf Screws, Inc.
 4. Textron Inc.

2.6 IDENTIFICATION FOR COMMON WORK FOR ELECTRONIC SECURITY SYSTEMS

- A. Labels
1. The following manufacturers are Conditionally Approved for generic labeling requirements for conduits, pullboxes, and equipment racks.
 - a. Brady www.bradycorp.com
 - b. Brother www.brother-usa.com
 - c. Dymo www.dymo.com
 - d. HellermannTyton www.hellermannntyton.com
 - e. Panduit www.panduit.com
 - f. Or Approved Substitution (submitted and accepted in the "pre-bid" phase)
 2. Specifications:
 - a. Refer to additional requirements in Part 3 – Execution.
 - b. Refer to individual sections for additional identification requirements for specific work.

PART 3 - EXECUTION

3.1 PATHWAYS FOR ELECTRONIC SAFETY AND SECURITY

- A. General
1. Refer to Electrical Division 26 for specific installation requirements.
 - a. Sizes, methods, and more stringent requirements shall be adhered to when specified in this Division.
 2. Comply with NECA 1 and NECA 101 for installation requirements except as specified in this Article.
 3. All supports shall be specifically designed to support the required cable weight and volume. Field manufactured supports will not be accepted.

4. Install a pull cord in each pathway (empty or not) for installation of new wires or cables. Use polypropylene or monofilament plastic line with not less than 200 lb (90.7 kg) tensile strength. Leave at least 12 inches (304.8 mm) of slack at each end of pull cord.
5. Unless otherwise noted, pathway routing shown on the Drawings is illustrative only and meant to indicate the general configuration of the work. Install pathways so that adequate clearances and offsets between pathways and other trades are provided. Coordinate all pathways with other trades prior to installation.
6. All pathways shall include empty space for a minimum of 25% growth beyond initial installation of cabling.
7. Cables shall be rigidly supported by cable pathways as indicated on the drawings. Cables shall be physically supported at intervals not to exceed 5 feet (1.52 m).
8. Store and keep dry all products in original container in a climate controlled environment until installation is to occur
9. Install all pathways:
 - a. So that cables are allowed to be pulled in accordance with referenced standards and guidelines.
 - b. So that cables are allowed to be pulled without damage to conductors, shield, armor, or jacket.
 - c. So that cables are not forced or allowed to exceed minimum allowed bend radius by manufacturer or referenced standards and guidelines.
 - d. So that the maximum allowable pulling tension is not exceeded.
 - e. To meet the requirements of the structure and the requirements of all other Work on the Project
 - f. To clear all openings, depressions, ducts, pipes, reinforcing steel, and so on.
 - g. Within or passing through the concrete structure in such a manner so as not to adversely affect the integrity of the structure. Become familiar with the Architectural and the Structural Drawings and their requirements affecting the raceway installation. If necessary, consult with the Architect.
 - h. Parallel or perpendicular to building lines or column lines.
 - i. When concealed, with a minimum of bends in the shortest practical distance, considering type of building construction and obstructions, unless otherwise indicated.
10. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or other methods shall not be used to attach cables to cable supports.
11. Provide adequate pathways so that cabling is not forced to attach, be supported, or use other pathways not specifically designed and provided for. Any deviation from this will not be accepted.
 - a. At no point shall cables come in contact with, be supported by, or attach to other trades equipment or supports.
 - b. At no point shall cables come in contact with, be supported by, or attach to building structures or supports.
12. Provide appropriately sized sleeves where cables (supported by J-hooks) are required to pass through non-rated full-height partitions. Where allowed, sleeves shall extend a

minimum of 3 inches beyond the partition surface on both sides, and shall be rigidly supported to support the weight of cables. Sleeves shall be sized so that no more than 40% of the cross-sectional area is utilized by the cabling to be installed.

13. Suspended cables shall be installed with at least 3 inches of clear vertical space above the ceiling tiles and support channels (T-bars).
14. Waterproofing
 - a. Avoid, if possible, the penetration of any waterproof membranes such as roofs, machine room floors, basement walls, and the like. If such penetration is necessary, make penetration prior to the waterproofing and furnish all sleeves or pitch-pockets required. Advise the Architect and obtain written permission before penetrating any waterproof membrane, even where such penetration is shown on the Drawings.
 - b. Restore waterproofing integrity of walls or surfaces after they have been penetrated without additional cost to the Owner.
15. Cutting and Patching
 - a. Where cutting, channeling, chasing or drilling of floors, walls, partitions, ceilings or other surfaces is necessary for the proper installation, support or anchorage of conduit or other equipment, layout the work carefully in advance. Repair any damage to the building, piping, equipment or defaced finished plaster, woodwork, metalwork, etc. using skilled tradespeople of the trades required at no additional cost to the Owner.
 - b. Do not cut, channel, chase or drill masonry, tile, etc., unless permission from the Architect is obtained. If permission is granted, perform this work in a manner acceptable to the Architect.
 - c. Patch around all openings to match adjacent construction.
 - d. Where conduit or equipment is mounted on a painted finished surface, or a surface to be painted, paint to match the surface. Cold galvanize bare metal whenever support channels are cut.
 - e. Provide slots, chases, openings and recesses through floors, walls, ceilings, and roofs as required. Where these openings are not provided, provide cutting and patching to accommodate penetrations at no additional cost to the Owner.
 - f. After the final waterproofing membrane has been installed, roofs may be cut only with written permission by the Architect.
16. Mounting Heights
 - a. Mounting heights for equipment and devices requiring operational access shall conform to ADA requirements.
 - b. Wall mounted devices requiring operational access shall be mounted a minimum of 15 inches above finished floor to bottom of device and a maximum of 48 inches above finished floor to top of device.
 - c. Mounting heights shall be from floor to center of device, unless otherwise noted. Verify exact locations and mounting heights with the Architect before installation.
 - d. Typical mounting heights shall match nearest adjacent typical electrical outlet mounting height UON or as directed by the Architect.
17. Painting
 - a. Refer to Division 9 Section "Painting" for painting requirements.

- b. Paint exposed ferrous surfaces, including, but not limited to, hangers, equipment stands and supports using materials and methods as specified under Division 9 of the Specifications; colors shall be as selected by the Architect.
 - 1) If painting happens after cabling has been installed, cabling shall be masked off or otherwise protected so that cables are not painted. Paint on cables degrades the cable over time. PAINTED CABLES SHALL BE REPLACED with no additional cost to the owner.
 - c. Re-finish all field-threaded ends of galvanized conduits and field-cut ends of galvanized supports with a cold-galvanizing compound approved for use on conductive surfaces. Follow closely manufacturer's instructions for pre-cleaning surfaces and application.
 - d. Factory finishes and shop priming and special finishes are specified in the individual equipment Specification sections.
 - e. Where factory finishes are provided and no additional field painting is specified, touch-up or refinish, as required by, and to the acceptance of, the Architect and Design Consultant, marred or damaged surfaces so as to leave a smooth, uniform finish. If, in the opinion of the Architect or Design Consultant, the finish is too badly damaged to be properly re-finished, replace the damaged equipment or materials at no additional costs to the Owner.
 - f. Provide touch-up paint as required by Specification Sections in this Division.
18. Fastenings
- a. Fasten equipment to building structure in accordance with the best industry practice.
 - b. Strength of Support Assemblies: Where not indicated, select sizes of components so strength will be adequate to carry present and future static loads within specified loading limits. Minimum static design load used for strength determination shall be weight of supported components plus 200 lbs.
 - c. Mounting and Anchorage of Surface-Mounted Equipment and Components: Anchor and fasten electrical items and their supports to building structural elements by the following methods unless otherwise indicated by code:
 - 1) To Wood: Fasten with lag screws or through bolts.
 - 2) To New Concrete: Bolt to concrete inserts.
 - 3) To Masonry: Approved toggle-type bolts on hollow masonry units and expansion anchor fasteners on solid masonry units.
 - 4) To Existing Concrete: Expansion anchor fasteners.
 - 5) To Steel: Welded threaded studs complying with AWS D1.1/D1.1M, with lock washers and nuts.
 - 6) To Light Steel: Sheet metal screws.
 - 7) Items Mounted on Hollow Walls and Nonstructural Building Surfaces: Mount cabinets, panelboards, disconnect switches, control enclosures, pull and junction boxes, transformers, and other devices on slotted-channel racks attached to substrate.
 - d. Where weight applied to building attachment points exceeds 300 pounds, coordinate with and obtain the approval of Architect and conform to the following as a minimum:
 - 1) Provide suitable auxiliary channel or angle iron bridging between building structural steel elements to establish fastening points. Bridging members shall be suitably

- welded or clamped to building steel. Provide threaded rods or bolts to attach to bridging members.
- e. For items, which are shown as being ceiling mounted at locations where fastening to the building construction element above is not possible, provide suitable auxiliary channel or angle iron bridging tying to the building structural elements.
 - f. Areas identified as noise critical spaces shall have all penetrations sealed to minimize sound transmission between adjacent spaces.
- B. Access to pathways and associated equipment
1. Locate all pull boxes, junction boxes and fire-rated pathway devices so as to provide easy access for operation, service inspection and maintenance.
 2. Provide an access door/panel where equipment or devices are located above inaccessible ceilings. Where access doors/panels are necessary but not shown on the plans, coordinate type and location with Architect and Design Consultant through an RFI.
 3. Maintain all code required clearances and clearances required by manufacturers.
- C. Cable Distribution
1. For low-voltage cabling (that provides power at 70v or less), refer to section 2.1 above.
- D. Conduits
1. Conduit shall be of the appropriate type required by code and as required by Electrical Division 26.
 2. Adequate access shall be available where cables enter conduits
 3. Bond and ground all metallic conduits and boxes in accordance with national or local requirements (ANSI STD-607 – “Commercial Building Grounding (Earthing) and Bonding Requirements For Telecommunications).
 4. Install conduits in the most direct route possible, running parallel to building lines
 5. Ream all conduit ends and fit them with an insulated bushing to eliminate sharp edges that can damage cables during installation or service.
 6. Conduits which enter Telecommunications or Security/Equipment rooms shall extend 3 inches AFF or through the wall.
 7. Flexible conduits may only be used where specifically allowed by these contract documents.
 - a. Where indicated, flexible conduit sections shall be less than 20 feet in length.
 8. No continuous section of a conduit may exceed 100 feet without a Pull Box.
 9. No more than (2) 90° bends, or equivalent will be allowed between Pull Boxes.
 - a. Each and any offset shall be considered a 90° bend.
 - b. A Pull Box is required wherever a reverse bend is installed.
 10. The minimum bend radius for conduits is:
 - a. (6) times the inside diameter for 2 inches conduits or less.
 - b. (10) times the inside diameter for conduits greater than 2 inches.
 11. Conduits shall contain no electrical condulets (also known as LBs).
 12. Underground Conduit Requirements

- a. Cabling and pathways serving devices exterior to the building, such as emergency phones/towers and security cameras.
 - b. Requirements
 - 1) Refer to applicable details on drawings for illustrative requirements.
 - 2) Route all underground conduit so there is no more than (3) 90 degree bends, including stub-up bend at communications room/equipment cabinet.
 - a) For underground conduit serving outlets/boxes outside the footprint of the building that require more than (3) 90 degree bends, provide appropriately-sized handhole(s). Coordinate location with Architect and Owner, indicate proposed location(s) on shop drawings, and include product information in pre-construction submittals. In general, handholes are NOT to be located in roadways, parking lots, sidewalks, or any location that may be subject to vehicular traffic.
 - b) These underground conduits shall stub directly into the serving Communications Room/Equipment Room. If not, extend cabling within the building in IMC or RMC to the serving Equipment Room.
 - 3) Approved conduit types:
 - a) When routed below slab-on-grade or outside the footprint of the building:
 - i) Horizontal conduit shall be RMC or Schedule 40 PVC a minimum of 12" below grade. If PVC is installed, also install tracer wire.
 - ii) All vertical and horizontal bends and areas subject to vehicular traffic (loads) such as parking lots and roadways shall be RMC or concrete-encased PVC.
- E. Outlet boxes
1. No outlet boxes shall be located back-to-back in a wall cavity.
 - a. Where possible offset to next stud cavity, with a minimum of 6 inch separation.
 2. Outlet boxes located in fire-rated walls are to have the appropriate firestopping for backboxes. These locations are to be identified on shop drawings.
 3. Where cabling enters a backbox directly (not via conduit), provide black rubber grommet on knockout.
- F. Pull Boxes
1. Pull Boxes shall be placed in Conveniently Accessible locations.
 2. Coordinate the location and installation of all Pull Boxes to ensure adequate access is provided.
 3. Pull Boxes above an accessible ceiling shall:
 - a. Be aligned directly over the ceiling grid to allow access
 - b. Be installed with a minimum of 3 inches (76.2 mm) clearance to ceiling grid and tiles
 4. No directional changes shall be allowed in Pull Boxes. Conduit shall continue in the same direction as it enters and then change direction via an appropriately sized bend in the conduit.
 5. Size Pull Boxes according to the following chart:

TABLE 1: Pull Box Sizing

Conduit Trade Size	Width	Length	Depth	Width Increase for Additional Conduit (of same size)
3/4" or smaller	4"	4"	2-1/8"	Not applicable
1"	4"	16"	3"	2"
1-1/4"	6"	20"	3"	3"
1-1/2"	8"	28"	4"	4"
2"	8"	36"	4"	5"
2-1/2"	10"	42"	5"	6"
3"	12"	48"	5"	6"
4"	16"	60"	8"	6"

3.2 LABELING

A. Labeling Installation

1. Labels are to be secured by adhesive. They shall have a type of adhesive that is appropriate for the particular surface upon which the label is to be installed. The mounting surface shall be free of dust, dirt, oil, etc. that would impede the adhesion of the labels.

B. Labeling Requirements

1. Labels are to be installed on or for:
 - a. All firestopping systems. For wall and floor penetrations, label on both sides. See Firestopping later in this section.
 - b. All pathways (e.g., conduit etc.) installed under this work.
 - 1) Label all conduit with "SECURITY". Conduit labels shall utilize text readable from a standing position on the finished floor. Conduit sleeves which pass through a single wall or floor need not be labeled.
 - a) For wall stub-up locations, label overhead only.
 - b) For conduits greater than 10', label both ends of conduit with far end location and Room/Number.
 - i) Example – "Security to Panel 1 in Equipment Room 127".
 - c) For conduits that stub directly up or into an Equipment Room, label both ends of conduit.
 - i) Example: underslab/ground conduit from Equipment Room 127 to Camera #13 attached to an exterior lightpole shall be labeled as follows:
 - (1) Conduit stub-up location in Equipment Room 127 – "Security to Camera #13".
 - (2) In the lightpole/junction box, immediately adjacent to serving conduit – "Security to Equipment Room 127".
 - 2) All pullboxes and junction boxes for Security shall be labeled "SECURITY PULLBOX" on the cover, such that the text is of sufficient size to be readable from a standing position on the finished floor.
 - a) Conduits entering and exiting all pullboxes and junction boxes shall be labeled with their destination/room number – ie "To Security Camera #17 in Room 114".
- c. In general, the label is to be provided and installed by whomever installed the item that is being labeled.

- d. Refer to individual Division 28 sections and to the drawings for additional information on labeling requirements.

3.3 FIRESTOPPING

A. General

1. Provide fire resistant materials of a type and composition necessary to restore fire ratings to all wall, floor or ceiling penetrations; including membrane penetrations. All materials shall be classified or listed as a complete system by UL (or an approved NRTL by the Design Consultant and AHJ) and meet NEC and local codes. The use of partial systems or components of systems is not allowed unless specifically identified in the documents.
2. All penetrations through fire rated floors and walls shall be sealed to prevent the passage of smoke, flame, toxic gas or water through the penetration before, during or after a fire. The fire rating (F and T) of the penetration seal shall be at least that of the floor or wall into which it is installed, so that the original fire rating of the floor or wall is maintained as required by referenced building codes.
 - a. Assume all floors are fire-rated, unless otherwise noted.
 - b. Also install fire stops at any other locations indicated in the Specifications or Drawings.
3. Provide a label on both sides of fire rated assembly at all fire stop locations indicating:
 - a. Fire stop Manufacturer
 - b. Installer and company
 - c. Date installed
 - d. UL system number with all relevant ratings indicated
4. Include labels in each Equipment Room in which one or more fire-rated walls is installed. Provide a 2" block letter stencil label on the inside of the room to indicate rating for each barrier.
5. Provide systems as identified on the drawings and specified herein. At locations where the cabling routing encounters a fire-rated barrier provide an adequately sized fire stop device for the quantities and types for all cables to be installed plus 25% growth.

B. Penetration Sealant – Conduits

1. Provide listed system to seal around openings between wall, floor or partition around conduits in accordance with system listing and manufacturer's instructions.

C. Penetration Sealant – Voids, Cavities, and Openings

1. Install fire stop materials in the framed openings through fire rated partitions per the Architect's drawings and in accordance with the NRTL listed system instructions.
2. Fire stop all voids, cavities, and openings left by the removal of cabling, conduits, conduit sleeves, cable trays or other equipment related to the communications systems not to be reused.
3. Install the fire stop system in accordance with the manufacturer's instructions and local codes.

D. Fire-Rated Pathway Device

1. Provide fire-rated pathway device anywhere cables are required to pass through fire-rated walls, floors or partitions.

2. Devices shall be installed in locations where required by the Contract Drawings, arranged individually or appropriately ganged.
3. Install the devices in strict accordance with the approved shop drawings and the equipment manufacturer's recommendations.
4. Apply the factory supplied gasketing material (where required) prior to the installation of the wall plates.
5. Secure wall plates (where required) to devices per the equipment manufacturer's recommendations.

END OF SECTION

SECTION 28 10 00 - ELECTRONIC SECURITY SYSTEMS

PART 1 - GENERAL REQUIREMENTS

1.1 CONFIDENTIALITY NOTICE

- A. Electronic Security System Work is confidential in nature. All drawings and relevant specification sections are considered confidential information and shall remain secure. Track all physical copies of Electronic Security System documents, restrict document access to those working directly on the project; properly dispose of the physical documents when no longer needed. Share and/or restrict access of electronic documents to only those working directly on the project having "a need to know".
1. Proper disposal of physical documents means that they are crosscut shredded, incinerated, or pulped such that there is reasonable assurance the hard copy materials cannot be reconstructed.
 2. These confidentiality requirements are a minimum. Follow local, state, and federal laws where more stringent.

1.2 SUMMARY

- A. Provide a complete and functioning electronically controlled physical security system ("Electronic Security System"), and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
1. All Electronic Security Systems shall have a level of immunity to power interruptions, be time synchronized, and employ a level of redundancy or failure recovery so as to minimize the loss of data, monitoring, and control.
 2. The Access Control System shall be used as the platform for integration of all Electronic Security System sub-systems, which may also be referred to as the Security Management System. Refer to the Definitions section later in this specification.
- B. Specification sections 281000 through 283999, and Drawings numbered with prefixes TN, generally describe these systems, but the scope of the Electronic Security System Work includes all such Work indicated in all of the Contract Documents, including, but not limited to: Instructions to Bidders; Proposal Form; General Conditions; Supplementary General Conditions; Architectural, Structural, Mechanical, Plumbing, Electrical, Communications, and Fire Alarm System Drawings and Specifications; and Addenda.
- C. The general scope includes, but is not limited to, these systems:
1. Provide a complete and functioning INTEGRATED Electronic Security System comprised of the following subsystems:
 - a. Access Control System
 - b. Video Surveillance System
 - c. With the core integration of the Security Management System formed by the existing campus Access Control System.
 2. Coordination with the Owner's IT Department to connect all necessary Electronic Security equipment onto the Owner's Local Area Network.

3. Provide time synchronization across all server and PC controlled and monitored Electronic Security System sub-systems. Where available, utilize the Owner's time server for time reference.

1.3 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions, apply to this Section.
- B. Work under this section shall follow Division 28 Section "General Electronic Safety and Security Requirements".
- C. Work under this section shall follow Division 28 Section "Common Work Results for Electronic Security Systems" for general pathway, firestopping, access panel, identification, and other requirements.
- D. Requirements of this Section apply to all Sections 281000 through 283999 and vice versa.

1.4 CODES, STANDARDS, AND GUIDELINES

- A. Follow the most current and up-to-date revisions or printings of the following codes and standards (UON):
 1. NFPA 70 – National Electrical Code (NEC)
 2. NFPA 101 – Life Safety Code
 3. NFPA 730 – Guide for Premises Security
 4. NFPA 731 – Installation of Electronic Premises Security Systems
 5. IEEE National Electrical Safety Code (NESC)
 6. IEEE 802.3af – POE standard
 7. IEEE 802.3at – POE Plus standard
 8. ANSI TIA-607-D – "Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises"
 9. ANSI/BICSI 005-2013 – Electronic Safety and Security System Design and Implementation Best Practices
 10. ADA Standards for Accessible Design (2010)
 11. BICSI Information Technology Systems Installation Methods Manual (ITSIMM)
 12. BICSI Telecommunications Distribution Methods Manual (TDMM)
 13. BICSI Electronic Safety and Security Design Reference Manual (ESSDRM)

1.5 ABBREVIATIONS

- | | | |
|----|-------|--|
| A. | BICSI | Building Industry Consulting Service International |
| B. | CCTV | Closed Circuit Television |
| C. | CPU | Central Processing Unit (computer) |
| D. | DESI | Detention Electronic Systems Integrator |
| E. | ESN | Electronic Security Network |
| F. | ESC | Electronic Security Contractor |
| G. | ESS | Electronic Safety & Security Designer, a BICSI designation |
| H. | NJATC | National Joint Apprenticeship and Training Committee |

- I. OSP Outside Plant
- J. PoE Power-over-Ethernet
- K. RCDD Registered Communications Distribution Designer, a BICSI designation
- L. RTPM Registered Telecommunications Project Manager, a BICSI designation
- M. TIA Telecommunications Industry Association

1.6 DEFINITIONS

- A. Electronic Security Contractor (ESC) – The primary contractor of this and all related specification sections (281000 through 283999). The ESC is also responsible for fully coordinating all Electronic Security System requirements with other Divisions and sections, such as power, grounding/bonding, fire alarm, and pathways/other common work.
- B. Equipment Grounding Conductor – as defined in the NEC, the conductive path installed to connect normally non-current-carrying metal parts of equipment together and to the system ground conductor or to the grounding electrode conductor, or both.
- C. Equipment Room – A secured room either exclusively reserved for Security System headend equipment, or shared with other low-voltage systems such as Telecommunications headend equipment, Fire Alarm panels, etc.
- D. Final Acceptance Review – the final site observation by Design Consultant; refer to Submittal paragraph (in Part 1 of this Section) and Project Close-Out Instructions (in Part 3 of this Section) for additional information / requirements.
- E. Security Management System (SMS) - the central component for managing physical security and the bridge between physical and logical security for the project. The system shall provide a variety of integral functions including (but not limited to): regulation of access and egress; provision of identification credentials; monitor, track and interface alarms and; view, record and store digital surveillance video linked to SMS events.
- F. System – short for Electronic Security System, all Work governed by this and related documents.

1.7 QUALITY ASSURANCE

- A. Contractor Qualifications
 - 1. ESC shall have a minimum five (5) continuous years in the business of integrating and/or installing Electronic Security equipment including but not limited to the systems identified with the Summary of Work paragraph of this Section.
 - 2. Prior to bidding this project, the ESC shall be a certified installer by the equipment manufacturers whose products shall be incorporated into this project. Post-award certification will not be accepted.
 - 3. ESC shall maintain certification by the manufacturers thru the duration of the warranty period.
 - 4. When requested, provide a list of projects (no less than 3) of similar size, scope and type in which the Bidder has performed in a capacity comparable to the size, scope and type outlined in these Construction Documents. Provide the project name, relevant project information for comparison evaluation, and contact names with telephone numbers of each such project.
 - 5. Refer to individual sections for additional Contractor qualifications.
- B. Personnel Qualifications
 - 1. Provide and maintain a Quality Control Specialist on staff as a full-time employee at all time. This person shall be familiar with the project and available to attend all scheduled project

meetings when required by the Owner/Design Consultant. This person shall conduct weekly inspections and approve all submittals and work performed. This person shall possess one or more of the following:

- a. Current BICSI RCDD or ESS Designer certification
 - b. Current ASIS Physical Security Professional (PSP) or Certified Protection Professional (CPP)
 - c. An individual with substantial industry experience (10+ years); submit a copy of this person's resume with Pre-Construction submittals and whenever requested.
2. Provide and maintain a qualified Project Manager, who shall be on-site at all times Work in this (and Related Sections) is being conducted and shall attend all scheduled project meetings. This person shall possess one or more of the following:
 - a. Current BICSI RCDD, ESS or RTPM certification.
 - b. Current ASIS PSP or CPP certification.
 - c. Level III Video Security Systems Technician certification by National Institute for Certification in Engineering Technologies (NICET) and be in good standing.
 - d. Technology-related degree from an ABET accredited institution.
 - e. An individual with significant industry experience as a project manager (5+ years); submit a copy of this person's resume with Pre-Construction submittals and whenever requested.
 3. Any additional personnel that will be physically installing any part of the Electronic Security System shall, at a minimum, be in good standing as one of the following:
 - a. NJATC Installer Technician
 - b. BICSI Certified Level 1 Commercial Installer
 - c. NICET Level III Technician (audio, automation, or video)
 - d. Or be assigned to work under the direct supervision and direction of a person holding said certifications.
 4. In addition, where required by state and local jurisdictions, any personnel working on-site shall be licensed, for security work or other work as required by this and related sections, and proof of licensure shall be submitted.
 5. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
 6. Alternate qualifications may be considered. Provide requested alternate considerations prior to Bid in accordance with the Substitution Request instructions in Division 28 Section "General Electronic Safety and Security Requirements".
- C. Warranties
1. Unless otherwise noted in Division 28 specifications, ESC shall warrant all work to be free of defects in workmanship and materials for a period of 1 year from the date of Substantial Completion.
 2. ESC shall provide a point of contact (phone number) for all warranty and service calls, such that the ESC will respond and be on-site within 12 hours of the first call, and the repair completed to the satisfaction of the Owner within 36 hours of arrival on site.

- a. For issues not properly resolved within this timeframe or those that are unable to be resolved in the field, ESC may elect from the following (subject to approval of the Owner):
 - 1) Provide temporary/loaner equipment of comparable function until such time that the component can be fixed or replaced.
 - 2) Reimburse the Owner for additional security staff necessary to cover the down time of that part of the System.
3. All Warranty Work shall be completed by factory-certified technician(s) of the component(s) being address.
- D. ESC shall visit the job 30 days prior to the end of the 1-year warranty period to check all equipment for proper system operation. Any defective equipment found shall be replaced or repaired under the terms of the system warranty.

1.8 WORK INCLUDED

- A. Provide labor, materials, and accessories required to install, test and place into operation the Electronic Security System and all sub-systems as called for in the Contract Documents, and in accordance with applicable codes and regulations. Include labor, materials, and accessories not specifically called for in the Contract Documents but required to provide complete operating systems without additional cost to the Owner. The Work includes, but is not necessarily limited to, the general scope of work as presented in the Summary paragraph above.
- B. The Work also includes, but is not necessarily limited to, the following:
 1. Conduit, backboxes, pull boxes, firestopping, and other pathways necessary for the completion of all Electronic Security Systems – installed per Division 28 “Common Work Results for Electronic Security”; if another sub-contractor is providing the pathways/common work (as coordinated with the Prime Contractor), the Project Manager and/or Quality Control Specialist of this section shall coordinate and inspect the installation of all pathways/common work with that sub-contractor.
 2. Cabling between the Electronic Security headend equipment and field devices, and between multiple Equipment Rooms.
 3. Full build-out of Equipment Rooms, including all terminations, patch panels, patch cords, cabinets, equipment racks, ladder rack, backboards, etc. Where equipment rooms and pathways are shared with other systems, such as Telecommunications and/or Audio Video, coordinate Division of Labor for shared infrastructure.
 4. A grounding/bonding system, as described in these construction documents, required by equipment manufacturers, and referenced codes and standards.
 5. Appropriate cable supports as required by these construction documents, such that all cabling external to Equipment Rooms is either installed in conduit or supported via J-hooks or cable tray every 48 to 60”.
 6. For cabling in Equipment Rooms cable shall be supported every 18” for both horizontal and vertical routing, by either ladder-type cable tray or D-Rings on backboards.
 - a. This is not a requirement for telecommunications cabling required for Work under this Division. Refer to Division 28 Section “Telecommunications Requirements for Electronic Security” for pathway requirements within Equipment Rooms.
 7. Testing, labeling, and documentation of all cables and hardware installed under this Division.
- C. Prepare and submit shop drawings, testing reports, as-built drawings, and cabling documentation in a timely manner to conform to all project schedules and timelines.

1. Submittals are a crucial requirement to a successful project. No work may begin until Pre-Construction Submittals have been approved by the Design Consultant.
2. Incomplete submittals, including submission of unedited bid drawings as shop drawings, will be immediately rejected and not reviewed.
3. The first Pre-construction Submittal shall be of such detail and thorough enough to demonstrate to the Design Consultant and Owner that the ESC understands the project requirements and for installers to have sufficient information to complete construction in accordance with the contract documents.
 - a. The project schedule is dependent upon the first pre-construction submittals being thorough enough that only minor edits (if necessary) will be required to be resubmitted.
4. Accurate Record Drawings and other close-out documentation are integral to the Owner's use and maintenance of the system, and are to be submitted prior to the Final Acceptance Review.

1.9 COORDINATION

- A. The locations of outlets, devices, panels, equipment racks and other equipment indicated on the Drawings are approximate and are understood to be subject to such minor revision as may be found necessary or desirable at the time the work is installed in order to meet field conditions, coordinate with modular requirements of ceilings, simplify the work, establish sight lines for cameras, improve visibility for interactive security devices, or for other legitimate causes.
- B. Exercise particular caution with reference to the location of outlets, devices, control panels, switches, etc. Verify with the Architect the exact location and mounting height of outlets, devices and equipment not dimensionally located on the Drawings.
- C. The Drawings show only the approximate locations of outlets and devices, and, if shown, general run of raceways. Any significant changes in location of outlets, devices, etc., necessary in order to meet field conditions shall be brought to the immediate attention of the Architect for review before such alterations are made. Except for unforeseeable extenuating circumstances, modifications shall be made at no additional cost to the Owner.
- D. Camera, door, and device tags in the form of alpha/numeric characters are used where shown to indicate the designation numbers for identification purposes at the equipment panels and/or patch panels. Show the actual camera, door and device numbers on the as-built Record Drawings, on the associated typed field labels and in the printed and computer readable cabling and device schedules. Submit sample camera, door, and device information tags (proposed labeling scheme).
- E. The drawings do not indicate the number of cables in conduit, or the actual identity of cables in specific conduits, cable tray or other cabling pathways. Under no circumstances shall 40 percent raceway fill be exceeded, regardless of the type of cabling installed.
- F. Provide the correct cable type and quantity as required by the indicated outlets, devices, cable schedules, the design intent of any example drawings or schedules, referenced wiring diagrams (if any), the maximum distance limitations, and the applicable requirements of the NEC and ANSI TIA-569.
- G. All cabling shall be installed complete and unspliced from field device termination to headend termination, unless otherwise noted.
- H. All cabling installed in Damp or Wet Locations (as defined by the NEC) shall be wet-rated / listed for installation in a Wet Location.
 1. Underground pathways for devices exterior to the building shall stub up directly in the serving Equipment Room; if conduits stub up elsewhere in the building, a junction box is required in an accessible ceiling location and the cabling shall transition from wet-rated to plenum- or

riser-rated cabling (per Division 28 Sections “Conductors and Cables for Electronic Security” and “Telecommunications Requirements for Electronic Security”).

- I. Wherever work interconnects with work of other trades, coordinate with other trades to ensure that they have the information necessary so that they may properly install the necessary connections and equipment.
 1. At a minimum, coordinate the following with the Division 26 Contractor:
 - a. All electrical circuits serving Electronic Security System equipment shall be supplied with an Equipment Grounding Conductor for each circuit.
 - b. All electrical circuits serving Electronic Security System equipment shall have dedicated neutrals (no shared neutrals between branch circuits).
- J. Within two weeks after the Notice to Proceed, schedule a meeting with the Owner’s IT and Security staff to coordinate network requirements and programming of the Electronic Security Systems.
 1. Refer to Division 28 Section “Network Requirements for Electronic Security” for additional coordination requirements with the Owner’s IT staff.

1.10 SUBMITTALS

- A. Refer to requirements in Division 28 Section “General Electronic Safety and Security Requirements”. At a minimum, follow these additional requirements:
 1. Pre-Bid Submittal (due at the questions deadline during the bid window)
 - a. Substitution Request for any one of the following:
 - 1) Product Substitutions
 - 2) Alternate Personnel Qualifications
 - 3) Contractor Qualifications (for ESCs wishing to be added to the Pre-qualified Contractors list)
 2. Bid
 - a. Unit Pricing for the following:
 - 1) Addition/deductions for the following components, including associated pathway, cabling, termination, and programming:
 - a) Adding/removing Card Reader door
 - b. Additional cost to extend the warranty coverage from 1 year to 3 years.
 3. Pre-Construction Submittal
 - a. Refer to Division 28 Section “General Electronic Safety and Security Requirements” for general Pre-Construction Submittal instructions / requirements.
 - b. Submit the following information for all Electronic Security Work together (Division 281000 through 283900) at the same time, with information grouped in the following categories, then identified by section and in the exact order of the specifications:
 - 1) Cover Page, which includes name of ESC and contact name, phone, and email of the following:
 - a) Quality Control Specialist
 - b) Project Manager
 - 2) Division of Labor

- a) Indicate any sub-systems – such as Common Work (conduit, backboxes, etc.), cabling, structured cabling – that will either be provided by a sub-contractor to the ESC or to the Prime Contractor. Indicate the company name that is provided each sub-system.
- 3) Schedule
 - a) Gantt chart format; coordinate with Prime Contractor as needed.
- 4) Equipment List
 - a) Typed list in the following format:
 - i) Product name / type
 - ii) Manufacturer
 - iii) Model name
 - iv) Model number
 - v) Manufacturer Warranty Term (wherever longer than 1 year)
 - b) Separated by specification section and in the exact order as listed in the specification sections.
- 5) Cut Sheets
 - a) Separated by specification section and in the exact order as listed in the specification sections.
- 6) Shop Drawings
 - a) Scaled floor plans, at not less than 1/8" = 1'-0" scale, to identify the following:
 - i) Room names and numbers
 - ii) Door numbers (to match the Architect's Door Schedule)
 - iii) Conduit, firestopping, cable tray, and other common work locations, sizes and routing, as required by Division 28 Section "Common Work Results for Electronic Security Systems",
 - iv) Cable type, quantities, routing, and approved identification,
 - v) Equipment Room locations and serving areas,
 - vi) Dimensioned device locations and approved identifiers,
 - vii) Where the System controls electronic door hardware, identify type (of electronic door hardware) and voltage for each door.
 - b) Enlarged scaled floor plans and elevations, at not less than 1/4" = 1'-0" scale, of Equipment Rooms, showing 3' of clearance space in front of all panels and wall-mounted racks/cabinets and 3' of clearance space in front of and behind all floor-mounted racks/cabinets.
 - c) Details of the following:
 - i) Termination, or pin-out, details of multiple or multi-conductor cables at the Device and Equipment ends for each type of device.
 - ii) Riser, block, functional, and grounding/bonding diagrams for all systems and sub-systems.
- c. Refer to individual sections in this Division for additional Pre-Construction Submittal requirements.

4. Preliminary Project Completion Submittal
 - a. A minimum of 1 week prior to the Final Acceptance Review, submit "Division 28 Electronic Security – Preliminary Project Completion Submittal", to include the following documentation:
 - 1) Resubmit approved Pre-Construction Submittals of the following, updated to reflect all changes during construction:
 - a) Equipment List
 - b) Cut Sheets
 - c) Preliminary Record Drawings – based on drawings kept on site.
 - i) Scans of on-site drawings are acceptable, provided notes and minor changes are legible
 - ii) These drawings shall include the actual installed device and cable IDs that correspond to submitted test results.
 - 2) Submit the following additional items (as part of each sub-system):
 - a) Operation and Maintenance Manuals
 - b) Test Results for all sub-systems.
 - i) Device and cable IDs shall correspond to submitted Preliminary Record Drawings.
 - 3) And additional items as required in other Division 28 Electronic Security specification sections.
 - b. Refer to the Project Close-Out Instructions in Part 3 of the section for additional information and requirements.
5. Final Project Completion Submittal
 - a. After Final Acceptance Review and before Substantial Completion:
 - 1) Address all Punch List items generated from Final Acceptance Review,
 - 2) Retest effected items
 - 3) Conduct Owner Training and deliver any spare parts / physical items to Owner.
 - b. Submit the following additional items as part of "Division 28 Electronic Security – Final Project Completion Submittal":
 - 1) Cover Page – to include ESC company name and contact information for Warranty issues
 - 2) (Updated) Equipment List (with length of manufacturer warranty that extends beyond 1 year), Cut Sheets, Operation & Maintenance Manuals, and Test Results
 - 3) (Updated) Record Drawings, in AutoCAD and searchable PDF file formats
 - 4) Spare Parts / Physical Media Confirmation – included scanned PDF of written confirmation from Owner that all spare parts and physical media were furnished to Owner at the time of Owner Training.
 - 5) Manufacturer Warranty Information and Certificates
 - c. Refer to the Project Close-Out Instructions in Part 3 of the section for additional information and requirements.

- d. Refer to individual sections in this Division for additional Project Completion Submittal requirements.

PART 2 - PRODUCTS AND MATERIALS

2.1 NOT USED

- A. Refer to individual Electronic Security System sections for product requirements.

PART 3 - EXECUTION

3.1 IDENTIFICATION / LABELING

- A. General Requirements
 1. The inclusion or installation of any equipment or assembly which bears on any exposed surface any name, trademark, or other insignia which is intended to identify the manufacturer, the vendor, or other source(s) from which such object has been obtained, is prohibited.
 2. Required UL labels shall not be removed nor shall identification specifically required under the various technical sections of the Specifications be removed.
- B. Refer to individual Electronic Security System sections for additional requirements.

3.2 START-UP OF SYSTEMS

- A. Prior to system start-up, conduct or ensure the following safeguards:
 1. Check all electrical circuits of the various devices for proper wiring polarity, grounding, and activation.
 2. Verify that equipment is effectively bonded and grounded to earth.
 3. Ensure all Equipment Rooms are properly conditioned and free of dust or other contaminants.
 4. Coordinate with Owner's IT department per Division 28 Section "Network Requirements for Electronic Security".

3.3 PROJECT CLOSE-OUT INSTRUCTIONS

- A. Functional Testing
 1. Conduct and finish functional tests of all sub-systems, and integrated testing where applicable. Correct any and all functional issues prior to requesting the Final Acceptance Review by the Design Consultant.
- B. Preliminary Project Completion Submittal
 1. Submit the following at least 1 week prior to requesting the Final Acceptance Review:
 - a. A copy of Pre-Construction Submittals updated with all changes made during construction.
 - 1) If changes noted on the jobsite work prints are readily legible, a scanned copy is sufficient at this time.
 - 2) Otherwise, obtain reproducible electronic copies of the final Drawings and incorporate changes noted on the jobsite work prints onto these drawings. These changes shall be done electronically in BlueBeam*, AutoCAD or BIM software and saved to PDF format. Each sheet shall contain the ESC's name/logo and be identified as "Preliminary Record Drawing".

- a) *Final Record Drawings shall be created in AutoCAD or BIM software; annotated PDF drawings will not be accepted.
 - b. Detailed Test Reports of the following sub-systems:
 - 1) Grounding and Bonding per Division 28 Section "Equipment Room Fittings for Electronic Security".
 - 2) Functional Test Reports per individual sections for the following:
 - a) Access Control doors, locations, and devices
 - b) Video Surveillance
 - c. Copy of the Operation and Maintenance Manuals for each specified piece of equipment.
- C. Final Acceptance Review
- 1. Upon completion of all functional testing, request in writing a Final Acceptance Review; this is a final site observation by the Design Consultant. Give the Architect and Design Consultant at least seven (7) days' notice prior to the review. Make the request sufficiently enough in advance for the review to properly be scheduled and completed such that punch list items can be addressed before substantial completion.
 - 2. State in the written request that the Contractor has complied with the requirements for Substantial Completion.
 - 3. Upon receipt of a request for review, the Architect will either proceed with the review or advise the Contractor of unfilled requirements.
 - 4. During the Final Acceptance Review, provide the following:
 - a. Services of the Project Manager, as identified in the Quality Assurance part of this Specification Section, and a minimum of two other technicians familiar with the project. The Project Manager shall facilitate the review and demonstration of the Electronic Security System and all sub-systems as requested by the Design Consultants.
 - 1) Provide a minimum of two cell phones or radios to allow two-way communication between the headend or Workstation location and a mobile technician to trigger various security alerts.
 - b. Ladders, lifts, and/or scaffolding as required to reach all cameras or other high-mounted devices.
 - c. Specific test equipment used during the Contractor's preliminary testing activities, and the services of qualified technicians to operate such test equipment.
 - 1) Per individual sections, the Design Consultant may request the Contractor conduct random retesting to confirm the documented test results.
 - 2) Refer to individual sections for exact requirements.
 - 5. If the Contractor requests a Final Acceptance Review prior to completing the requirements of the Contract Documents, then provide reimbursement to the Design Consultant for time and expenses incurred for the visit.
 - 6. Upon completion of the review, the Design Consultant will prepare a "punch list" of outstanding items not in compliance with the Contract Documents, to be completed or corrected for final acceptance.
 - a. Omissions on the "punch list" shall not relieve the Contractor from the requirements of the Contract Documents.
- D. Owner Training

1. Conduct in-person training for the Owner in operation and general maintenance for all Electronic Security System and sub-system equipment. Assume a single 2-hour training session for the following sub-systems, unless otherwise noted:
 - a. Access Control
 - b. Video Surveillance
 2. Furnish to Owner any spare parts, as required by individual specification sections.
 - a. Obtain written acknowledgement from owner that the spare parts were furnished to owner. Written documentation to include:
 - 1) Equipment Part name, manufacturer, model number and quantities for each part
 - 2) Date, time, name of owner's representative, and their signature indicating that they have accepted the spare parts into their possession.
- E. Punch List Completion
1. Complete all punch list items before Substantial Completion.
 2. Retest affected items.
 3. Update Preliminary Project Completion Submittal with all changes.
- F. Project Completion Submittal
1. At the completion of the project, compile the following electronic files, divided into the following sub-folders:
 - a. Equipment List, in PDF and Microsoft Excel format, to include:
 - 1) Specification Section number
 - 2) Quantity
 - 3) Manufacturer
 - 4) Part Number
 - 5) Serial Number
 - 6) Manufacturer's warranty end date, if greater than 12 months after Substantial Completion
 - b. Cutsheets and Operation and Maintenance Manuals
 - c. Test Results and Cable Databases, in PDF and Microsoft Excel format
 - d. Record Drawings, in PDF and AutoCAD file formats
 - e. Spare Parts / Physical Media
 - 1) Copy of written documentation indicating that the spare parts were furnished to the owner.
 2. All products and submittals are to be in the exact order as these specifications.
 3. Cutsheets and O&M Manuals are to be separate files identified by ## - Product Name – Manufacturer – Model.pdf, where ## is the sequential order of the product in that specification. Example (manufacturer and products may be different for this project):
 - a. 01 – Headend System – Lenel – OnGuard – 7.2
 - b. 02 – Server Software – Lenel – OnGuard – SWS-32ES
 - c. 03 – Workstation – Dell – Precision T3500

- d. 04 – Controller – Lenel – Intelligent Dual Reader
 - e. 05 – Interface Module – Lenel – Dual Reader Interface Module
 - f. 06 – Power Supply – Altronix – Multi-Output Power Supply
 - g. 07 – Card Reader – HID – Multi-class Reader
 - h. 08 – (continue as needed)
4. Test Results and Cable Database requirements are to include the following:
- a. Test Results to include PDF of passing Functional Test Report for each device, organized by sub-system. Refer to individual sub-sections for Functional Test Report requirements.
 - b. Cable Database requirements – refer to Division 28 Section “Conductors and Cables for Electronic Security” and “Telecommunications Requirements for Electronic Security”; these are to be submitted in PDF and Microsoft Excel file formats.
5. Record Drawings
- a. Refer to Record Drawings paragraph in Division 28 Section “General Electronic Safety and Security Requirements” for additional requirements.
 - b. Record Drawings shall be updated versions of the approved Shop Drawings and shall meet all Shop Drawing requirements.
 - c. Record Drawings for each Electronic Security sub-system shall be provided with final cable routing and pathway routing noted.
 - 1) J-hook / cable routing shall be indicated.
 - 2) Conduit and pullbox routing and locations shall be indicated.
6. After Design Consultant makes comments on the Final Project Completion Submittal, incorporate changes and:
- a. Save a copy of these files onto the Workstations provided by the ESC.
 - b. Forward updated Final Project Completion Submittal files to Owner. Include file path information for these updated files on the Workstations provided by the ESC.

END OF SECTION

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SECTION 28 10 10 - CONDUCTORS AND CABLES FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. As part of a complete and functioning Electronic Security System and associated infrastructure, provide conductors and cables of appropriate type. This section includes:
 - 1. Low-voltage Control and Power Cables
- B. Conductor and cable requirements are unique to each manufacturer equipment / device. Unless otherwise noted, exact conductor and cable types are to be coordinated by the ESC to meet the requirements of the Electronic Security manufacturer

1.2 RELATED SECTIONS

- A. Work under this section shall follow Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- B. Conductors and cables as specified in this section shall be supported and installed into pathways, backboxes, firestopping, and other general/common work per Division 28 Section "Common Work Results for Electronic Security Systems".
- C. Refer to Division 28 Section "Telecommunications Requirements for Electronic Security" for all Category 6A and Fiber Optic Cable requirements.
- D. Refer to Division 28 Section "Equipment Room Fittings for Electronic Security" for grounding and bonding requirements.
- E. Refer to individual Electronic Security System sections for additional conductor and cabling requirements.

1.3 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- B. The following additional requirements at due at the following submittal phases:
 - 1. Pre-Construction Submittal
 - a. Cut sheets shall contain the following information for each of the cables specified.
 - 1) Manufacturers name and logo
 - 2) Cable outside diameter
 - 3) Number of conductors/strands in each cable and binder group
 - 4) Gauge or strand thickness
 - 5) Cable jacket material and rating (ie Plenum, Riser, wet-rated, etc.)
 - 6) Maximum pulling tension
 - 7) Jacket/Sheath color
 - 8) Individual conductor or strand insulation colors (if applicable)
 - 9) Minimum bend radius
 - a) During installation and post installation, if it differs.
 - b. Shop Drawings

- 1) Cable types required by this Section are to be identified on Shop Drawings for the following Electronic Security sub-systems: (separate 281010 Shop Drawings for this section are not needed)
 - a) Access Control
 - b) Video Surveillance
 - 2) On the Shop Drawings for those Electronic Security sub-systems, show the proposed routing of all conductors and cables and the means of support:
 - a) Cable Tray
 - b) Conduit (solid line)
 - c) J-hooks every 48"-60" (dashed line), if allowed by Contract Documents
 - 3) On the Shop Drawings for those Electronic Security sub-systems, include details showing the proposed termination and labeling (ID) scheme at each device and panel for each conductor/cable.
2. Preliminary Project Completion Submittal
- a. Follow all requirements as specified in Division 28 Section "Electronic Security Systems".
 - b. Update the approved shop drawings with any changes in cable routing, and submit as part of Preliminary Record Drawings per Division 28 Section "Electronic Security Systems".
 - c. Test Results
 - 1) Include conductor/strand test as part of the Functional Test Reports for each Electronic Security sub-system.
 - d. Cable ID spreadsheet, saved in PDF and Microsoft Excel file formats, which shall include the following for each cable installed under this section:
 - 1) Electronic Security Sub-System
 - 2) Device Type
 - 3) Device Identifier
 - 4) Device Room Number (if not part of Device Identifier)
 - 5) Headend Panel Identifier
 - 6) Headend Panel Room Number (if not part of Headend Panel Identifier)
 - 7) Cable Identifier

TABLE 1: CABLE IDENTIFICATION SPREADSHEET

<u>Sub-System</u>	<u>Device Type/ID</u>	<u>Device Rm</u>	<u>Headend ID</u>	<u>Headend Rm</u>	<u>Cable ID</u>
Access Control	Card Reader 01	Vestibule 101	ACP-01	IDF 114	AC-CR01-ACP01

3. Final Project Completion Submittal
- a. Follow all requirements as specified in Division 28 Section "Electronic Security Systems".
 - b. Incorporate any changes from punch list items.

- c. Include updated Cable ID spreadsheet.

1.4 DEFINITIONS

- A. Damp Location – as defined by the NEC, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.
- B. Point of Entrance (Building Entrance) – as defined by the NEC, the point within a building where the security cabling routed through a Wet Location emerges from an external wall, a concrete floor slab, or IMC/RMC.
- C. Qualified Electrician – one who has skills and knowledge related to the construction and operation of the electrical equipment and installations and has received safety training to recognize and avoid the hazards involved; in regards to this project, a Qualified Electrician is also licensed in the jurisdiction of the project to install electrical equipment (ie Journeyman or Master Electrician License).
- D. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL REQUIREMENTS

- A. Conductors and cables shall meet the following the requirements:
 - 1. UL Listed and Approved for the intended application
 - a. Where areas above accessible ceilings are serving as plenum (air) return, and conductors/cabling is not installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Plenum (CMP) rated.
 - b. Where conductors/cabling are installed in conduit from device to serving panel or Equipment Room, the conductors/cabling shall be Riser (CMR) or Plenum rated.
 - c. Where conductors are/cabling are routed through a Wet Location,
 - 2. Cable type and conductor size/quantity shall be as recommended or required by the device/equipment manufacturer. Where the Contract Documents differ from manufacturer recommendations or requirements, notify the Architect requesting clarification.
 - 3. Conductor sizes, if shown, are minimum. Where approved by the Design Consultant and at no extra cost to the Owner, larger conductor sizes may be installed at Contractor's option in order to utilize stock sizes, provided raceway sizes are increased to correspond with fill ratio requirements defined the NEC.
 - 4. Conductors and cables shall be shielded.
 - a. Submit RFI for any manufacturer equipment that recommends non-shielded cable.
- B. The following Manufacturers are conditionally approved:
 - 1. Belden
 - 2. Draka
 - 3. General Cable
 - 4. Tappan
 - 5. West Penn Wire

2.2 LOW-VOLTAGE CONTROL AND POWER CABLES

- A. For 10 AWG through 24 AWG, and single conductors through 24-pair applications, as needed per project.
- B. General requirements:
 - 1. Shielded (overall shield)
 - 2. Stranded and insulated conductors
 - 3. PVC jacket
 - 4. Size conductors per manufacturer recommendations and power/voltage drop based on installed cable length.
- C. Manufacturer shall be:
 - 1. Submit product cutsheets concurrently with Shop Drawings, identifying cable type, manufacturer, and part number on the Riser Diagram.
 - a. Call out non-plenum (Riser-rated and Wet-rated) cables (where specifically allowed)

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

- A. Pre-Installation
 - 1. Following the Notice to Proceed, the ESC's Quality Control Specialist or Project Manager (as defined in Division 28 section "Electronic Security Systems") shall coordinate with the Contractor or Sub-Contractor responsible for Division 28 "Common Work Results for Electronic Security Systems" (ie the conduits, backboxes, etc), if Contractors are different. Items of coordination shall include, but are not limited to:
 - a. Conduit routing
 - b. Conduit type for Building Entrance(s) – (see requirements below)
 - 2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:
 - a. Division 28 "Common Work Results for Electronic Security"
 - b. Division 28 "Electronic Security Systems"
 - 3. After conduits/pathways are installed, but prior to cable installation, ESC's Quality Control Specialist and Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:
 - a. Conduit sizes and quantities matches Construction Documents and Project requirements
 - b. Minimum bend radius
 - c. Quantity of bends in conduit between pullboxes (180 degree change in direction, maximum)
 - d. Building Entrance conduits are of appropriate type
 - e. Any visible indication of improper or incomplete installation that may damage cable as it is installed.
- B. General Requirements

1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.
 - a. Conduits are not required above accessible (drop) ceilings; when not installed in conduit, cables shall be supported via j-hooks every 48 to 60 inches or less and at every change in direction. For areas where accessible ceiling is not available for pathway back to the Equipment Room, cables may be consolidated and routed in overhead conduit and conduit sleeves.
 - b. Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pullboxes in accordance with Division 28 Section "Common Work Results for Electronic Security"; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.
2. Install continuous conductors between outlets, devices and boxes without splices or taps. Do not pull connections into raceways. Leave at least 12 inches of conductor in backbox at each device location.
3. A Qualified Electrician shall install all control wire operating at 120V nominal and above. Control wiring operating at less than 120V (e.g., 12V and 24V) may be installed under the Division furnishing it.
4. All cables shall be plenum-rated, unless noted otherwise.
5. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
6. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.
7. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
8. Comply with all referenced standards and guidelines.
9. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
10. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be:
11. A minimum of 3 feet (1 meter) in length, unless noted otherwise.
12. Prior to using any cable pulling lubricants provide the Design Consultant with written documentation from the cable manufacturer supporting the cable manufacturers' acceptance of its use in compliance with all required warranties as part of these contract documents. The use of non-water based lubricants shall be provided when pulling PVC jacketed and all cables not suitable for contact with water.
13. Install all cables and conductors in compliance with the requirements of Article 725 of the NEC, paying special attention to the following:
 - a. Cables shall be installed in a neat and workmanlike manner.
 - b. Separation requirements dependent upon installation location and proximity to other circuits.

- C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Wet Locations or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space nor shall they be allowed to transition between different levels of the building.
 2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Equipment Room in accordance with the NEC; or a suitably-sized junction box shall be provided in an accessible location within 50' of where the outdoor cabling/conduit enters the building enters the building to allow the cable to transition from wet-rated to plenum-rated.
 - a. Indicate this location on pre-construction shop drawings and final Record Drawings.
 3. All cables which extend beyond the envelope/footprint of the building shall be installed with entrance protectors in accordance with Division 28 Section "Equipment Room Fittings for Electronic Security".

3.2 CABLE IDENTIFICATION

- A. Label all cabling with machine-printed labels according to the labeling scheme identified on the drawings or as described in Division 28 Section "Electronic Security Systems". Where the drawings and specifications are silent, submit RFI through appropriate channels requesting labeling scheme.
1. Shop drawings shall include floor plan and/or riser diagram that indicates proposed cable/device identification for each device.
- B. Cables shall be labeled within 6" at each end.
- C. All cable labels shall be thermal-transfer type and utilize self-adhesive labels. The following are approved manufacturers:
1. Brady, IDXPRT
 2. Hellermann Tyton, Spirit 2100
 3. Panduit LS9
 4. Or equivalent

3.3 GENERAL CABLE TESTING

- A. Pre-installation testing:
1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
 2. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.
- B. Post-installation testing (but prior to termination to devices/panels):
1. Conduct cable continuity testing upon completion of installation on each conductor.
 2. Remove all defective cables from pathway systems. Do not abandon cables in place.

3.4 CABLE TERMINATIONS

- A. Cable connections to device and security panel shall be soldered and heat-shrunk from jacket to jacket. Exposed conductors, even within an enclosure or backbox, are not allowed.

3.5 ACCEPTANCE

- A. The ESC's Quality Control Specialist shall conduct an inspection after conductors and cabling have been installed to ensure compliance with the Construction Documents and project requirements.
- B. Functional tests of the conductors and cables connected to equipment will be conducted by the ESC as part of Test Reports as specified in Division 28 "Electronic Security Systems" and individual Electronic Security sub-system Sections.

END OF SECTION

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SECTION 28 10 15 - TELECOMMUNICATIONS REQUIREMENTS FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide a Telecommunications Structured Cabling System to support a complete and functioning Electronic Security System. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, and transport to provide the following:
 - 1. Category 6A Horizontal Cabling
 - 2. Category 6A Connectivity
 - 3. Category 6A Patch Panels
- B. All Structured Cabling components provided under this section shall be covered by a manufacturer's 20-year (or longer) Advanced System Warranty and installed and tested by a certified contractor of the warranty provider. Refer to the Quality Assurance section of this specification for more information on this requirement.

1.2 RELATED DOCUMENTS

- A. Work under this section shall follow Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- B. Work under this section shall follow Division 28 Section "Common Work Results for Electronic Security Systems" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Work under this section shall follow Division 28 "Seismic Controls for Electronic Safety & Security".
- D. Refer to Division 27 for approved Telecommunications / Structured Cabling System manufacturers.
- E. Refer to Division 28 Section "Equipment Room Fittings for Electronic Security" for rack, protectors, and grounding and bonding requirements.

1.3 CODES, STANDARDS, AND GUIDELINES

- A. In addition to all applicable codes, standards, and guidelines listed in Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems", follow the most recent editions of the following:
 - 1. NFPA 70 – National Electrical Code (NEC)
 - 2. IEEE National Electrical Safety Code (NESC)
 - 3. ANSI/BICSI 005-2013 – Electronic Safety and Security System Design and Implementation Best Practices
 - 4. ANSI/NECA/BICSI-607 – Standard for Telecommunications Bonding and Grounding Planning and Installation methods for Commercial Buildings
 - 5. ANSI/TIA-568-C.O - Generic Telecommunications Cabling for Customer Premises
 - 6. ANSI/TIA-568-C.1 - Commercial Building Telecommunications Cabling Standard Part 1: General Requirements
 - 7. ANSI/TIA-568-C.2 - Balanced Twisted-Pair Telecommunications Cabling and Components Standards

8. ANSI/TIA-568-C.3 - Optical Fiber Cabling Components Standards
9. ANSI/TIA/568-C.4 – Broadband Coaxial Cabling and Components Standard
10. ANSI TIA-569-C – Commercial Building Standard for Telecommunications Pathways and Spaces
11. ANSI TIA-606-B – Administration Standard for Commercial Telecommunications Infrastructure
12. ANSI TIA-607-D – Generic Telecommunications Bonding and Grounding (Earthing) for Customer Premises
13. ANSI Z136.2, ANSI For Safe Use Of Optical Fiber Communication Systems Utilizing Laser Diode And LED Sources
14. BICSI - Telecommunications Distribution Methods Manual
15. BICSI – Information Technology Systems Installation Methods Manual

1.4 DEFINITIONS

A. Acronyms:

1. ESC – Electronic Security Contractor – refer to Division 28 Section “Electronic Security Systems” for definition.
2. WAO – Work Area Outlet, the outlet or connector at the far end of horizontal cable.

B. Definitions

1. Advanced System Warranty – a minimum 20-year warranty covering material and performance of the telecommunications structured cabling system offered by a reputable manufacturer. Refer to the Quality Assurance section of this specification for more information.
2. Certified Structured Cabling Contractor – a contractor that is certified by one of the approved Structured Cabling System manufacturers to install the Telecommunications / Structured Cabling required for Electronic Security Systems and covered by that manufacturer's Advanced System Warranty.
3. Communications Room – for the purpose of this section, means the location of a floor-serving facility for housing telecommunication equipment, cable terminations, and cross-connect wiring. This room is recognized in ANSI/TIA 569 as the transition point between the telecommunications horizontal (station) pathway facilities and the backbone (riser) pathway facilities. The room may be identified by other names, including: Equipment Room, IDF, MDF, IT, Telecom/Telecommunications Room, LAN, Network Room, etc. The functional connection points may also be located in Security equipment rooms and/or racks; refer to drawings for exact locations and room names.
4. Contractor – in regards to this section only, the contractor responsible for providing a complete Telecommunications Structured Cabling System for Electronic Security. This contractor shall be a certified contractor of the manufacturer providing the Advanced System Warranty. Where the ESC does not meet this requirement, they shall engage the services of subcontractor who meets these requirements.
5. Damp Location – as defined by the NEC, locations protected from weather and not subject to saturation with water or other liquids but subject to moderate degrees of moisture. For the purposes of Work under this division, assume all Damp Locations require wet-rated cabling.

6. Direct Attach Method – as defined in ANSI/BICSI 005-2013, the horizontal cabling on the remote device end directly attaching (or connecting) to the device through a connectorized cable or hard-wired termination, eliminating the workstation outlet, jack and equipment cord.
7. Horizontal Cabling
 - a. Horizontal cable and its connecting hardware provide the means of transporting signals between the telecommunications outlet/connector and the horizontal cross-connect located in the communications equipment room. This cabling and its connecting hardware are called "permanent link," a term that is used in the testing protocols.
 - 1) Horizontal cabling shall contain no more than one transition point or consolidation point between the horizontal cross-connect and the telecommunications outlet/connector
 - 2) Bridged taps and splices shall not be installed in the horizontal cabling
 - 3) Splitters shall not be installed as part of the optical fiber cabling
 - b. The maximum allowable horizontal cable length for Category copper cable is 295 feet (90 meter), which includes total cable length (including vertical routing and slack). Horizontal cables longer than 295 feet shall be optical fiber with power conductors hybrid cable with a Power-over-Ethernet Extender transmitter/receiver on each end.
 - 1) Power-over-Ethernet Extenders are specified in Division 28 Section "Equipment Room Fittings for Electronic Security".
8. Structured Cabling / Telecommunications System – a fully-functional passive telecommunications system (infrastructure), that includes permanently installed category copper cable terminated onto a patch panel or outlet.
9. Wet Location - as defined in the NEC, installations underground or in concrete slabs or masonry in direct contact with the earth; in locations subject to saturation with water or other liquids, such as vehicle washing areas; and in unprotected locations exposed to weather.

1.5 QUALITY ASSURANCE

- A. All Work under this section shall be performed by the same Structured Cabling contractor for Division 27, and shall meet all Quality Assurance requirements as specified in Division 27 Section "Structured Cabling".
 1. Connectors and patch panels shall be the same manufacturer and model that is being provided for Telecommunications / Structured Cabling Work, and covered under the same Advanced System Warranty.
 2. Contractor Qualifications
 - a. Subject to other requirements of this section, Contractor shall be certified and capable of offering an Advanced System Warranty from one of the manufacturers listed above.
 3. Personnel Qualifications
 - a. Provide and maintain a Project Manager who is a BICSI Registered Certified Technician Level 2 Installer in good standing on site at all times that Work in this section is being performed.
 - b. The person(s) conducting the testing for all Telecommunications cabling shall be a current BICSI Certified Level II Commercial Installer or higher.
 - 1) Submit certificates with pre-construction submittals.
 - c. Any additional personnel that will be physically installing any part of the Telecommunications Infrastructure covered by this Section shall, at a minimum, be a

BICSI Certified Level 1 Commercial Installer in good standing or have equivalent manufacturer training.

- d. These requirements are provided as a minimum level of qualification. Any additional or more stringent requirements by the specific manufacturer chosen to provide the proper level or term of warranty as specified in this division shall be met.
- e. Alternate qualifications may be considered if requested alternates are provided in accordance with the Substitution instructions in Division 28 Section "General Electronic Safety and Security Requirements".

1.6 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Sections "General Electronic Safety & Security Requirements" and "Electronic Security Systems".
- B. Pre-Bid Submittal - the following submittals are due before the questions deadline before Bid:
 - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- C. Pre-Construction Submittal
 - 1. Refer to Division 28 Section "Electronic Security Systems" submittal requirements, with additional requirements as noted:
 - a. Division of Labor – including Company name and contact information of Project Manager for the Contractor performing this Work.
 - b. Warranty Information
 - 1) Sample warranty certificate for the Advanced System Warranty, indicating manufacturer and their terms/conditions
 - 2) Proof that Contractor is certified with the Advanced System Warranty manufacturer
 - c. Contractor and Personnel Qualifications and Certificates
 - d. Schedule
 - e. Typed Parts List
 - f. Cut Sheets
 - 1) Product data on cabling and patch cables shall contain the following:
 - a) Manufacturers name and logo
 - b) Cable outside diameter
 - c) Number of conductors/strands in each cable
 - d) Gauge or strand thickness
 - e) Minimum transmission performance rating
 - f) Cable jacket material and rating
 - g) Maximum pulling tension
 - h) Jacket/Sheath color
 - i) Minimum bend radius

- j) During installation and post installation, if different
 - 2) Product data on faceplates, modules, connectors, patch panels, and enclosures shall contain the following:
 - a) Manufacturers name and logo
 - b) Material type
 - c) Performance rating
 - d) Physical Dimensions
 - e) Color
 - g. Shop Drawings
 - 1) Scaled layout drawings showing the routing (and support method) of all cabling, and the locations where patch panels, Telecommunications outlets, cable types, cable jacket listing information, firestop locations (with quantity and NRTL system number identified), and fiber optic termination panels are to be installed.
 - 2) Each individual work area outlet on the drawings shall have proposed outlet identification indicated.
 - 3) Scaled enlarged plan and rack elevation drawings showing the locations of patch panels and Rack-Mount Enclosures.
 - 4) Unless otherwise required by these specifications, it is permissible to show Work in this section on Electronic Security shop drawings.
- D. Preliminary Project Completion Submittal
 - 1. As part of "Division 28 Electronic Security – Preliminary Project Completion Submittal", include the following requirements:
 - a. Resubmit approved Pre-Construction Submittals of the following, updated to reflect all changes during construction:
 - 1) Equipment List
 - 2) Cut Sheets
 - 3) Preliminary Record Drawings – based on drawings kept on site.
 - a) Scans of on-site drawings are acceptable, provided notes and minor changes are legible
 - b) These drawings shall include the actual installed device and cable IDs that correspond to submitted test results.
 - b. Submit the following additional items:
 - 1) Operation and Maintenance Manuals
 - 2) Category 6 Test Results, in accordance with Part 3 of this section.
 - a) Cable IDs shall correspond to submitted Preliminary Record Drawings.
- E. Final Project Completion Submittal
 - 1. As part of "Division 28 Electronic Security – Final Project Completion Submittal", include the following requirements:
 - a. Updated Equipment List, Cut Sheets, Operation & Maintenance Manuals, and Test Results

- b. Updated Record Drawings, in AutoCAD and searchable PDF file formats
- c. Advanced System Warranty Information and Certificates, including contact number for any warranty claim

1.7 COORDINATION

- A. Review pathways and other Work, as installed per Division 28 section “Common Work Results for Electronic Security Systems”, prior to performing any Work under this section for conformance to all referenced codes, standards, and guidelines.
 - 1. While Division 28 section “Common Work Results for Electronic Security Systems” is being installed, the Project Manager of this section and the ESC’s Quality Control Specialist shall make weekly inspections and report any issues to the Prime Contractor for correction prior to installation of any cabling.
 - a. Example – Conduit for Category 6 data outlets shall not contain more than two 90 degree bends between pull points.
- B. Coordinate with ESC for all Work in Communications / Equipment Rooms.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL REQUIREMENTS

- A. All cabling shall be from a single manufacturer, except where noted.
- B. All connectivity shall be from a single manufacturer, except where noted.
- C. All cabling and connectivity specified in this section shall be covered by a single Advanced System Warranty, except where noted.
- D. Refer to the Quality Assurance paragraph in Part 1 of this specification for conditionally approved manufacturers that meet the Advanced System Warranty requirements.

2.2 CATEGORY 6A HORIZONTAL CABLING

- A. All Category 6A cable will be furnished by Owner and installed by Division 27 Contractor

2.3 CATEGORY 6A CONNECTIVITY – WORK AREA OUTLET

- A. All Category 6 modular jacks and connectivity will be furnished and installed by Owner.

2.4 CATEGORY 6A CONNECTIVITY – COMMUNICATION ROOMS

- A. All Category 6 Patch Panels will be furnished and installed by Owner.

2.5 CATEGORY 6A PATCH CABLES

- A. All Category 6 patch cords will be furnished and installed by Owner.

PART 3 - EXECUTION

3.1 CABLE INSTALLATION

- A. Pre-Installation
 - 1. Following the Notice to Proceed, the Project Manager of the Work associated with this section shall coordinate with the ESC and the Contractor or Sub-Contractor responsible for Division 28 “Common Work Results for Electronic Security Systems” (ie the conduits, backboxes, etc), if Contractors are different. Items of coordination shall include, but are not limited to:

- a. Conduit routing
 - b. Conduit type for Building Entrance(s) – (see requirements below)
 2. Conduit routing and type shall be indicated on at least one of the following Pre-Construction Shop Drawings:
 - a. Division 28 “Common Work Results for Electronic Security”
 - b. Division 28 “Electronic Security Systems”
 - c. Division 28 “Telecommunications Requirements for Electronic Security”
 - d. Division 27 “Structured Cabling”
 3. After conduits/pathways are installed, but prior to cable installation, the Project Manager shall inspect the Common Work (pathways and backboxes), paying special attention to:
 - a. Conduit sizes and quantities matches Construction Documents and Project requirements
 - b. Minimum bend radius
 - c. Quantity of bends in conduit between pullboxes (180 degree change in direction, maximum)
 - d. Building Entrance conduits are of appropriate type
 - e. Any visible indication of improper or incomplete installation that may damage cable as it is installed.
- B. General Requirements
1. Unless otherwise noted, all cables shall be routed through concealed conduit raceway.
 - a. Conduits are not required above accessible (drop) ceilings; when not installed in conduit, cables shall be supported via j-hooks every 48 to 60 inches or less and at every change in direction. For areas where accessible ceiling is not available for pathway back to the Equipment Room, cables may be consolidated and routed in overhead conduit and conduit sleeves.
 - b. Contractor is responsible for determining final cable and conduit routing; conduits may be consolidated in overhead pullboxes in accordance with Division 28 Section “Common Work Results for Electronic Security”; proposed (cable and) conduit routing and sizing shall be indicated on pre-construction shop drawings.
 2. Install continuous conductors between outlets, devices and boxes without splices or taps, unless otherwise noted. Do not pull connections into raceways. Leave at least 12 inches of slack in backbox at each device location.
 3. All cables shall be plenum-rated, unless noted otherwise.
 4. Cables shall remain unattached to pathways or other cables and shall simply lay at rest on the supports provided by its pathway (including cable trays, wire basket, j-hooks, conduit, etc.). Wire ties, velcro straps, electrical tape or any other method shall not be used to attach cables to cable supports or to create cable bundles.
 - a. Except when supported by ladder racking within each Telecommunications room, UON.
 5. At the same time horizontal cables are pulled into a conduit also install a pull cord to facilitate future cable pulls along those. Use polypropylene or monofilament plastic line with not less than 200 lb tensile strength. Leave at least 12 inches of slack at each end of pull cord.

6. Do not install kinked, scored, deformed, or abraded cable. Remove and discard cable if damaged during installation and replace it with new cable
 7. Comply with all referenced standards and guidelines.
 8. Cables shall be masked, covered, or otherwise protected from being painted or coming in contact with any other substance that may degrade the performance or physical characteristics of the cable jacket or insulation over time.
 9. Where space allows, all cables shall be provided with slack/service loops near each end of the cable, one in the accessible ceiling space or overhead J-box at the device and one at the Equipment Room. Each slack/service loop shall be:
 - a. A minimum of 15 feet in length at all camera locations.
 - b. A minimum of 10 feet in length in the ladder rack of the serving Communications Room.
 10. Use of any cable pulling lubricants is prohibited.
 - a. Where lubricant is deemed necessary by the contractor to facilitate installation of cable in conduit, submit RFI with explanation, effected conduit run, proposed lubricant type, letter from cable manufacturer indicating proposed lubricant will not damage or degrade cable, and a letter from the manufacturer providing the Advanced System Warranty that the use of this lubricant will not exclude that cable run from the required warranty.
 11. Install all cables and conductors in compliance with the requirements of Article 725 of the NEC, paying special attention to the following:
 - a. Cables shall be installed in a neat and workmanlike manner.
 - b. Separation requirements dependent upon installation location and proximity to other cables and sources of EMI.
- C. Outside plant (OSP)/wet-rated cable installation: for cables placed in Damp or Wet Locations or as required by these construction documents. (I.e. all cables which extend beyond the footprint/envelope of the building or pathways leading to floor-boxes embedded in a ground floor slab)
1. No portion of outdoor only (unlisted) cables may be installed with the cable jacket exposed in any plenum or other air handling space, nor shall they be allowed to transition between different levels of the building.
 2. Rigid or intermediate metallic conduit shall be used to route outdoor (unlisted) cabling to the serving Communications Room in accordance with the NEC; or a suitably-sized junction box shall be provided in an accessible location within 50' of where the outdoor cabling/conduit enters the building to allow the cable to transition from wet-rated to plenum-rated.
 - a. Indicate this location on pre-construction shop drawings and final Record Drawings.
 3. All cables which extend beyond the envelope/footprint of the building and serving devices mounted on the roof (or within 10' of the roof) shall be installed with entrance protectors in accordance with Division 28 Section "Equipment Room Fittings for Electronic Security".

3.2 CONNECTOR INSTALLATION

- A. Owner will Furnish and install all cable connectors.

3.3 FACEPLATE INSTALLATION

- A. Owner will Furnish and install all faceplates.

3.4 CABLE IDENTIFICATION

1. Owner will furnish and install all cable identification.

3.5 GENERAL CABLE TESTING

A. Pre-installation testing:

1. Visually inspect all cables, cable reels/boxes, and shipping cartons to detect cable damage incurred during shipping and transport. Return visibly damaged items to the manufacturer.
2. Mark reels or boxes as tested/inspected.
3. Do not install any cable with less than the manufacturer's guaranteed number of serviceable conductors.
4. The field-test instruments shall be within the calibration period recommended by the manufacturer and shall contain the most recent software and firmware provided by the manufacturer prior to testing.

B. Post-installation testing:

1. Owner will conduct cable testing upon completion of installation.
2. Remove all defective cables from pathway systems.
3. All cables that fail testing are to be corrected prior to substantial completion and acceptance by owner. Replace entire cable if bad pair or conductor is found. Do not abandon cables in place.

3.6 COPPER CABLE TESTING

- #### **A.**
- Perform all manufacturer recommended and required test calibration procedures prior to testing any cables.

3.7 ACCEPTANCE

- #### **A.**
- All Work in this section is subject to the Project Completion and Schedule requirements of Division 28 section "Electronic Security Systems".

B. After Final Acceptance Review:

1. Complete all Punch List items.
2. Retest effected cables.
3. Among other requirements, submit updated and complete Record Drawings/Test Results and the Advanced System Warranty certificate as part of Division 28 Electronic Security – Project Completion Final Submittal.

END OF SECTION

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SECTION 28 10 20 - EQUIPMENT ROOM FITTINGS FOR ELECTRONIC SECURITY

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Section includes fittings that are within the physical walls of Electronic Security Equipment Rooms (Communications Rooms), unless otherwise noted. Fittings include but are not limited to
 - 1. Grounding/bonding requirements
- B. Section does not specify fittings such as cables, cable terminations, termination blocks, and patch panels for telecommunications systems. These components are specified in Division 27.
- C. Section does not specify wall-mounted Electronic Security panels or rack-mounted Electronic Security network equipment such as switches or servers. Refer to other Division 28 Sections for those sub-system requirements.

1.2 RELATED SECTIONS

- A. Work under this section shall follow Division 28 Section "General Electronic Safety and Security Requirements".
- B. Work under this section shall follow Division 28 Section "Common Work Results for Electronic Security Systems" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Work under this section shall follow Division 28 Section "Electronic Security Systems". All submittals associated with this section shall be submitted as part of a single Electronic Security Systems submittal.

1.3 DEFINITIONS

- A. Communications Entrance Protection – Fittings that reduce risk to life, limb, or property by protecting against power surges. This definition shall encompass protection devices and fittings described in Article 770 "Optical Fiber Cables and Raceways" and Article 800 "Communications Circuits" of NFPA 70 "National Electrical Code".
- B. Cabinet – A floor or wall mount unit enclosed with side panels. Communications equipment is supported by mounting rails separated at 19" or 23" inches.
- C. DVR – digital video recorder
- D. Ground or Grounding – A conducting connection, whether intentional or accidental, between an electrical circuit (e.g. telecommunications) or equipment and the earth, or to some conducting body that serves in place of earth.
- E. NVR – network video recorder
- F. POE – Power-over-Ethernet
- G. Rack – A floor or wall mount unit without side panels. Racks can be constructed with 2 or 4 vertical posts. Rack-mounted equipment is supported by mounting rails separated at 19" or 23" inches.
- H. RU – Rack Unit (1.75 inches high)
- I. Telecommunications Grounding Busbar (TGB) – A busbar placed in a convenient and accessible location in an Equipment Room and bonded by means of the bonding conductor to the building service equipment (power) ground.

1.4 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of device from a single manufacturer and through one source. Where practical and possible, obtain all devices from a single manufacturer and one source.
- B. Equipment room fittings shall be listed by a NRTL.

1.5 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Sections “General Electronic Safety & Security Requirements” and “Electronic Security Systems”.
- B. Pre-Bid Submittal - the following submittals are due before the questions deadline before Bid:
 - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.
- C. Pre-Construction Submittal
 - 1. Refer to Division 28 Section “Electronic Security Systems” submittal requirements, with additional requirements as noted:
 - a. Product Submittals (as part of complete Division 28 “Electronic Security Systems” Pre-Construction Submittal):
 - 1) Product Cutsheets
 - b. Shop Drawings (as part of complete Division 28 “Electronic Security Systems” Pre-Construction Submittal):
 - 1) Enlarged Plans for each Equipment Room, at no smaller than 1/4" = 1'-0" scale, showing 3' of clearance in front of all wall-mounted equipment and 3' of clearance in front of and behind each floor-mounted equipment racks and cabinets.
 - 2) Equipment rack and cabinet elevations, at no smaller than 1/2" = 1'-0" scale, identifying each piece of rack-mounted equipment by product name, manufacturer, and part number.
 - 3) Grounding & Bonding
 - a) Where TGBs are required by this section, indicate on the Electronic Security System Shop Drawing floor plans the routing and final connection point for the bonding conductors from each TGB to building steel / serving electrical panelboard. Also indicate proposed length and size of this bonding conductor (sized per this section).
- D. Preliminary Project Completion Submittal
 - 1. Refer to Division 28 Section “Electronic Security Systems” submittal requirements, with additional requirements as noted:
 - a. Test Results
 - 1) Include Test Report for all UPS units.
- E. Final Project Completion Submittal
 - 1. Refer to Division 28 Section “Electronic Security Systems” submittal requirements, with additional requirements as noted:

- a. Record Drawings
 - 1) Grounding and Bonding
 - a) Add written confirmation that all required bonding connections have been made and the resistance tested to be 10 milli-ohms or below.

PART 2 - PRODUCTS AND MATERIALS

2.1 PLYWOOD BACKBOARD

- A. Where Electronic Security System equipment is co-located in a Communications Room with telecommunications equipment, plywood backboard shall be provided by Division 27 "Structured Cabling System".

2.2 ENTRANCE PROTECTION

- A. General
 1. Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NEC chapter 8. This includes:
 - a. Cameras mounted on the roof, parapet, or exterior wall within 10' of roof line.
 - b. Cameras mounted to site light poles or fences.
 2. Refer to Division 28 section "Access Control" for surge protection devices for Access Control site devices.
- B. Category 6A Surge Protection
 1. General
 - a. Shall meet UL 497
 - b. Shall exceed TIA/EIA 568 Category 6 performance standards
 - c. Shall be capable of being used with POE+ applications
 2. Wall-mount Protectors – for single cables, where quantity of cables in Equipment Room needing protection is 6 or less
 - a. Manufacturer shall be:
 - 1) Vertiv Edco
 - 2) ITWLinx SurgeGate Series
 3. Rack-mount Protectors – where more than 6 cables in an Equipment Room require surge protection
 - a. Shall be rack-mountable in 19" wide equipment rack
 - b. Provide quantity of Category 6 protectors/modules required for install, plus 25% spare
 - c. Manufacturer shall be:
 - 1) APC ProtectNet Chassis
 - 2) Vertiv Edco
 4. Camera-end Protection – exterior POE cameras should have integral protection against power surges and transients. Where cameras do not have integral protection, provide the following at the far-end of cable connecting exterior POE camera:
 - a. Blackbox In-Line Surge Protector

- b. Vertiv

2.3 RACKS, CABINETS, AND ENCLOSURES

- A. Two-Post Rack
 - 1. Where Electronic Security System equipment is co-located in a Communications Room with Telecommunications equipment, Two-Post Floor Racks shall be provided by Division 27 "Structured Cabling System". Coordinate installation of Electronic Security equipment into Rack with Division 27 contractor.
- B. Remote Equipment Cabinet Light Pole – as identified on drawings and/or for light pole locations as needed
 - 1. Minimum 16 gauge steel construction
 - 2. Color shall be light grey
 - 3. Provide with lockable, hinged cover
 - 4. Size cabinet and provide all accessories needed for a complete installation, including but not limited to:
 - a. Patch Panel
 - b. Mounting brackets & rails
 - c. Fan w/dust filters
 - d. Back Board
 - e. Surge Suppression
 - f. Fiber Optic Brackets
 - 5. Manufacturer shall be:
 - a. Hoffman RE series

2.4 CABLE MANAGEMENT & LADDER RACK

- A. General
 - 1. Where Electronic Security System equipment is co-located in a Communications Room, cable management and ladder rack shall be by Division 27 "Structured Cabling System" contractor, unless otherwise noted.

2.5 POWER-OVER-ETHERNET (POE) EXTENDERS

- A. General
 - 1. To be utilized where noted on drawings and for any Electronic Security equipment that requires a Category 6A connection, where the cable distance exceeds 295 feet.
 - 2. Shall support extension of PoE (10W at device) and PoE+ (25W at device) up to a minimum of 700 feet.
- B. Fiber POE Extender
 - 1. Shall utilize hybrid Berk-Tek OneReach cable specified in Division 28 section "Telecommunications Requirements for Electronic Security".
 - 2. Head End Device(s) shall be:
 - a. Berk-Tek OneReach
 - 3. Remote End Device(s) shall be:

- a. Berk-Tek OneReach

2.6 GROUNDING AND BONDING REQUIREMENTS

A. General Requirements

1. Where Electronic Security System equipment is co-located in a Communications Room:
 - a. Grounding/Bonding bar (TGB) and connection to Electrical System ground shall be by Division 27 "Structured Cabling System" contractor.
 - b. Electronic Security Contractor shall provide all ground wire and final connections from Division 28 Electronic Security System equipment to TGB. Coordinate with Division 27 Structured Cabling System contractor.
 - c. Refer to Grounding Diagram detail(s) on the drawings and Part 3 of this section for additional requirements.

PART 3 - EXECUTION

3.1 GENERAL

- A. Prior to start-up of Electronic Security System, check all electrical circuits that will serve Electronic Security Equipment to ensure correct wiring polarity and ground impedance is less than 5.0 ohm (per IEEE 1100). Notify Design Consultant of any issues in a timely manner and await correction prior to use of effected circuits.
- B. Labeling requirements
 1. Equipment Racks, Cabinets, and Enclosures are to be labeled at the top of both the front and back sides, minimum text height shall be 3/8".
 - a. Submit proposed labeling scheme on Shop Drawings for review and approval by Design Consultant and Owner.
 - 1) For multiple racks/cabinets in a single equipment room, racks are to be numbered left to right, from front of room to back.
 - 2) For projects with more than one Equipment Room, labeling scheme shall first indicate Equipment Room number/designator.
 2. Wall-mounted Entrance Protectors shall be labeled with device/location it is protecting. Example – "Camera #54 on SW corner of building".
 3. Grounding and Bonding conductors that leave the room shall be labeled with size, far-end destination, and total length. Example - #1/0 to Panelboard A2, 50'
- C. Quantities and sizes of equipment room fittings shown on the Drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of all materials necessary to accommodate the work described in these specifications and schedules and shown on the Drawings.

3.2 PLYWOOD BACKBOARDS

- A. Install plywood backboard in Equipment Rooms such that bottom is 12" AFF with smooth side facing the room interior.
- B. If plywood isn't fire-retardant, mask out a stamp on the front of the plywood and paint plywood with two coats of white, fire-retardant paint. Remove masking material so stamp is visible.

3.3 ENTRANCE PROTECTION

- A. Fully protect each end of all incoming conductors which are considered to have lightning exposure in accordance with NEC chapter 8.
- B. Install grounding/bonding wire as straight as possible from protector to TGB.
- C. Grounding and bonding
 - 1. Bond all metallic shields and armored jacketing material for all incoming cables as close as practicable to the entry into the building.
 - 2. Bonding conductors shall be connected to the TGB as specified in this Section and in accordance with NEC chapter 8.

3.4 CABINETS, RACKS, AND ENCLOSURES

- A. Wall cabinets and enclosures shall be installed on a plywood backboard or attached to a masonry wall. The rack should not be attached to sheet rock (gypsum wall board).
- B. Tags/labels shall be placed on each equipment rack, cabinet and frame in accordance with Part 3 – General instructions of this section.

3.5 GROUNDING/BONDING REQUIREMENTS

- A. General:
 - 1. Installation shall follow ANSI/NECA/BICSI 607-2011 Standard for Telecommunications Bonding and Grounding Planning and Installation Methods for Commercial Buildings.
 - 2. Install the grounding and bonding conductors (wire) without splices or mechanical couplers installed between the wire points of origin and termination.
 - 3. Where insulated conductors are necessary provide adequately rated insulation jackets or pathways to meet all required building codes. (I.e. Plenum, riser, outside plant, run entirely in conduit, etc.)
 - 4. Size all grounding and bonding conductors per the Table in Part 2.
 - 5. Grounding and bonding conductors should not be placed in ferrous metallic conduit. If it is necessary to place grounding and bonding conductors in ferrous metallic conduit that exceeds 3 feet in length, the conductors shall be bonded to each end of the conduit using a grounding bushing and a No. 6 AWG conductor, minimum.
- B. Required Connections:
 - 1. Provide and install all bonding/grounding connections as required by Grounding Diagram Detail(s) on the drawings, and as required by equipment manufacturers, applicable codes, and the referenced standards.
 - 2. Provide and install one individual ground wire from each equipment rack/cabinet/frame and wall-mounted enclosure to the TGB in the room. Each conductor is to be “home run”; do not “daisy chain” the connections, except as may be indicated on the drawings.
 - 3. Provide and install one individual ground wire from the overhead ladder racking (installed under this work) to the TGB in the room
 - 4. Install one individual ground wire from each TGB to one of the following:
 - a. Properly-bonding building steel (if available)
 - b. The serving electrical panel ground bus.
- C. Connector Installation:

1. Provide all ground wire connectors as shown on the Drawings or as indicated herein, unless otherwise noted.
 2. Follow the connector manufacturer's instructions for installing the connector to the cable and the connector to the cabinet/rack, ground bar, etc. Use the appropriate tools for the job, tighten nuts/bolts to proper torque, remove paint, insulation, oxidation as needed to assure good metal to metal contact, etc. If the manufacturer does not provide tightening specifications, follow the recommendations of UL Standard 486.
- D. Cable Identification:
1. Label individual bonding and grounding conductors in accordance with Part 3 – General instructions of this section.
 2. Additional, provide a label above each TGB that states the following: IF CONNECTORS OR CABLES ARE LOOSE OR MUST BE REMOVED, PLEASE CALL THE BUILDING SECURITY MANAGER.
- E. Quantities of Ground Wire / Bonding Conductors
1. Location and placement of grounding and bonding wires/conductors and components shall be as shown on the Drawings or defined herein.
 2. Quantities of ground/bond wires/conductors, bonding components, etc. shown on the drawings are illustrative only and are meant to indicate the general configuration of the work. Provide the correct quantities of materials to construct a complete grounding and bonding system that meets the intent of these Specifications, the relevant codes, and referenced standards.
- F. Testing
1. As a minimum test, as described below, all metallic bonding conductors installed under these Specifications.
 2. Test the conductor and the terminal connectors for total resistance between the equipment item being grounded and the TGB in the room. This resistance shall be less than 0.10 Ohm (100 milliohms).
 3. Recommended test equipment:
 - a. An ohmmeter capable of indicating resistance down to 10 milli-ohms or below.
 - b. Earth Ground Resistance Tester that is configured for continuity test (two-point test)
- G. Record Drawings
1. The Project Record Drawings shall show the types and locations of installed grounding and bonding conductors.

END OF SECTION

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SECTION 28 13 00 - ACCESS CONTROL

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide a complete functioning Access Control System as an extension of the existing Campus Access Control System, and each element thereof, as specified, indicated, or reasonably inferred on the Drawings and in this Specification, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. This Section consists of the control and monitoring of electro-mechanical barriers that limits physical access to authorized persons to openings (such as a gate or door) of a secured area (such as a property, facility, room, or cabinet). The system shall also monitor openings and initiate alarm if opening is forced open or left open for a set period of time.
- C. The additions to the Access Control System shall consist of, but is not limited to, the following components:
 - 1. Head-end Equipment
 - a. Access Control Panels / Controllers
 - b. Entrance Protectors
 - c. Power Supplies & Integral Batteries
 - d. Wall-Mounted Enclosures
 - 2. Devices:
 - a. Credential card readers and cards.
 - b. Request to Exit Buttons
 - c. Regulating access through:
 - 1) Doors

1.2 RELATED SECTIONS

- A. Drawings and general provisions of the Contract apply to this Section.
- B. Work under this section shall follow Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- C. Pathways and other Common Work required by this section shall be provided per Division 28 section "Common Work Results for Electronic Security".
- D. Cabling required by this section shall be provided per Division 28 section "Conductors and Cables for Electronic Security".
- E. Phone and data connections required by this section shall be provided by Division 27 "Structured Cabling".
 - 1. LAN and WAN connectivity required by this section shall be provided by Owner.
- F. For installation of ACS equipment in Equipment Rooms, refer to Division 28 Section "Equipment room Fittings for Electronic Security" for additional requirements.
- G. For integration of the ACS with the Video Surveillance system and cameras, refer to Division 28 section "Video Surveillance" for additional requirements.

- H. Some Electronic Security and Access Control devices required by this project are specified by other divisions.
 - 1. Refer to the following sections and coordinate Division of Labor for each device with Prime Contractor prior to bid and installation:
 - a. Division 08 Section “Door Hardware” or “Commercial Door Hardware” for electric/electro-magnetic locks and strikes, door position switches, and request-to-exit motion detectors.

1.3 CODES, STANDARDS, AND GUIDELINES

- A. Refer Division 28 Sections “General Electronic Safety and Security Requirements” and “Electronic Security Systems” for a complete list of Codes, Standards, and Guidelines that Work under this section shall follow.

1.4 ABBREVIATIONS AND DEFINITIONS

- A. ACS: Access Control System
- B. API: Application Programming Interface
- C. Central Station: A PC/Server with software designated as the main controlling PC of the security access system. Where this term is presented with initial capital letters, this definition applies.
- D. Controller: An intelligent peripheral control unit that uses a computer for controlling its operation. Where this term is presented with an initial capital letter, this definition applies.
- E. CPU: Central processing unit.
- F. Credential: Data assigned to an entity and used to identify that entity.
- G. EMI: Electromagnetic Interference.
- H. ESS: Electronic Security System.
- I. Fail-Safe (Door): if power fails, the door is to unlock.
- J. Fail-Secure (Door): if power fails, the door remains secure (locked).
- K. Server: A PC in a network that stores the programs and data files shared by users.
- L. Identifier: A credential card, keypad personal identification number or code, biometric characteristic, or other unique identification entered as data into the entry-control database for the purpose of identifying an individual. Where this term is presented with an initial capital letter, this definition applies.
- M. I/O: Input/Output.
- N. LAN: Local area network.
- O. LDAP: Lightweight Directory Access Protocol.
- P. LED: Light-emitting diode.
- Q. Location: A Location on the network having a PC-to-Controller communications link. Where this term is presented with an initial capital letter, this definition applies.
- R. PC: Personal computer. This acronym applies to the Central Station, workstations, and file servers.
- S. PIN: Personal Identification Number.
- T. PDF: (Portable Document Format.) The file format used by the Acrobat document exchange system software from Adobe.

- U. RF: Radio frequency.
- V. RS-232: A TIA standard for asynchronous serial data communications between terminal devices. This standard defines a 25-pin connector and certain signal characteristics for interfacing computer equipment.
- W. RS-485: A TIA standard for multipoint communications.
- X. UPS: Uninterrupted power supply.
- Y. VMS: Video Management System.
- Z. WAN: Wide area network.
- AA. Wiegand: Patented magnetic principle that uses specially treated wires embedded in the credential card.
- BB. Workstation: A PC with software that is configured for specific limited access control system functions.
- CC. WYSIWYG: (What You See Is What You Get.) Text and graphics appear on the screen the same as they will print.

1.5 QUALITY ASSURANCE

- A. Contractor Qualifications
 - 1. The Access Control System shall be provided by the Electronic Security Contractor (ESC), as defined in Division 28 Section "Electronic Security Systems".
 - a. The ESC shall be a certified installed of the ACS vendor prior to bid; post-bid certification will not be accepted.
 - b. The ESC shall be pre-qualified; refer to Quality Assurance paragraph in Division 28 Section "Electronic Security Systems" for a list of pre-qualified contractors, and instructions for potential bidders wishing to become pre-qualified.
- B. Personnel Qualifications
 - 1. Refer to Division 28 Section "Electronic Security Systems" for personnel qualifications.

1.6 WARRANTIES

- A. Refer to Division 28 Section "Electronic Security Systems" for warranty requirements.

1.7 COORDINATION

- A. Access Control is an integrated system. Coordinate integration with installers and equipment of all other Electronic Security Systems.
- B. Within two weeks after the Notice to Proceed, schedule a meeting with the Owner's Security and/or Facility staff to confirm and coordinate additional sequence of operation and programming requirements of the Access Control System.
 - 1. Document all direction from Owner in writing and distribute to the Design Consultant and Architect through the Prime Contractor.

1.8 SUBMITTALS

- A. Follow the requirements for submittals in Division 28 Sections "General Electronic Safety & Security Requirements" and "Electronic Security Systems".
- B. Pre-Bid Submittal - the following submittals are due before the questions deadline before Bid:
 - 1. For all products for which a substitute is to be considered as an approved equivalent or acceptable substitution, provide submittals with sufficient detail for review by the Design

Consultant. Submittals shall at a minimum provide detailed information substantiating all performance requirements as well as all necessary code compliance and NRTL listing information.

C. Pre-Construction Submittal

1. Refer to Division 28 Section "Electronic Security Systems" submittal requirements, with additional requirements as noted:
 - a. Product Cutsheets and Shop Drawings shall be submitted concurrently as part of the complete Electronic Security Systems pre-construction submittal. If the first submittal only includes Product Cutsheets, submittal will be returned "Not Reviewed".
 - b. Shop Drawings:
 - 1) Submit plans, elevations, and details that include the following:
 - a) Indicate all system device locations on architectural floor plans, identified by number/ID. No other system(s) shall be included on these plans.
 - b) Enlarged Equipment Room wall elevation(s), indicating all wall-mounted pathways/cable management, wall-mounted enclosures, and all internal components of wall-mounted enclosures.
 - i) All components on these elevations shall be identified by part name, manufacturer and model number.
 - c) Include full schematic wiring information on these drawings for all devices. Wiring information shall include cable type, conductor routings, quantities, and connection details at device.
 - d) Include a complete ACS one-line, block diagram.
 - i) Each far-end device shall be identified by number/ID and room number.
 - e) Include a statement of the system sequence of operation.
 - f) Backup Power-Supply (Battery) Capacity Calculations

D. Preliminary Project Completion Submittal

1. Refer to Division 28 Section "Electronic Security Systems" submittal requirements, with additional requirements as noted:
 - a. Test Results for the Access Control System. Refer to Project Close-Out Instruction in Part 3 of this section and Division 28 Section "Electronic Security Systems" for additional information and requirements.

E. Final Project Completion Submittal

1. Refer to Division 28 Section "Electronic Security Systems" submittal requirements, with additional requirements as noted:
 - a. Include scan of written documentation that Spare Parts / Physical Media were delivered to Owner at time of Owner Training.
2. Refer to Project Close-Out Instruction in Part 3 of this section and Division 28 Section "Electronic Security Systems" for additional information and requirements.

PART 2 - PRODUCTS AND MATERIALS

2.1 GENERAL

A. System Description

1. Expansion of Owner's Existing Enterprise-Level Access Control System to Project Site/Facility
 - a. All card access controllers and card readers will be furnished by Owner and installed by Contractor.
 - b. Cabling for access control will be furnished by Owner and installed by Contractor.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to PCs, controllers, card readers, and other cable-connected devices to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. In meetings with Architect and Owner, present Project planning documents and review, adjust, and prepare final setup documents. Use final documents to set up system software.
- B. After turn-over of Equipment Rooms by the Prime Contractor and Division 26 (Electrical) Contractor:
 1. Verify the room is properly conditioned and all general construction dust and debris are removed. Verify that all electrical branch circuits provided for the ACS equipment are installed properly and active. Do not start up any powered ACS equipment until these requirements are verified.
 - a. Refer to the following article for appropriate testing of branch circuits:
<http://www.ecmweb.com/content/ten-easy-steps-testing-branch-circuits>
 2. Do not commence installation of any ACS equipment within Equipment Rooms until entry door to that room is equipped with a lock and construction key. All Equipment Room doors shall be locked, even during construction, when no personnel are present and working in that room.

3.3 CABLING

- A. Install cabling for all access controlled doors and gates identified on the drawings and these specifications. Cable type and size shall meet all ACS vendor requirements for each type of device / connection. Coordinate the required cable specifications with Division 28 "Conductors and Cables for Electronic Security" contractor (if different from the ESC) prior to Bid.
 1. Utilize shielded cables/conductors, unless ACS vendor specifically forbids the use of shielded cables/conductors.

2. Use of a multi-conductor composite cable to access controlled doors is preferred, but not required, unless otherwise noted.
 3. Coordinate cable size and pathway requirements with Division 28 "Common Work Results for Electronic Security" contractor.
- B. Comply with NECA 1, "Good Workmanship in Electrical Construction."
 - C. Cables and wiring shall be installed according to requirements in Division 28 Section "Conductors and Cables for Electronic Security."
 - D. Boxes and enclosures containing ACS components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.
 - E. Install end-of-line resistors at the field device location and not at the controller or panel location.
 - F. Maintain insulation on all conductors to the final termination point within the enclosure; exposed copper conductors of any length are not allowed.
 - G. Provide a minimum of 6 inches of slack (service loop) at both ends of all cabling (at the device and within the ACS enclosure).

3.4 CABLE APPLICATION

- A. Coordinate these requirements with Division 28 "Conductors and Cables for Electronic Security" contractor.
- B. Cable application requirements are minimum requirements and shall be exceeded if recommended or required by manufacturer of system hardware.
- C. TIA 232-F Cabling (if required): Install at a maximum distance of 50 ft.
- D. TIA 485-A Cabling (if required): Install at a maximum distance of 4000 ft.
- E. Card Readers and Keypads:
 1. Install number of conductor pairs recommended by manufacturer for the functions specified.
 2. Unless manufacturer recommends larger conductors, install No. 22 AWG wire if maximum distance from controller to the reader is 250 ft., and install No. 20 AWG wire if maximum distance is 500 ft..
 3. For greater distances, install "extender" or "repeater" modules recommended by manufacturer of the controller.
 4. Install minimum No. 18 AWG shielded cable to readers and keypads that draw 50 mA or more.
- F. Install minimum No. 16 AWG cable from controller to electrically powered locks. Do not allow voltage drop from power supply to lock to drop below manufacture's stated minimum operating voltage.
- G. Install minimum No. 14 AWG ac power wire from transformer to controller, with a maximum distance of 25 ft.

3.5 GROUNDING AND BONDING

- A. Properly ground/bond all ACS equipment in accordance with manufacturer's instructions and per the drawings and Division 28 section "Equipment Room Fittings for Electronic Security".

- B. Ground cable shields, drain conductors, and equipment to eliminate shock hazard and to minimize ground loops, common-mode returns, noise pickup, cross talk, and other impairments.
- C. Bond shields and drain conductors to ground at only one point in each circuit.
- D. Each entrance protector shall have its own ground/bond conductor to the TGB; do not bond to ACS enclosure.
- E. Each ACS enclosure shall have its own ground/bond conductor to the TGB; do not daisy-chain enclosures together.
- F. Minimum bonding/conductor size, in accordance with "Equipment Room Fittings for Electronic Security", is #6 AWG.

3.6 IDENTIFICATION & LABELING

- A. Owner will furnish and install all cable and equipment labels.

3.7 SYSTEM SOFTWARE

- A. Develop, program, install, and test software and hardware, and perform database tests for the complete and proper operation of systems involved. Assign software license to Owner.

3.8 FIELD QUALITY CONTROL

- A. Refer to Part 3 of Division 28 section "Electronic Security Systems" for general installation and project close-out instructions.
- B. Perform the following functional tests and inspections - and correct any issues - before requesting Final Acceptance Review by Design Consultant:
 - 1. Follow Test Methods as required by ACS vendor.
 - 2. Also follow Test Methods as listed in NFPA 731 Standard for the Installation of Electronic Premises Security Systems (2017), Table 10.4.3(a) and Table 10.4.3(b)
 - 3. Test Reports:
 - a. Utilize Sample Record of Completion Report from NFPA 731 Standard for the Installation of Electronic Premises Security Systems (2017), Figure A.4.12.2.1(3)(a) as cover page of Access Control Test Reports.
 - b. Utilize Sample Access Control Report from NFPA 731 Standard for the Installation of Electronic Premises Security Systems (2017), Figure A.4.12.2.1(3)(c) to document testing of all ACS components.
 - c. Scan to PDF and combine these reports, arranged logically by serving Equipment Room and Device type/ID. Include this PDF as part of Preliminary Project Completion Submittal.
- C. After Final Acceptance Review by Design Consultant, address/correct any issues, and re-test effected devices and components of the ACS.
 - 1. Update Test Reports and include complete Test Reports as part of Final Project Completion Submittal.

END OF SECTION

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SECTION 28 20 00 - VIDEO SURVEILLANCE

PART 1 - GENERAL REQUIREMENTS

1.1 SUMMARY

- A. Provide cabling and pathways for an Owner-provided Video Surveillance System and each element thereof, as specified, indicated, or reasonably inferred, on the Drawings and in these Specifications, including every article, device, or accessory (whether or not specifically called for by item) reasonably necessary to facilitate each system's functioning as indicated by the design and the equipment specified. Elements of the work include, but are not limited to, materials, labor, supervision, supplies, tools, equipment, transportation and utilities.
- B. System Description:
 - 1. This Video Surveillance system shall consist of IP cameras, the majority of which shall be Power-over-Ethernet, connected to the Electronic Security Network.
 - 2. Other components include, but are not limited to, fiber to media converters, power supplies, surge protection devices, video servers, storage servers, client stations, video management software and associated equipment.

1.2 RELATED DOCUMENTS

- A. Work under this section shall follow Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".
- B. Work under this section shall follow Division 28 Section "Common Work Results for Electronic Security Systems" for general pathway, firestopping, access panel, identification, and other requirements.
- C. Other related documents include:
 - 1. Division 28 Section "Conductors and Cables for Electronic Safety and Security".
 - 2. Division 28 Section "Telecommunications Requirements for Electronic Security".
 - 3. Division 28 Section "Equipment Room Fittings for Electronic Security".

1.3 ABBREVIATIONS AND DEFINITIONS

- A. In addition to the Abbreviations and Definitions listed in Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems", products and installation shall meet the requirements of the following standards:
 - 1. AC: Alternating Current
 - 2. AGC: Automatic gain control.
 - 3. B/W: Black and White
 - 4. Bit Rate: B/s = Bytes per second, b/s = bits per second
 - 5. CCD: Charge-coupled device
 - 6. DC: Direct Current
 - 7. DSP: Digital signal processing
 - 8. FTP: File Transfer Protocol
 - 9. GB: Gigabyte
 - 10. IP: Internet Protocol

11. IRE: Institute of Radio Engineers. Units of measurement dividing the area from the bottom of the sync to the peak white level into 140 equal units. 140 IRE equals 1 Vp-p. The range of active video is 100 IRE.
12. IR light: Infrared light
13. JPEG. Joint Photographic Experts Group
14. KVM: Keyboard, Video, Mouse
15. LCD: Light-emitting diode
16. Lumen [lm]. A unit for measuring intensity
17. Lux [lx]: a unit for measuring illumination
18. MPEG: Moving picture experts group
19. NIC: Network Interface Card
20. NVR: Network Video Recorder
21. Pixel: Derived from picture element. Refers to CCD chip unit picture cell
22. POE: Power Over Ethernet
23. PTZ: Pan-Tilt-Zoom
24. RAM: Random Access Memory
25. RAID: Redundant arrays of independent disks
26. UXGA: Computer screen resolution offering 1600 X1200 Pixels
27. VGA: Video Graphics Array with resolution of 640 X 480 Pixels
28. VMS: Video Management Software
29. WAN: Wide Area Network
30. XGA: Computer screen resolution offering 1024 X 768 Pixels

1.4 QUALITY ASSURANCE

- A. Contractor qualifications:
 1. The ESC, or a qualified Video Surveillance Contractor acting as a sub-contractor to the ESC, shall have a minimum five (5) continuous years in the business of installing and integrating Video Surveillance Systems.
 2. ESC or qualified sub-contractor shall be a certified installer by video surveillance manufacturers whose products shall be incorporated into this project. Post-award certification will not be accepted.
 3. ESC or qualified sub-contractor shall maintain certification by the manufacturers thru the duration of the warrantee period.
- B. Personnel qualifications
 1. All equipment/device installation and programming shall be conducted by factory-certified technicians of the components being installed.
- C. Warranty
 1. Refer to Division 28 Section "Electronic Security Systems" for warranty and service call requirements.

- a. All Warranty Work shall be completed by factory-certified technician(s) of the component(s) being address.

1.5 SUBMITTALS

- A. Refer to requirements in Division 28 Sections "General Electronic Safety and Security Requirements" and "Electronic Security Systems".

PART 2 - PRODUCTS

2.1 VIDEO MANAGEMENT SYSTEM SERVER(S)

- A. Owner will furnish and install VMS equipment and software.

2.2 SECURITY CAMERAS (IP)

- A. Owner will furnish Cat6A cabling for cameras and Contractor shall install it.
- B. Owner will furnish and install all security cameras and supporting equipment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine pathway elements intended for cables. Check raceways, cable trays, and other elements for compliance with space allocations, installation tolerances, hazards to cable installation, and other conditions affecting installation.
- B. Examine roughing-in for LAN and control cable conduit systems to cameras and servers to verify actual locations of conduit and back boxes before device installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 CABLING

- A. Coordinate these requirements with Division 28 "Conductors and Cables for Electronic Security" contractor and "Telecommunications Requirements for Electronic Security".
- B. Comply with NECA 1, "Good Workmanship in Electrical Construction."
- C. Install cables and wiring according to requirements in Division 28 Section "Conductors and Cables for Electronic Security."
- D. Wiring Method: Install wiring in raceway and cable tray except within consoles, cabinets, desks, and counters. Conceal raceway and wiring except in unfinished spaces.
- E. Boxes and enclosures containing security-system components or cabling, and which are easily accessible to employees or to the public, shall be provided with a lock. Boxes above ceiling level in occupied areas of the building shall not be considered accessible. Junction boxes and small device enclosures below ceiling level and easily accessible to employees or the public shall be covered with a suitable cover plate and secured with tamperproof screws.

3.3 IDENTIFICATION / LABELING

- A. Owner will furnish and install all device and equipment labels.

3.4 GROUNDING

- A. Refer to Division 28 Section "Equipment Room Fittings for Electronic Security" for entrance protection and additional grounding requirements.
- B. Coordinate this work with Drawings.

3.5 CAMERA INSTALLATION

- A. Refer to contract drawings for installation heights.
- B. Install power supplies and other auxiliary components in Equipment Rooms, unless otherwise indicated.

3.6 CLEANING

- A. Clean installed items using methods and materials recommended in writing by manufacturer.
- B. Clean video surveillance system components, including camera-housing windows, lenses, and monitor screens.

3.7 PROJECT CLOSE-OUT INSTRUCTIONS

- A. Follow all Project Close-Out requirements as detailed in Division 28 Section "Electronic Security System".

END OF SECTION

SECTION 28 46 21 - ADDRESSABLE FIRE-ALARM SYSTEMS

PART 1 - GENERAL

1.1 SUMMARY

A. Section Includes:

1. Addressable fire-alarm system.
2. Fire-alarm control unit (FACU).
3. Manual fire-alarm boxes.
4. System smoke detectors.
5. Duct smoke detectors.
6. Heat detectors.
7. Fire-alarm notification appliances.
8. Fire-alarm remote annunciators.
9. Fire-alarm addressable interface devices.
10. Digital alarm communicators and cellular transmitters (DACTs).

B. Related Requirements:

1. Section 26 05 19 "Low-Voltage Electrical Power Conductors and Cables" for cables and conductors for fire-alarm systems.
2. Section 07 84 13 "Penetration Firestopping" for material and methods for firestopping systems.

1.2 DEFINITIONS

- A. DACT: Digital alarm cellular transmitter.
- B. EMT: Electrical metallic tubing.
- C. FACU: Fire-alarm control unit.
- D. NICET: National Institute for Certification in Engineering Technologies.
- E. PC: Personal computer.
- F. Voltage Class: For specified circuits and equipment, voltage classes are defined as follows:
1. Control Voltage: Listed and labeled for use in remote-control, signaling, and power-limited circuits supplied by a Class 2 or Class 3 power supply having rated output not greater than 150 V and 5 A, allowing use of alternate wiring methods complying with NFPA 70, Article 725.
 2. Low Voltage: Listed and labeled for use in circuits supplied by a Class 1 or other power supply having rated output not greater than 1000 V, requiring use of wiring methods complying with NFPA 70, Article 300, Part I.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product, including furnished options and accessories.
1. Include construction details, material descriptions, dimensions, profiles, and finishes.
 2. Include rated capacities, operating characteristics, and electrical characteristics.
- B. Shop Drawings: For fire-alarm system.
1. Comply with recommendations and requirements in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 2. Include plans, elevations, sections, and details, including details of attachments to other Work.
 3. Include details of equipment assemblies. Indicate dimensions, weights, loads, required clearances, method of field assembly, components, and locations. Indicate conductor sizes, indicate termination locations and requirements, and distinguish between factory and field wiring.
 4. Annunciator panel details as required by authorities having jurisdiction.
 5. Detail assembly and support requirements.
 6. Include voltage drop calculations for notification-appliance circuits.
 7. Include battery-size calculations.
 8. Include input/output matrix.
 9. Include written statement from manufacturer that equipment and components have been tested as a system and comply with requirements in this Section and in NFPA 72.
 10. Include performance parameters and installation details for each detector.
 11. Verify that each duct detector is listed for complete range of air velocity, temperature, and humidity possible when air-handling system is operating.
 12. Provide control wiring diagrams for fire-alarm interface to HVAC; coordinate location of duct smoke detectors and access to them.
 - a. Show critical dimensions that relate to placement and support of sampling tubes, detector housing, and remote status and alarm indicators.
 - b. Show field wiring required for HVAC unit shutdown on alarm.
 - c. Locate detectors in accordance with manufacturer's written instructions.
 - d. Show air-sampling detector pipe routing.
 13. Include voice/alarm signaling-service equipment rack or console layout, grounding schematic, amplifier power calculation, and single-line connection diagram.
 14. Include floor plans to indicate final outlet locations showing address of each addressable device. Show size and route of cable and conduits and point-to-point wiring diagrams.
- C. Delegated Design Submittal: For notification appliances and smoke and heat detectors, in addition to submittals listed above, indicate compliance with performance requirements and design criteria, including analysis data. Fire alarm shop drawings and calculations shall be signed and sealed by a qualified professional engineer licensed in the State of Missouri who shall be responsible for their preparation.
1. Drawings showing location of each notification appliance and smoke and heat detector, ratings of each, and installation details as needed to comply with listing conditions of device.

2. Design Calculations: Calculate requirements for selecting spacing and sensitivity of detection, complying with NFPA 72. Calculate spacing and intensities for strobe signals and sound-pressure levels for audible appliances.

1.4 INFORMATIONAL SUBMITTALS

- A. Field quality-control reports.
- B. Qualification Statements: For Installer.
- C. Sample Warranty: Submittal must include line item pricing for replacement parts and labor.

1.5 CLOSEOUT SUBMITTALS

- A. Operation and Maintenance Data: For fire-alarm systems and components to include in emergency, operation, and maintenance manuals.
 1. Include the following and deliver copies to authorities having jurisdiction:
 - a. Comply with "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - b. Provide "Fire-Alarm and Emergency Communications System Record of Completion Documents" in accordance with "Completion Documents" Article in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - c. Complete wiring diagrams showing connections between devices and equipment. Each conductor must be numbered at every junction point with indication of origination and termination points.
 - d. Riser diagram.
 - e. Device addresses.
 - f. Record copy of site-specific software.
 - g. Provide "Inspection and Testing Form" in accordance with "Inspection, Testing and Maintenance" chapter in NFPA 72, and include the following:
 - 1) Equipment tested.
 - 2) Frequency of testing of installed components.
 - 3) Frequency of inspection of installed components.
 - 4) Requirements and recommendations related to results of maintenance.
 - 5) Manufacturer's user training manuals.
 - h. Manufacturer's required maintenance related to system warranty requirements.
 - i. Abbreviated operating instructions for mounting at FACU and each annunciator unit.
- B. Software and Firmware Operational Documentation:
 1. Software operating and upgrade manuals.
 2. Program Software Backup: On USB media or approved online or cloud solution.
 3. Device address list.

1.6 MAINTENANCE MATERIAL SUBMITTALS

- A. Extra Stock Material: Furnish extra materials that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
1. Lamps for Remote Indicating Lamp Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 2. Lamps for Strobe Units: Quantity equal to 10 percent of amount installed, but no fewer than one unit.
 3. Smoke Detectors: Quantity equal to 10 percent of amount of each type installed, but no fewer than one unit of each type.
 4. Detector Bases: Quantity equal to two percent of amount of each type installed, but no fewer than one unit of each type.
 5. Keys and Tools: One extra set for access to locked or tamperproofed components.
 6. Audible and Visual Notification Appliances: One of each type installed.
 7. Fuses: Two of each type installed in system. Provide in box or cabinet with compartments marked with fuse types and sizes.

1.7 QUALITY ASSURANCE

- A. Installer Qualifications:
1. Personnel must be trained and certified for installation of units required for this Project.
 2. Installation oversight must be by personnel certified by NICET as fire-alarm Level III technician.
 3. A qualified and licensed electrician may install conduit and back boxes.

1.8 WARRANTY

- A. Special Warranty: Manufacturer agrees to repair or replace fire-alarm system equipment and components that fail because of defects in materials or workmanship within specified warranty period.
1. Warranty Period: One year from date of Substantial Completion.

PART 2 - PRODUCTS

- A. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to the following:
1. Bosch Security Systems, Inc.
 2. Faraday.
 3. Fike Corporation.
 4. Fire-Lite Alarms, Inc.; a Honeywell International company.
 5. Gamewell - FCI by Honeywell.
 6. GE UTC Fire & Security; A United Technologies Company.
 7. Johnson Controls Company (Tyco SimplexGrinnell).

8. Notifier.
9. Potter Electric Signal Company, LLC.
10. Siemens Industry, Inc.; Fire Safety Division.
11. Silent Knight.

2.2 ADDRESSABLE FIRE-ALARM SYSTEM

A. Description:

1. Noncoded, UL-certified addressable system, with multiplexed signal transmission and voice-and-strobe notification for evacuation.

B. Performance Criteria:

1. Regulatory Requirements:

- a. Fire-Alarm Components, Devices, and Accessories: Listed and labeled by a NRTL in accordance with NFPA 70 for use with selected fire-alarm system and marked for intended location and application.

2. General Characteristics:

- a. Automatic sensitivity control of certain smoke detectors.
- b. Fire-alarm signal initiation must be by one or more of the following devices:
 - 1) Manual stations.
 - 2) Heat detectors.
 - 3) Smoke detectors.
 - 4) Automatic sprinkler system water flow.
- c. Fire-alarm signal must initiate the following actions:
 - 1) Continuously operate alarm notification appliances, including voice evacuation notices.
 - 2) Identify alarm and specific initiating device at FACU and remote annunciators.
 - 3) Transmit alarm signal to remote alarm receiving station.
 - 4) Release fire and smoke doors held open by magnetic door holders.
 - 5) Activate voice/alarm communication system.
 - 6) Switch HVAC equipment controls to fire-alarm mode.
 - 7) Close smoke dampers in air ducts of designated air-conditioning duct systems.
 - 8) Recall elevators to primary or alternate recall floors.
 - 9) Activate elevator power shunt trip.
 - 10) Activate emergency lighting control.
 - 11) Record events in system memory.
- d. Supervisory signal initiation must be by one or more of the following devices and actions:
 - 1) Valve supervisory switch
 - 2) Duct smoke detector.
 - 3) Elevator shunt-trip supervision.

- 4) Zones or individual devices have been disabled.
 - 5) FACU has lost communication with network.
- e. System trouble signal initiation must be by one or more of the following devices and actions:
- 1) Open circuits, shorts, and grounds in designated circuits.
 - 2) Opening, tampering with, or removing alarm-initiating and supervisory signal-initiating devices.
 - 3) Loss of communication with addressable sensor, input module, relay, control module, remote annunciator, printer interface, or Ethernet module.
 - 4) Loss of primary power at FACU.
 - 5) Ground or single break in internal circuits of FACU.
 - 6) Abnormal ac voltage at FACU.
 - 7) Break in standby battery circuitry.
 - 8) Failure of battery charging.
 - 9) Abnormal position of switch at FACU or annunciator.
 - 10) Voice signal amplifier failure.
- f. System Supervisory Signal Actions:
- 1) Identify specific device initiating event at FACU and remote annunciators.
 - 2) Record event in system memory.
 - 3) After time delay of 200 seconds, transmit trouble or supervisory signal to remote alarm receiving station.
- g. Network Communications:
- 1) Provide network communications for fire-alarm system in accordance with fire-alarm manufacturer's written instructions.
 - 2) Provide network communications pathway per manufacturer's written instructions and requirements in NFPA 72 and NFPA 70.
- h. Device Guards:
- 1) Description: Welded wire mesh of size and shape for manual station, smoke detector, or other device requiring protection.
 - a) Factory fabricated and furnished by device manufacturer.
 - b) Finish: Paint of color to match protected device.
- i. Document Storage Box:
- 1) Description: Enclosure to accommodate standard 8-1/2-by-11 inch manuals and loose document records. Legend sheet will be permanently attached to door for system required documentation, key contacts, and system information. Provide two key ring holders with location to mount standard business cards for key contact personnel.
 - 2) Material and Finish: 18-gauge cold-rolled steel; four mounting holes.
 - 3) Color: Red powder-coat epoxy finish.
 - 4) Labeling: Permanently screened with 1 inch high lettering "SYSTEM RECORD DOCUMENTS" with white indelible ink.
 - 5) Security: Locked with 3/4 inch barrel lock. Provide solid 12 inch stainless steel piano hinge.

2.3 FIRE-ALARM CONTROL UNIT (FACU)

- A. Description: Field-programmable, microprocessor-based, modular, power-limited design with electronic modules.
- B. Performance Criteria:
1. Regulatory Requirements: Comply with NFPA 72 and UL 864.
 2. General Characteristics:
 - a. System software and programs must be held in nonvolatile flash, electrically erasable, programmable, read-only memory, retaining information through failure of primary and secondary power supplies.
 - b. Include real-time clock for time annotation of events on event recorder and printer.
 - c. Provide communication between FACU and remote circuit interface panels, annunciators, and displays.
 - d. FACU must be listed for connection to central-station signaling system service.
 - e. Provide nonvolatile memory for system database, logic, and operating system and event history. System must require no manual input to initialize in the event of complete power down condition. FACU must provide minimum 500-event history log.
 - f. Addressable Initiation Device Circuits: FACU must indicate which communication zones have been silenced and must provide selective silencing of alarm notification appliance by building communication zone.
 - 1) Addressable Control Circuits for Operation of Notification Appliances and Mechanical Equipment: FACU must be listed for releasing service.
 - g. Fire-Alarm Annunciator: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
 - 1) Annunciator and Display: LCD, 80 characters, minimum.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands.
 - h. Alphanumeric Display and System Controls: Arranged for interface between human operator at FACU and addressable system components including annunciation and supervision. Display alarm, supervisory, and component status messages and programming and control menu.
 - 1) Annunciator and Display: LCD, two line(s) of 40 characters, minimum.
 - 2) Keypad: Arranged to permit entry and execution of programming, display, and control commands and to indicate control commands to be entered into system for control of smoke-detector sensitivity and other parameters.
 - i. Initiating-Device, Notification-Appliance, and Signaling-Line Circuits:
 - 1) Pathway Class Designations: NFPA 72, Class B.
 - 2) Pathway Survivability: Level 0.

- 3) Install no more than 256 addressable devices on each signaling-line circuit. Each floor shall be on a separate circuit(s). An Intelligent Module (IM) shall be provided after every 20 devices.
 - 4) Install fault circuit isolators to comply with circuit performance requirements of NFPA 72 or with manufacturer's written instructions, whichever is more conservative.
- j. Serial Interfaces:
- 1) One dedicated RS 485 port for remote station operation using point ID DACT.
 - 2) One RS 485 port for remote annunciators, Ethernet module, or multi-interface module (printer port).
 - 3) One USB or RS 232 port for PC configuration.
 - 4) One RS 232 port for air-aspirating smoke detector connection.
 - 5) One RS 232 port for voice evacuation interface.
- k. Notification-Appliance Circuit:
- 1) Audible appliances must sound in three-pulse temporal pattern, as defined in NFPA 72, preceding voice messages.
 - 2) Visual alarm appliances must flash in synchronization where multiple appliances are in same field of view, as defined in NFPA 72.
 - 3) Notification appliance circuits shall contain a minimum of 20% spare capacity for future expansion on each circuit.
 - 4) Each floor shall be on a separate circuit(s).
- l. Elevator Recall: Initiate by one of the following alarm-initiating devices:
- 1) Elevator lobby detectors except lobby detector on designated floor.
 - 2) Smoke detectors in elevator machine room.
 - 3) Smoke detectors in elevator hoistway.
- m. Elevator controller must be programmed to move cars to alternate recall floor if lobby detectors located on designated recall floors are activated.
- n. Heat detection alarm in elevator shaft and elevator machine room must shut down elevators associated with location without time delay.
- 1) Heat detection in elevator pit may have delay to allow elevators to move to designated floor.
- o. Door Controls: Door hold-open devices that are controlled by smoke detectors at doors in smoke-barrier walls must be connected to fire-alarm system.
- p. Remote Smoke-Detector Sensitivity Adjustment: Controls must select specific addressable smoke detectors for adjustment, display their current status and sensitivity settings, and change those settings. Allow controls to be used to program repetitive, time-scheduled, and automated changes in sensitivity of specific detector groups. Record sensitivity adjustments and sensitivity-adjustment schedule changes in system memory, and print out final adjusted values on system printer.
- q. Fire alarm system shall interface with any public address (PA), sound systems simulating crowd noise, or other sound-producing equipment to silence equipment upon activation of fire alarm signal.

- r. Fire alarm system shall be provided with a "walk test" feature to allow for testing of the system without activation of notification appliances.
- s. Transmission to Remote Alarm Receiving Station: Automatically transmit alarm, supervisory, and trouble signals to remote alarm station.
- t. Voice/Alarm Signaling Service: Central emergency communication system with redundant microphones, preamplifiers, amplifiers, and tone generators provided as special module that is part of FACU.
- u. Indicate number of alarm channels for automatic, simultaneous transmission of different announcements to different zones or for manual transmission of announcements by use of central-control microphone. Amplifiers must comply with UL 1711.
 - 1) Allow application of, and evacuation signal to, indicated number of zones and simultaneously allow voice paging to other zones selectively or in combination.
 - 2) Programmable tone and message sequence selection.
 - 3) Standard digitally recorded messages for "Evacuation" and "All Clear."
 - 4) Generate tones to be sequenced with audio messages of type recommended by NFPA 72 and that are compatible with tone patterns of notification-appliance circuits of FACU.
- v. Status Annunciator: Indicate status of various voice/alarm speaker zones and status of elevator two-way telephone communication zones.
- w. Preamplifiers, amplifiers, and tone generators must automatically transfer to backup units, on primary equipment failure.
- x. Primary Power: 24 V(dc) obtained from 120 V(ac) service and power-supply module. Initiating devices, notification appliances, signaling lines, trouble signals, and supervisory signals must be powered by 24 V(dc) source.
- y. Alarm current draw of entire fire-alarm system must not exceed 80 percent of power-supply module rating.
- z. Secondary Power: 24 V(dc) supply system with batteries, automatic battery charger, and automatic transfer switch.
- aa. Batteries: Sealed lead calcium; sealed, valve-regulated, recombinant lead acid; or vented, wet-cell pocket, plate nickel cadmium.
 - 1) Capacity: Batteries shall be sized to operate the system under normal conditions for 24 hours, followed by 15 minutes of alarm at minimum. Battery size shall be a minimum of 125% of the calculated requirement.

C. Accessories:

- 1. Instructions: Computer printout or typewritten instruction card mounted behind plastic or glass cover in stainless steel or aluminum frame. Include interpretation and describe appropriate response for displays and signals. Briefly describe functional operation of system under normal, alarm, and trouble conditions.

2.4 MANUAL FIRE-ALARM BOXES

- A. General Requirements for Manual Fire-Alarm Boxes: Comply with UL 38. Boxes must be finished in red with molded, raised-letter operating instructions in contrasting color; must show visible indication of operation; and must be mounted on recessed outlet box. If indicated as surface mounted, provide manufacturer's surface back box.

1. Double-action mechanism requiring two actions to initiate alarm, pull-lever type; with integral addressable module arranged to communicate manual-station status (normal, alarm, or trouble) to FACU.
2. Station Reset: Key- or wrench-operated switch.
3. Able to perform at up to 90 percent relative humidity at 90 deg F.

4. Material: Manual stations made of Lexan polycarbonate.
5. Able to be used in indoor areas.

2.5 SYSTEM SMOKE DETECTORS

A. Photoelectric Smoke Detectors:

1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 268.
 - b. General Characteristics:
 - 1) Detectors must be two-wire type.
 - 2) Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - 3) Base Mounting: Detector and associated electronic components must be mounted in twist-lock module that connects to fixed base. Provide terminals in fixed base for connection to building wiring.
 - 4) Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - 5) Integral Visual-Indicating Light: LED type, indicating detector has operated.
 - 6) Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
 - 7) Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - a) Primary status.
 - b) Device type.
 - c) Present average value.
 - d) Present sensitivity selected.
 - e) Sensor range (normal, dirty, etc.).
 - 8) Detector must have functional humidity range within 10 to 90 percent relative humidity.
 - 9) Color: White.
 - 10) Remote Control: Unless otherwise indicated, detectors must be digital-addressable type, individually monitored at FACU for calibration, sensitivity, and alarm condition and individually adjustable for sensitivity by FACU.
 - 11) Rate-of-rise temperature characteristic of combination smoke- and heat-detection units must be selectable at FACU for 15 or 20 deg F per minute.
 - 12) Fixed-temperature sensing characteristic of combination smoke- and heat-detection units must be independent of rate-of-rise sensing and must be settable at FACU to operate at 135 or 155 deg F.
 - 13) Multiple levels of detection sensitivity for each sensor.

- 14) Sensitivity levels based on time of day.

2.6 DUCT SMOKE DETECTORS

- A. Description: Photoelectric-type, duct-mounted smoke detector.
- B. Performance Criteria:
 1. Regulatory Requirements:
 - a. NFPA 72.
 - b. UL 268A.
 2. General Characteristics:
 - a. Detectors must be two-wire type.
 - b. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
 - c. Self-Restoring: Detectors do not require resetting or readjustment after actuation to restore them to normal operation.
 - d. The detector shall be listed for releasing service if used for direct interface with a smoke damper.
 - e. Integral Visual-Indicating Light: LED type, indicating detector has operated.
 - f. Detector address must be accessible from FACU and must be able to identify detector's location within system and its sensitivity setting.
 - g. Operator at FACU, having designated access level, must be able to manually access the following for each detector:
 - 1) Primary status.
 - 2) Device type.
 - 3) Present average value.
 - 4) Present sensitivity selected.
 - 5) Sensor range (normal, dirty, etc.).
 - h. Weatherproof Duct Housing Enclosure: NEMA 250, Type 4X; NRTL listed for use with supplied detector for smoke detection in HVAC system ducts.
 - i. Each sensor must have multiple levels of detection sensitivity.
 - j. Sampling Tubes: Design and dimensions as recommended by manufacturer for specific duct size, air velocity, and installation conditions where applied.
 - k. Relay Fan Shutdown: Fully programmable relay rated to interrupt fan motor-control circuit.

2.7 HEAT DETECTORS

- A. Combination-Type Heat Detectors:
 1. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 521.

- b. General Characteristics:
 - 1) Temperature sensors must test for and communicate sensitivity range of device.
- c. Actuated by fixed temperature of 135 deg F or rate of rise that exceeds 15 deg F per minute unless otherwise indicated.
- d. Mounting: Twist-lock base interchangeable with smoke-detector bases.
- e. Integral Addressable Module: Arranged to communicate detector status (normal, alarm, or trouble) to FACU.
- f. Detector must have functional humidity range of 10 to 90 percent relative humidity.
- g. Color: White.

2.8 FIRE-ALARM NOTIFICATION APPLIANCES

- A. Fire-Alarm Voice/Tone Notification Appliances:
 - 1. Description: Notification appliances capable of outputting voice evacuation messages.
 - 2. Speakers shall be Wheelock series ET or equal.
 - 3. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1480.
 - b. General Characteristics:
 - 1) Speakers for Voice Notification: Locate speakers for voice notification to provide intelligibility requirements of "Notification Appliances" and "Emergency Communications Systems" chapters in NFPA 72.
 - 2) High-Range Units: Rated 2 to 15 W.
 - 3) Low-Range Units: Rated 1 to 2 W.
 - 4) Mounting: Semi-recessed or surface mounted.
 - 5) Matching Transformers: Tap range matched to acoustical environment of speaker location.
 - 6) Combination Devices: Factory-integrated audible and visible devices in single-mounting assembly, equipped for mounting as indicated, and with screw terminals for system connections.
- B. Fire-Alarm Visible Notification Appliances:
 - 1. Strobes shall be Wheelock RSS series or equal.
 - 2. Performance Criteria:
 - a. Regulatory Requirements:
 - 1) NFPA 72.
 - 2) UL 1971.
 - b. General Characteristics:

- 1) Rated Light Output:
 - a) 15/30/75/110 cd, selectable in field.
 - b) Higher candela may be required for playing surface.
- 2) Clear or nominal white polycarbonate lens mounted on aluminum faceplate.
- 3) Mounting: Wall mounted unless otherwise indicated.
- 4) For units with guards to prevent physical damage, light output ratings must be determined with guards in place.
- 5) Flashing must be in temporal pattern, synchronized with other units.
- 6) Strobe Leads: Factory connected to screw terminals.
- 7) Mounting Faceplate: Factory finished, red or white.

2.9 FIRE-ALARM REMOTE ANNUNCIATORS

A. Performance Criteria:

1. Regulatory Requirements:
 - a. NFPA 72.
2. General Characteristics:
 - a. Annunciator functions must match those of FACU for alarm, supervisory, and trouble indications. Manual switching functions must match those of FACU, including acknowledging, silencing, resetting, and testing.
 - 1) Mounting: Flush cabinet, NEMA 250, Type 1.
 - b. Display Type and Functional Performance: Alphanumeric display and LED indicating lights must match those of FACU. Provide controls to acknowledge, silence, reset, and test functions for alarm, supervisory, and trouble signals.

2.10 FIRE-ALARM ADDRESSABLE INTERFACE DEVICES

A. Performance Criteria:

1. Regulatory Requirements:
 - a. NFPA 72.
2. General Characteristics:
 - a. Include address-setting means on module.
 - b. Store internal identifying code for control panel use to identify module type.
 - c. Listed for controlling HVAC fan motor controllers.
 - d. Monitor Module: Microelectronic module providing system address for alarm-initiating devices for wired applications with normally open contacts.
 - e. Integral Relay: Capable of providing direct signal to elevator controller to initiate elevator recall and to circuit-breaker shunt trip for power shutdown.

- 1) Allow control panel to switch relay contacts on command.
 - 2) Have minimum of two normally open and two normally closed contacts available for field wiring.
- f. Control Module:
- 1) Operate notification devices.

2.11 DIGITAL ALARM CELLULAR TRANSMITTERS (DACTs)

A. Performance Criteria:

1. Regulatory Requirements:
 - a. NFPA 72.
2. General Characteristics:
 - a. DACT may be separate or an integral part of the fire alarm control panel.
 - b. DACT must be acceptable to remote central station and must be listed for fire-alarm use.
 - c. Functional Performance: Unit must receive alarm, supervisory, or trouble signal from FACU and automatically transmit to a UL-listed 3rd party monitoring service. Transmitter shall support both dynamic (DHCP) or Public and Private Static IP addressing. Communication may be over Ethernet 10/100 Base network connection or GSM as primary. Data shall be secured with industry-standard Advanced Encryption Standard (AES 256 bit). Coordinate transmission methods with University PM. When contact is made with central station(s), signals must be transmitted. If service on any means is interrupted for longer than 45 seconds, transmitter must initiate local trouble signal and transmit signal indicating loss of service to remote alarm receiving station over remaining service means. Transmitter must automatically report service restoration to central station. If service is lost on all means, transmitter must initiate local trouble signal.
 - d. Local functions and display at DACT must include the following:
 - 1) Verification that services are available.
 - 2) Programming device.
 - 3) LED display.
 - 4) Manual test report function and manual transmission clear indication.
 - 5) Communications failure with central station or FACU.
 - e. Digital data transmission must include the following:
 - 1) Address of alarm-initiating device.
 - 2) Address of supervisory signal.
 - 3) Address of trouble-initiating device.
 - 4) Loss of ac supply.
 - 5) Loss of power.
 - 6) Low battery.
 - 7) Abnormal test signal.
 - 8) Communication bus failure.

- f. Secondary Power: Integral rechargeable battery and automatic charger.
- g. Self-Test: Conducted automatically every 24 hours with report transmitted to central station.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for ventilation, temperature, humidity, and other conditions affecting performance of the Work.
 - 1. Verify that manufacturer's written instructions for environmental conditions have been permanently established in spaces where equipment and wiring are installed, before installation begins.
- B. Examine roughing-in for electrical connections to verify actual locations of connections before installation.
- C. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protection of In-Place Conditions: Protect devices during construction unless devices are placed in service to protect facility during construction.

3.3 INSTALLATION OF EQUIPMENT

- A. Comply with NECA 305, NFPA 72, NFPA 101, and requirements of authorities having jurisdiction for installation and testing of fire-alarm equipment. Install electrical wiring to comply with requirements in NFPA 70 including, but not limited to, Article 760, "Fire Alarm Systems."
 - 1. Devices placed in service before other trades have completed cleanup must be replaced.
 - 2. Devices installed, but not yet placed, in service must be protected from construction dust, debris, dirt, moisture, and damage in accordance with manufacturer's written storage instructions.
- B. Install wall-mounted equipment, with tops of cabinets not more than 78 inch above finished floor.
- C. Manual Fire-Alarm Boxes:
 - 1. Install manual fire-alarm box in normal path of egress within 60 inches of exit doorway.
 - 2. Mount manual fire-alarm box on background of contrasting color.
 - 3. Operable part of manual fire-alarm box must be between 42 and 48 inches above floor level. Devices must be mounted at same height unless otherwise indicated.
- D. Smoke- and Heat-Detector Spacing:

1. Comply with "Smoke-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for smoke-detector spacing.
 2. Comply with "Heat-Sensing Fire Detectors" section in "Initiating Devices" chapter in NFPA 72, for heat-detector spacing.
 3. HVAC: Locate detectors not closer than 36 inches from air-supply diffuser or return-air opening.
 4. Lighting Fixtures: Locate detectors not closer than 12 inches from lighting fixture and not directly above pendant mounted or indirect lighting.
- E. Install cover on each smoke detector that is not placed in service during construction. Cover must remain in place except during system testing. Remove cover prior to system turnover.
- F. Duct Smoke Detectors: Comply with NFPA 72 and NFPA 90A. Install sampling tubes so they extend full width of duct. Tubes more than 36 inches long must be supported at both ends.
1. The detector or tubes within the duct shall be within 5 feet of the damper.
 2. Do not install smoke detector in duct smoke-detector housing during construction. Install detector only during system testing and prior to system turnover.
- G. Air-Sampling Smoke Detectors: If using multiple pipe runs, runs must be pneumatically balanced.
- H. Elevator Shafts: Coordinate temperature rating and location with sprinkler rating and location.
- I. Single-Station Smoke Detectors: Where more than one smoke alarm is installed within dwelling or suite, they must be connected so that operation of smoke alarm causes alarm in smoke alarms to sound.
- J. Remote Status and Alarm Indicators: Install in visible location near each smoke device that is not readily visible from normal viewing position.
- K. Audible Alarm-Indicating Devices: Install not less than 6 inches below ceiling. Install speakers on flush-mounted back boxes with device-operating mechanism concealed behind grille. Install devices at same height unless otherwise indicated.
- L. Visible Alarm-Indicating Devices: Install adjacent to each speaker and at least 6 inches below ceiling. Install devices at same height unless otherwise indicated.

3.4 ELECTRICAL CONNECTIONS

- A. Connect wiring in accordance with NFPA 70 and NFPA 72.
- B. Ground equipment in accordance with NFPA 70 and NFPA 72.
- C. Install electrical devices furnished by manufacturer, but not factory mounted, in accordance with NFPA 70 and NECA 1.
- D. Install nameplate for each electrical connection, indicating electrical equipment designation and circuit number feeding connection.

1. Nameplate must be laminated acrylic or melamine plastic signs, as specified NFPA 70 and NFPA 72.

3.5 CONTROL CONNECTIONS

- A. Install control and electrical power wiring to field-mounted control devices.
- B. Connect control wiring in accordance with NFPA 70 and NFPA 72.
- C. Install nameplate for each control connection, indicating field control panel designation and I/O control designation feeding connection.

3.6 PATHWAYS

- A. All pathways must be installed in conduit.

3.7 CONNECTIONS

- A. For fire-protection systems related to doors in fire-rated walls and partitions and to doors in smoke partitions, comply with requirements in NFPA 70 and NFPA 72. Connect hardware and devices to fire-alarm system.
 1. Verify that hardware and devices are listed for use with installed fire-alarm system before making connections.
- B. Make addressable connections with supervised interface device to the following devices and systems. Install interface device less than 36 inches from device controlled. Make addressable confirmation connection when such feedback is available at device or system being controlled.
 1. Smoke dampers in air ducts of designated HVAC duct systems.
 2. Magnetically held-open doors.
 3. Alarm-initiating connection to elevator recall system and components.
 4. Alarm-initiating connection to activate emergency lighting control.
 5. Supervisory connections at elevator shunt-trip breaker.

3.8 IDENTIFICATION

- A. Identify system components, wiring, cabling, and terminals. Comply with requirements for identification specified in NFPA 70 and NFPA 72.
- B. Install framed instructions in location visible from FACU.

3.9 GROUNDING

- A. Ground FACU and associated circuits in accordance with NFPA 70 and NFPA 72.
- B. Ground shielded cables at control panel location only. Insulate shield at device location.

3.10 FIELD QUALITY CONTROL

- A. Field tests must be witnessed by authorities having jurisdiction.
- B. Administrant for Tests and Inspections:
 - 1. Administer and perform tests and inspections.
- C. Tests and Inspections:
 - 1. Visual Inspection: Conduct visual inspection prior to testing.
 - a. Inspection must be based on completed record Drawings and system documentation that is required by "Completion Documents, Preparation" table in "Documentation" section of "Fundamentals" chapter in NFPA 72.
 - b. Comply with "Visual Inspection Frequencies" table in "Inspection" section of "Inspection, Testing and Maintenance" chapter in NFPA 72; retain "Initial/Reacceptance" column and list only installed components.
 - 2. System Testing: Comply with "Test Methods" table in "Testing" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Test audible appliances for public operating mode in accordance with manufacturer's written instructions. Perform test using portable sound-level meter complying with Type 2 requirements in ASA S1.4 Part 1/IEC 61672-1.
 - 4. Test visible appliances for public operating mode in accordance with manufacturer's written instructions.
 - 5. Prepare "Fire Alarm System Record of Completion" in "Documentation" section of "Fundamentals" chapter in NFPA 72 and "Inspection and Testing Form" in "Records" section of "Inspection, Testing and Maintenance" chapter in NFPA 72.
- D. Reacceptance Testing: Perform reacceptance testing to verify proper operation of added or replaced devices and appliances.
- E. Fire-alarm system will be considered defective if it does not pass tests and inspections.
- F. Prepare test and inspection reports.
- G. Maintenance Test and Inspection: Perform tests and inspections listed for weekly, monthly, quarterly, and semiannual periods. Use forms developed for initial tests and inspections.
- H. Annual Test and Inspection: One year after date of Substantial Completion, test fire-alarm system complying with visual and testing inspection requirements in NFPA 72. Use forms developed for initial tests and inspections.

3.11 DEMONSTRATION

- A. Train Owner's maintenance personnel to adjust, operate, and maintain fire-alarm system. Allow Owner to record training.

3.12 MAINTENANCE

- A. Maintenance Service: Beginning at Substantial Completion, maintenance service must include 12 months' full maintenance by skilled employees of manufacturer's designated service organization. Include preventive maintenance, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper operation. Parts and supplies must be manufacturer's authorized replacement parts and supplies.
 - 1. Include visual inspections in accordance with "Visual Inspection Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 2. Perform tests in "Test Methods" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.
 - 3. Perform tests per "Testing Frequencies" table in "Testing" paragraph of "Inspection, Testing and Maintenance" chapter in NFPA 72.

3.13 SOFTWARE SERVICE AGREEMENT

- A. Comply with UL 864.
- B. Technical Support: Beginning at Substantial Completion, service agreement must include software support for one year.
- C. Upgrade Service: At Substantial Completion, update software to latest version. Install and program software upgrades that become available within one year from date of Substantial Completion. Upgrading software must include operating system and new or revised licenses for using software.
 - 1. Upgrade Notice: At least 30 days to allow Owner to schedule access to system and to upgrade computer equipment if necessary.

END OF SECTION 28 46 21

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SECTION 31 10 00 – SITE CLEARING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Protecting existing vegetation to remain.
 2. Removing existing vegetation.
 3. Clearing and grubbing.
 4. Stripping and stockpiling topsoil.
 5. Removing above- and below-grade site improvements.
 6. Disconnecting, capping or sealing site utilities.
 7. Temporary erosion- and sedimentation-control measures.

1.2 MATERIAL OWNERSHIP

- A. Except for stripped topsoil and other materials indicated to be stockpiled or otherwise remain Owner's property, cleared materials shall become Contractor's property and shall be removed from Project site.

1.3 PROJECT CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
- B. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
1. Provide alternate routes around closed or obstructed traffic ways if required by Owner or authorities having jurisdiction.
- C. Salvable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- D. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- E. Do not commence site clearing operations until temporary erosion- and sedimentation-control and plant-protection measures are in place.
- F. The following practices are prohibited within protection zones:
1. Storage of construction materials, debris, or excavated material.
 2. Parking vehicles or equipment.
 3. Foot traffic.
 4. Erection of sheds or structures.
 5. Impoundment of water.
 6. Excavation or other digging unless otherwise indicated.

7. Attachment of signs to or wrapping materials around trees or plants unless otherwise indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 312000 "Earth Moving."
 1. Obtain approved borrow soil material off-site when satisfactory soil material is not available on-site.

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Locate and clearly identify trees, shrubs, and other vegetation to remain or to be relocated.
- C. Protect existing site improvements to remain from damage during construction.
 1. Restore damaged improvements to their original condition, as acceptable to Owner.

3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL

- A. Provide temporary erosion- and sedimentation-control measures to prevent soil erosion and discharge of soil-bearing water runoff or airborne dust to adjacent properties and walkways, according to erosion- and sedimentation-control drawings and requirements of authorities having jurisdiction.
- B. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- C. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- D. Remove erosion and sedimentation controls and restore and stabilize areas disturbed during removal.

3.3 TREE AND PLANT PROTECTION

- A. General: Protect trees and plants remaining on-site.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations, in a manner approved by Design Professional.

3.4 EXISTING UTILITIES

- A. Locate, identify, disconnect, and seal or cap utilities indicated to be removed or abandoned in place.
 - 1. Arrange with utility companies to shut off indicated utilities.
- B. Interrupting Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility services according to requirements indicated:
 - 1. Notify Design Professional not less than two days in advance of proposed utility interruptions.
 - 2. Do not proceed with utility interruptions without Design Professional's written permission.

3.5 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
 - 1. Grind down stumps and remove roots, obstructions, and debris to a depth of 18 inches (450 mm) below exposed subgrade.
 - 2. Use only hand methods for grubbing within protection zones.
- B. Fill depressions caused by clearing and grubbing operations with satisfactory soil material unless further excavation or earthwork is indicated.
 - 1. Place fill material in horizontal layers not exceeding a loose depth of 8 inches (200 mm), and compact each layer to a density equal to adjacent original ground.

3.6 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches (150 mm) in a manner to prevent intermingling with underlying subsoil or other waste materials.
- C. Stockpile topsoil away from edge of excavations without intermixing with subsoil. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

3.7 SITE IMPROVEMENTS

- A. Remove existing above- and below-grade improvements as indicated and necessary to facilitate new construction.

3.8 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus soil material, unsuitable topsoil, obstructions, demolished materials, and waste materials including trash and debris, and legally dispose of them off Owner's property.

- B. Separate recyclable materials produced during site clearing from other non-recyclable materials. Store or stockpile without intermixing with other materials and transport them to recycling facilities. Do not interfere with other Project work.

END OF SECTION

SECTION 31 20 00 – EARTH MOVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Excavation for paving and grading.
 2. Excavation for building foundations, slabs-on-grade, paving, and grading.
 3. Excavation for Site structures.
 4. Site filing and backfilling.
 5. Drainage course for slabs-on-grade.
 6. Consolidation and compaction.
 7. Excavation for trenches for utilities and footings.
 8. Consolidation and compaction of bedding under utilities.
 9. Rough grading.
- B. Related Sections:
1. Division 1 – Unit Prices.
 2. Section 015713 – Temporary Erosion and Sediment Control.
 3. Section 033000 – Cast-In-Place Concrete.
 4. Section 311000 – Site Clearing.
 5. Section 331100 - Water Utility Distribution Piping
 6. Section 333100 – Sanitary Utility Sewerage Piping
 7. Section 334100 – Storm Utility Drainage Piping.
 8. Section 334613 – Foundation Drainage.

1.2 DEFINITIONS

- A. Subgrade: Uppermost surface of an excavation or the top surface of a fill or backfill immediately below subbase, drainage fill, drainage course, or topsoil materials, and bottom of over excavation areas if required by the contract document.
- B. Subbase Course: Aggregate layer placed between the subgrade and hot-mix asphalt pavement, or aggregate layer placed between the subgrade and a cement concrete pavement or a cement concrete or hot-mix asphalt walk.
- C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.
- D. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.
- E. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill, when sufficient approved soil material is not available from excavations.
- F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated, regardless of the character and density of materials, including reuse or disposal of materials removed.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Design Professional. Authorized additional excavation and replacement material will be paid for according to Contract provisions for changes in the Work.
 2. Unauthorized Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions without direction by Design Professional. Unauthorized excavation, as well as remedial work directed by Design Professional, shall be without additional compensation.
- G. Fill: Suitable materials used to raise existing grades.
- H. Finish Grade: The top surface of sod, top surface of topsoil where sod is not indicated or exposed rock surface where indicated on the drawing.
- I. Trench Backfill: Soil material or controlled low-strength material used to fill an excavation.
1. Initial Backfill: Backfill placed beside and over pipe in a trench, including haunches to support sides of pipe.
 2. Final Backfill: Backfill placed over initial backfill to fill a trench.
- J. Structures: Buildings, footings, foundations, retaining walls, slabs, tanks, curbs, mechanical and electrical appurtenances, or other man-made stationary features constructed above or below the ground surface.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables, as well as underground services within buildings.
- L. Rock: Rock material in beds, ledges, unstratified masses, conglomerate deposits, and boulders of rock material that exceed **1 cu. yd. (0.76 cu. m)** for bulk excavation or **3/4 cu. yd. (0.57 cu. m)** for footing and trench excavation that cannot be removed by rock-excavating equipment equivalent to the following in size and performance ratings, without systematic drilling, ram hammering, ripping, or blasting, when permitted:
1. Equipment for Footing and Trench: Late-model, track-mounted hydraulic excavator; equipped with a 42-inch- (1065-mm-) maximum-width, short-tip-radius rock bucket; rated at not less than 138-hp (103-kW) flywheel power with bucket-curling force of not less than 28,700 lbf (128 kN) and stick-crowd force of not less than 18,400 lbf (82 kN) with extra-long reach boom.
 2. Equipment for Bulk Excavation: Late-model, track-mounted loader; rated at not less than 230-hp (172-kW) flywheel power and developing a minimum of 47,992-lbf (213.3-kN) breakout force with a general-purpose bare bucket.

1.3 SUBMITTALS

- A. Submit in accordance with Division 1 unless otherwise indicated.
- B. Product Data: For each type of material indicated in Part 2 of this section.
- C. Contract Closeout Submittals: Submit in accordance with Division 1.
 1. Project Record Documents.
 - a. Accurately record location of underground utilities remaining, rerouted utilities, and new utilities by horizontal dimensions from above grade permanent fixtures, elevations or inverts, and slope gradients.
- D. Blasting Plan in accordance with Section 1.4B.

- E. Reports of blasting and vibration monitoring in accordance with Section 1.4C.
- F. Soil testing reports as required by Section 1.4D

1.4 QUALITY ASSURANCE

- A. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
 - 1. Not less than 3 years experience with systems.
 - 2. Successfully completed not less than 5 comparable scale projects using this system.
- B. Blasting: Comply with applicable requirements in NFPA 495, "Explosive Materials Code." Contractor shall hire a blasting consultant to prepare a blasting plan reporting the following:
 - 1. Types of explosive, blast pattern, hole size, stemming and other details, delay pattern, blast schedule, and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage and settlement to site improvements and structures on Project site and adjacent properties.
 - 2. Seismographic monitoring during blasting operations.
 - 3. Safety requirements.
 - 4. Monitoring criteria, including threshold and limiting peak particle velocity vibration values at existing structures..
 - 5. Environmental considerations.
 - 6. Post blast reporting requirements.
 - 7. Other blasting related issues.
 - 8. Test-blast program: pre-construction testing of proposed blasting procedures to determine the site-specific attenuation of vibration at all adjacent buildings, including... Adjust procedures as required to avoid damage to existing facilities.
 - 9. Per owner request, first blast must occur on Monday afternoon between 2pm and 4pm. Contractor to coordinate with owner representative prior to first blast.
- C. Seismic Survey Agency: An independent testing agency hired by Contractor, acceptable to authorities having jurisdiction, experienced in seismic surveys and blasting procedures to perform the following services:
 - 1. Report types of explosive and sizes of charge to be used in each area of rock removal, types of blasting mats, sequence of blasting operations, and procedures that will prevent damage to site improvements and structures on Project site and adjacent properties.
 - 2. Seismographic monitoring during blasting operations.
 - 3. Provide certificates showing that all siesmographs have been calibrated by a certified firm within the last 12 months.
- D. Testing Agency: A qualified independent geotechnical engineering testing agency shall classify proposed on-Site and borrow soils to verify that soils comply with specified requirements and to perform specified field and laboratory testing.
- E. Pre-excavation Conference:
 - 1. Convene pre-excavation conference under provision of Division 1, one week prior to commencing Work of this Section.
 - 2. Contractor shall be presiding officer at conference.
 - 3. Conference shall be attended by Contractor, Owner's Representative, testing agency, and earthwork subcontractor.

4. Purpose of conference will be to review contract requirements and discuss schedules, work procedures, acceptable materials specified under this Section, locations where specified materials may be incorporated, and quality control.

1.5 PROJECT CONDITIONS

- A. Existing Conditions:
 1. Locate existing underground utilities in areas of excavation Work.
 - a. Do not interrupt existing utilities serving facilities occupied by the Owner or others except when permitted in writing by Owner's Representative and then only after acceptable temporary utility services have been provided.
 - b. Provide not less than 72 hours notice to Design Professional and Owner's Representative and receive written authorization to proceed before interrupting any utility.

1.6 MAINTENANCE

- A. Where settling is measurable or observable at excavated areas during correction period required by General Conditions, remove surface (pavement, lawn, or other finish), add backfill material, compact as specified in this Section for location of material, and replace surface treatment.
 1. Restore appearance, quality, and condition of surface or finish to match adjacent materials.
 2. Eliminate evidence of restoration.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. General:
 1. Provide approved borrow soil materials from off-Site when sufficient approved soil materials are not available from excavations, at no increase in Contract Sum or extension of Contract Time.
 2. Dispose of any excess materials legally off site at no increase in contract sum or extension of contract time. On site disposal of suitable materials may only be permitted where shown on the drawings.
 3. Fill and backfill materials shall be subject to the approval of testing agency and the Owner's Representative.
 4. For approval of fill and backfill materials, notify testing agency and Owner's Representative at least 5 working days in advance of intention to import material.
 - a. Designate proposed borrow area and excavate test pits to permit testing agency to sample as necessary from borrow area for the purpose of making acceptance tests to confirm quality of proposed material.
- B. General Fill Materials
 1. Definition: That material used to obtain finish subgrade levels at locations specified under this section.
 2. Acceptable material: Excavated on-Site material or off-Site borrow material which is free from debris, organics, decomposable, and corrodible materials, and containing the proper

moisture content, liquid limit, and plasticity index to obtain specified compaction requirements.

- a. Existing on-Site material proposed for reuse, and off-Site borrow material shall be approved by testing agency.

C. Construction Fill and Backfill

1. Engineered fill is defined as soil or granular fill containing sufficient fines to establish moisture/density relationship. Engineered fill shall be free of frozen soil, organics, rubbish, large rocks, wood, or other deleterious material. Cohesive soils shall be uniformly compacted to at least 95 percent of the maximum standard dry density and be within -2 to +4 percent of optimum moisture content as described by ASTM D698. granular fill, such as MoDOT 1007 Type 1 or 5, shall be compacted to at least 95% of the maximum dry density as determined by the Standard Proctor, ASTM D698. The moisture content shall be high enough to provide for proper compaction but low enough to prevent undue pumping. Should the results of the in-place density tests indicate that the specified compaction limits have not been achieved, the area represented by the test shall be reworked and retested as required until the specified limits are reached. Proposed fill shall be analyzed by the geotechnical engineer as soon as borrow sources are identified to determine suitability and conformance with the following recommendations:
 - a. Soil classified as MH, OH, OL, or PT (high plasticity soils and organic soils) by the Unified Soil Classification system (ASTM D 2487) shall not be imported for use as engineered fill.
 - b. Soils that classify as CH shall be analyzed and approved by a qualified geotechnical engineer prior to use on site.
 - c. Soils found during this investigation are acceptable for use as engineered fill, however, material considered undocumented fill found in the southern half of the site shall be approved by a qualified geotechnical engineer prior to being used as engineered fill.
2. The fill material shall be placed in layers, not to exceed eight inches in loose thickness, and shall be wetted or dried as required to secure specified compaction. Effective spreading equipment shall be used on each lift to obtain a uniform lift thickness prior to compaction. Each layer shall be uniformly compacted by means of suitable equipment of the type required by the materials composing the fill. The fill layers shall be placed approximately parallel to the finished grade. Rocks and stones that exceed the thickness of the 8 inch loose lift layer shall be removed and disposed of off the immediate construction site

D. Low Volume Change Material:

1. Definition: That material used to obtain the upper 24 inches of finish subgrade beneath granular base in building areas, and material used as trench backfill material in building areas.
2. Acceptable material:
 - a. On-site or Off-Site borrow material which is free from debris, organics, decomposable, and corrodible materials with a liquid limit of less than 50 percent and a plasticity index less than 30, or another material acceptable to the testing agency.
 - 1) Existing on-Site material proposed for reuse, and off-Site borrow material shall be approved by testing agency.
 - b. A granular fill containing sufficient fines to exhibit a definite moisture/density relationship.

E. Granular Fill:

1. Definition: Free-draining granular base used beneath building slabs-on-grade and used as backfill behind foundation and retaining walls.

2. Acceptable materials: Clean crushed stone or gravel, free of Shale, clay, friable material, and debris, complying with ASTM C33 Size No. 67.
- F. Pavement Subbase Course:
 1. Definition: Granular base used beneath concrete pavement and other pavements indicated on Drawings.
 2. Acceptable materials: Comply with APWA Street Construction and Material Specifications, Division II.
- G. Crushed Limestone Fill Material:
 1. Definition: That material used at trench backfill under pavements, at locations specified under this Section, and at locations indicated on Drawings.
 2. Acceptable materials: Comply with APWA Street Construction and Material Specifications, Division II.
- H. Bedding Materials: Type 1 aggregate per MoDOT Standard Specification for Highway Construction, Section 1007.
- I. Trench Backfill Materials:
 1. Slab on grades: Low volume change materials per this section.
 2. Pavement areas: Low volume change material per this section.
 3. Other areas: General Fill Material or other materials specified under this Section at locations specified or indicated on Drawings.
- J. Backfill Material
 1. Definition: Material requiring placement and compaction with manual procedures because of restricted spaces or new construction.
 2. Acceptable materials: Either General Fill Material, Granular Fill Material, or other materials specified under this Section at locations specified or indicated on Drawings.
- K. Suitable Soils: Suitable soils within 36 inches of finished grade in lawn and plater areas shall be cohesive soils in Soil Classification Groups ML, CL, CH or a combination thereof, free of rock or gravel greater than one (1) inch in any dimension, debris, waste, frozen materials, vegetation and other deleterious matter.
- L. Unsuitable Material
 1. Definition: That excavated material which does not meet the consistency requirements of any other defined materials in this Section, including muck, frozen material, organic material, top soil, rubbish, and rock within the limits defined for General Fill Material
 2. Dispose of unsuitable material off-Site, at no increase in Contract Sum or extension of Contract Time.
 - a. Submit an acceptable agreement with the property owner on whose property the unsuitable material is placed.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
 1. Verify location and elevations of existing building foundations.
 2. Verify location and elevations of existing underground utilities.

3. Verify erosion control systems are in place.
4. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

A. Protection:

1. Protect trees, shrubs, lawns, other plant growth, and other features indicated on Drawings to remain.
2. Protect bench marks, monuments, existing structures, existing fences, existing roads, existing sidewalks, existing paving, and existing curbs from damage caused by settlement, lateral movement, undermining, washout, and other hazards caused by Work of this Section.
 - a. If damaged or displaced, notify Owner's Representative and correct defects as directed by Owner's Representative.
3. Protect above and below grade utilities which are to remain.
4. Protect adjacent and downstream properties from pollution, sedimentation, or erosion caused by the work of this Contract.

B. Precautions:

1. Use all means necessary to control dust on and near the Work, and on and near off-Site borrow storage, and spoil areas, if such dust is caused by performance of the Work of this Section, or if resulting from the condition in which Project Site is left by Contractor.
2. Moisten surfaces as required to prevent dust from being a nuisance to the public, neighbors, and concurrent performance of other Work on Project Site.
3. Identify required lines, levels, contours, and datum.
4. Identify above and below grade utilities.
5. Provide and maintain positive surface drainage.

3.3 WATER CONTROL

- A. Provide berms or channels to prevent flooding of subgrades.
- B. Prevent infiltration of water into excavations from whatever sources as may exist.
- C. Prevent ponding of water on finish subgrades.
- D. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- E. Prevent flooding of Project Site and surrounding areas.
- F. Promptly remove water collection in depressions.
 1. Provide and maintain ample means and devices with which to remove and dispose of water entering excavations.
 2. Ensure dry excavations and preservation of final lines and grades of bottoms of excavations.

3.4 EXCAVATION, GENERAL

- A. Excavation above subgrade as defined in paragraph 1.2 of this section is unclassified and includes excavation of any material encountered regardless of its character including rock, soil materials, debris, and other obstructions and shall be included in the base bid.
- B. Perform excavation to the lines and grades indicated on Drawings within a tolerance of 0.10 foot.
 - 1. Extend excavations a sufficient distance from structures for placing and removing concrete formwork, installing services and other construction, and for inspections.
- C. Perform Excavation Work in compliance with applicable requirements of authorities having jurisdiction, including United States Department of Labor, Occupational Safety and Health Administration (OSHA) "Construction Standards for Excavations, 29 CFR Part 1926".
- D. Perform Work in a manner and sequence that will provide drainage at all times and that will prevent surface water from draining into excavations.
- E. Protect subgrades and foundation soils against freezing temperatures and frost.
 - 1. Provide protective insulation materials as necessary.
- F. When excavating through roots, perform Work by hand cutting roots with sharp axe.
- G. Excavation cut shall not interfere with normal 45 degree bearing splay of foundations.
- H. Machine slope banks to comply with local codes, ordinances, and requirements of agencies having jurisdiction.
 - 1. Provide materials for shoring and bracing.
 - a. Maintain shoring and bracing in excavations regardless of time period excavations will be open.
 - b. Extend shoring and bracing as excavation progresses
 - 2. Control surface drainage down slopes.
 - 3. Cover slopes to prevent loss of moisture content of soil and to prevent raveling.
- I. When materials encountered at subgrade are determined to be unacceptable for use by testing agency, remove such material to depths and limits determined by testing agency.
 - 1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material.
- J. Where depressions result from, or have resulted from the removal of surface or subsurface obstructions, open depressions to equipment working width, and remove debris and soft material as directed by testing agency, at no increase in Contract Sum or extension of Contract time.
 - 1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material, at no increase in Contract Sum or extension of Contract Time.
- K. Backfill and compact over-excavations and unauthorized as specified for the area at which it occurs, at no increase in Contract Sum or extension of Contract Time.
 - 1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material, at no increase in Contract Sum or extension of Contract Time.
- L. Stockpile excavation material which testing agency has approved for reuse.

1. Stockpile soil materials without intermixing soil materials with different consistencies and gradation.
 2. Place, grade, and shape stockpiles to drain surface water.
 3. Do not stockpile within drip line of trees which are to remain.
 4. Cover stockpiles to prevent wind-blown dust.
- M. Remove unacceptable excavation material from Site, at no increase in Contract Sum or extension of Contract Time.
- N. Hand trim excavations.
1. Remove loose matter.
- O. Excavation for Footings and Foundations:
1. Do not disturb bottom of excavation.
 - a. Excavate by hand to final grade immediately prior to placement of concrete reinforcement.
 - b. Trim bottom of excavations to required lines and grades to leave solid base to receive other work.
 2. Drill probe holes at exposed bottom of excavations as directed by testing agency.

3.5 TRENCH EXCAVATIONS

- A. Trench excavation is unclassified and includes excavation to required exposed subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.
- B. Excavate trenches to gradients, lines, depths, and elevations indicated on Drawings, within a tolerance of 0.10 foot.
- C. Perform excavation Work in compliance with applicable requirements of authorities having jurisdiction, including United States Department of Labor, Occupational Safety and Health Administration (OSHA) "Construction Standards for Excavations, 29 CFR Part 1926".
- D. Do not perform trench excavation in areas to receive fill until fill operations are complete to an elevation of not less than 24 inches above the top of the proposed pipe or conduit for which the trench is to receive.
- E. Perform Work in a manner and sequence that will provide drainage at all times and that will prevent surface water from draining into trenches.
- F. Protect subgrades against freezing temperatures and frost.
- G. Provide protective insulation materials as necessary.
- H. When excavating through roots, perform Work by hand cutting roots with a sharp axe.
- I. Excavation cut shall not interfere with normal 45 degree bearing splay of foundations.
- J. Excavate trenches to uniform width, sufficiently wide to enable installation of utilities and to allow safe inspection of installed utilities.
- K. Excavate trenches 6 inches deeper than bottom of pipe elevation to allow for bedding course

1. Hand excavate for bell of pipe.
 2. Excavate trenches 6 inches deeper than elevation required in rock or other unyielding bearing material to allow for bedding course.
 3. Comply with local codes, ordinances, and requirements of agencies having jurisdiction.
 4. Provide materials for shoring and bracing.
 - a. Maintain shoring and bracing in trenches regardless of time period trenches will be open.
 - b. Extend shoring and bracing as excavation progresses.
 5. Control surface drainage down slopes.
 6. Cover slopes to prevent loss of moisture content of soil and to prevent raveling.
 7. Hand trim trenches.
 - a. Remove loose matter.
- L. When subgrade materials are encountered which testing agency determines to be unacceptable for use, remove such material to depths and limits determined by testing agency:
1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material.
 2. Removal and replacement of unacceptable material will be paid on basis of Unit Prices included in the Contract Documents.
- M. Where depressions result from, or have resulted from the removal of surface or subsurface obstructions, open depressions to equipment working width, and remove debris and soft material as directed by testing agency at no increase in Contract Sum or extension of Contract Time.
1. Backfill with material acceptable to testing agency and compact to density equal to the specified requirements for subsequent fill material, at no increase in Contract Sum or extension of Contract Time.
- N. Stockpile excavation material which testing agency has approved for reuse.
1. Stockpile soil materials without intermixing soil materials with different consistencies and gradations.
 2. Place, grade, and shape stockpiles to drain surface water.
 3. Do not stockpile within drip line of trees which are to remain.
 4. Cover stockpiles to prevent wind-blown dust.
- O. Remove unacceptable excavation material from Site, at no increase in Contract Sum or extension of Contract Time.
1. Submit an acceptable agreement with the property owner on whose property the unsuitable material is placed.

3.6 SUBGRADE PREPARATION FOR BUILDING SLABS-ON-GRADE

- A. General:
1. Excavation for subgrade preparation is unclassified and includes excavation to required subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.
 2. Testing agency shall be present to observe and evaluate subgrades in building areas prior to placement of fill and/or low volume change materials and shall be present during placement and compaction of fill materials in building areas. Undercut as specified herein to develop 24 inch thick low volume change zone below building floor slabs. Subgrades in building areas shall be observed and evaluated by geotechnical engineer prior to fill and/or low volume change placement. Evaluation may include probing by geotechnical engineer and opening of test pits and/or test trenches with contractors

- assistance to explore areas of suspected unsuitable materials. Subgrades shall also be proof-rolled with loaded tandem axle dump truck in presence of geotechnical engineer and scarified, moisture conditioned and recompacted as specified herein prior to placement of fill and/or low volume change materials.
3. Fill material shall not be placed, spread, or rolled while the material is frozen or thawing, or during unfavorable weather conditions.
 4. Moisture condition or dry fill material as required to obtain specified moisture content limits.
 - a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
 5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
 6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
 7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.
 8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
 9. In excavations where testing agency determines that subgrade material is unacceptable, remove unacceptable material and backfill in accordance with procedures determined by testing agency.
 10. Minimize construction traffic, including foot traffic, from floor slab finished subgrades in order to prevent unnecessary disturbances of subgrade materials.
 - a. If testing agency determines that finished subgrades have been disturbed, remove disturbed areas and replace and recompact to required density as directed by testing agency.
 - b. If testing agency determines that rutting has occurred, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
 - c. Testing agency shall be present during compaction of material.
- B. In cut areas below building slabs-on-grade requiring less than 24 inches of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside building areas, excavate existing materials to a depth of not less than 24 inches below bottom of floor slab granular fill.
1. Scarify subgrade to a depth of 6 inches to result in a surface free from ruts, hummocks, and other uneven features which, in the opinion of the testing agency, would prevent uniform compaction by the equipment proposed for use.
 - a. Moisture condition subgrade to achieve moisture content specified in this Section.
 - b. Compact to a minimum of 95% of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 2. After scarifying, moisture conditioning, and recompacting, backfill fill areas using low volume change materials placed in loose lifts not exceeding 8 inches.
 - a. Compact each lift of low volume change clay soil to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698. Compact each lift of granular low volume change material to a minimum of

- 95 percent of the material's maximum standard proctor dry density at a workable moisture content sufficient to obtain the required density.
- 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
3. Fill operations shall continue in compacted layers until finish subgrade elevations have been obtained.
 - a. Compact each lift of low volume change clay soil to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698. Compact each lift of granular low volume change material to a minimum of 95 percent of the material's maximum standard proctor dry density at a workable moisture content sufficient to obtain the required density.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 4. Protect excavations from excessive wetting and drying during construction.
 - a. Remove water entering excavation, and remove disturbed or softened soil.
 5. The upper 24 inches of fill material shall be low volume change material.
 6. Maintain subgrade moisture content within specified range until building slabs-on-grade are installed.
 - a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
 - b. Recompact and retest until required density and moisture content is obtained.
- C. In areas below building slabs-on-grade requiring 24 inches or more of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside building areas, scarify subgrade to a depth of 6 inches to result in surface free from ruts, hummocks, and other uneven features which, in the opinion testing agency, would prevent uniform compaction by the equipment proposed for use.
1. Moisture condition subgrade to achieve moisture content specified in this Section.
 - a. Compact to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 2. After scarifying, moisture conditioning, and recompacting, backfill areas using suitable materials as specified herein placed in loose lifts not exceeding 8 inches. Suitable on-site clay materials may be used below the 24-inch thick low volume change zone.
 - a. Compact each lift of suitable clay soil or low volume change material to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698. Compact each lift of granular low volume change material to a minimum of 95 percent of the material's maximum Standard Proctor dry density at workable moisture content sufficient to obtain the required density.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.

- 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 3. Fill operations shall continue in compacted layers until finish subgrade elevations have been obtained.
 - a. Compact each lift of suitable clay soil or low volume change material to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 4. Protect excavations from excessive wetting and drying during construction.
 - a. Remove water entering excavation, and remove disturbed or softened soil.
 5. The upper 24 inches of fill material shall be low volume change material.
 6. Maintain subgrade moisture content within specified range until building slabs-on-grade are installed.
 - a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
 - b. Recompact and retest until required density and moisture content is obtained.
- D. Tolerances:
 1. Top surface of finish subgrade under slabs-on-grade: Plus or minus ¼ inch from required elevations.

3.7 SUBGRADE PREPARATION FOR FOUNDATION FOOTING

- A. General:
 1. Excavation for subgrade preparation for foundations is unclassified and includes excavation to required subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.
 2. Testing agency shall be present during placement and compaction of fill material.
 3. Fill material shall not be placed, spread, or rolled while the material is frozen or thawing, or during unfavorable weather conditions.
 4. Moisture condition dry fill material as required to obtain specified moisture content limits.
 - a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
 5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
 6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
 7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.
 8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
 9. In excavations where testing agency determines that subgrade material is unacceptable, remove unacceptable material and backfill in accordance with procedures determined by testing agency.

10. Minimize construction traffic, including foot traffic, from floor slab finished subgrades in order to prevent unnecessary disturbances of subgrade materials.
 - a. If testing agency determines that finished subgrades have been disturbed, remove disturbed areas and replace and recompact to required density as directed by testing agency.
 - b. If testing agency determines that rutting has occurred, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
 - c. Testing agency shall be present during compaction of material.

3.8 SUBGRADE PREPARATION AT PAVEMENTS

A. General:

1. Excavation for subgrade preparation is unclassified and includes excavation to required subgrade elevations regardless of the character of surface and subsurface conditions encountered, including rock, soil materials, debris, and other obstructions.
2. Testing agency shall be present to observe proof-rolling of subgrades in pavement and sidewalk areas prior to placement of fill and shall be present during placement and compaction of fill materials in pavement and sidewalk areas. Testing agency shall also be present to observe proof-rolling of finished subgrades prior to installation of pavement and sidewalk sections.
3. Fill material shall not be placed, spread, or rolled while the material is frozen or thawing, or during unfavorable weather conditions.
4. Moisture condition or dry fill material as required to obtain specified moisture content limits.
 - a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.
8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
9. In excavations where testing agency determines that subgrade material is unacceptable, remove unacceptable material and backfill in accordance with procedures determined by testing agency.
10. Minimize construction traffic, including foot traffic, from pavement finished subgrades in order to prevent unnecessary disturbances of subgrade materials.
 - a. If testing agency determines that finished subgrades have been disturbed, remove disturbed areas and replace and recompact to required density as directed by testing agency.
 - b. If testing agency determines that rutting has occurred, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
 - c. Testing agency shall be present during compaction of material.

- #### B.
- In cut areas below pavements requiring less than 12 inches of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside pavement areas, excavate existing material to a depth of not less than 6 inches below bottom of pavement subbase course.

1. Proof-roll subgrade and repair as required in paragraph 3.8.E below, then scarify to a depth of 6 inches to result in a surface free from ruts, hummocks, and other uneven features which, in the opinion of the testing agency, would prevent uniform compaction by the equipment proposed for use.
 - a. Moisture condition subgrade to achieve moisture content specified in this Section.
 - b. Compact to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 2. After scarifying, moisture conditioning, and recompacting, backfill areas using approved materials placed in loose lifts not exceeding 8 inches.
 - a. compact each lift to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 3. Protect excavations from excessive wetting and drying during construction.
 - a. Remove water entering excavation, and remove disturbed or softened soil.
 4. Maintain subgrade moisture content within specified range until pavements are installed.
 - a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
 - b. Recompact and retest until required density and moisture content is obtained.
- C. In areas below pavements requiring 12 inches or more of fill to obtain finish subgrade elevations, and a lateral distance of 5 feet outside pavement areas, proofroll existing subgrade in presence of testing agency using a fully loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of 20 tons.
1. Remove soft areas as directed by testing agency and recompact in loose 9 inch lifts to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between 0 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 2. After proofrolling operations are performed and observed soft areas repaired, place approved material in loose lifts not exceeding 8 inches.
 - a. Compact each lift to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between 0 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

3. Fill operations shall continue in compacted layers until finish subgrade elevations have been obtained.
 - a. Compact each lift to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - 1) Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - 2) When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 4. Protect excavations from excessive wetting and drying during construction.
 - a. Remove water entering excavation, and remove disturbed or softened soil.
 5. Maintain subgrade moisture content within specified range until pavements are installed.
 - a. Rework non-complying area as required to achieve specified requirements as directed by testing agency.
 - b. Recompact and retest until required density and moisture content is obtained.
- D. Tolerances
1. Top surface of finish subgrade under paved areas: Plus or minus ¼ inch from required elevations.
- E. Immediately prior to placement of pavement subbase course and pavements, proofroll subgrade in presence of testing agency using a fully loaded tandem axle dump truck or similar type of pneumatic tired equipment with a minimum gross weight of 20 tons.
1. Remove soft areas as directed by testing agency and recompact in loose 9 inch lifts to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

3.9 GENERAL SITE FILL

- A. General:
1. Testing agency shall be present during placement and compaction of fill material.
 2. Fill material shall not be placed, spread, or rolled while the material is frozen or thawing, or during unfavorable weather conditions.
 3. Moisture condition or dry fill material as required to obtain specified moisture limits.
 4. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by dishing, harrowing, or pulverizing.
 5. Place fill material using spreading equipment capable of obtaining uniform loose lift thickness.
 6. Compact fill material using equipment appropriate to the material being compacted, as determined by testing agency.
 7. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed fill area is as specified.
 8. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
- B. Perform grading to the contours and elevations indicated on Drawings:

1. Uniformly grade areas to a smooth surface, free from irregular surface changes.
 2. Provide a smooth transition between existing adjacent grades and new grades.
- C. Place general fill material in systematic and uniform horizontal lifts not exceeding the following loose-depth-measurements:
1. For fill material to be compacted with heavy compaction equipment: 9 inches.
 2. For fill material to be compacted with hand operated tampers: 4 inches.
- D. Under sidewalks and ramps compact each lift of material to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698
1. In other areas, compact each lift of material to a minimum of 90 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698
 - a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework on-complying area as required to achieve specified requirements.
- E. Bench existing slopes horizontal sections equal in width to equipment used.
- F. Where embankments, regardless of height, are placed against hillsides or existing embankments having a slope of steeper than 1 vertical to 5 horizontal, bench or step existing slope in approximately 24 inch rises:
1. Place fill in lifts not exceeding 9 inches in loose-depth-measurement
 2. Compact material bladed out, bottom area which was cut to form benches, and fill material being placed, to a minimum of 95 percent of the material's maximum Standard Proctor dry density with a moisture content between -2 and +4 percent above optimum moisture content in accordance with ASTM D698.
 - a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
- G. Remove surplus materials from Site, at no increase in Contract Sum or extension of Contract Time.
1. Submit an acceptable agreement with the property owner on whose property the material is placed.
- H. Tolerances:
1. Top surface of finish subgrade under paved areas: Plus or minus $\frac{1}{4}$ inch from required elevations.
 2. Top surface of finish subgrade under unpaved surfaces: Plus or minus $\frac{1}{2}$ inch from required elevations.

3.10 INSTALLATION OF GRANULAR FILL

- A. Immediately prior to placement floor slab granular base, testing agency will evaluate subgrade to determine whether moisture content is within specified range, and whether subgrade has been disturbed.

1. In areas where testing agency determines subgrade is not within specified moisture content range, remove non-complying areas and replace and recompact to required density, within specified moisture content range, as directed by testing agency.
 - a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - b. When test indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
 2. If testing agency determines that rutting has occurred or other detrimental conditions exist, excavate 6 inches, or other depth as directed by testing agency, of subgrade material and recompact as specified for affected area.
 - a. Field density tests shall be taken after the compaction of each layer of fill by testing agency.
 - b. When tests indicate that any layer of fill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.
- B. Place granular fill in equal continuous layers not exceeding 6 inches.
1. Compact granular fill using heavy vibrating equipment, in 3 passes, to achieve a total compacted thickness of 4 inches in presence of Owner's representative or testing agency.
 2. Compact granular fill in confined areas using a combination of manually operated vibratory plates and "wacker" compaction equipment.
- C. Tolerances:
1. Top surface of finish subgrade under slabs-on-grade: Plus or minus ¼ inch from required elevations.

3.11 INSTALLATION OF PAVEMENT SUBBASE COURSE

- A. Place pavement subbase course in equal continuous layers not exceeding 6 inches.
1. Compact granular fill for pavement and sidewalk subbase course to a minimum of 95 percent of the material's maximum standard proctor dry density in accordance with ASTM D698.
 2. Compact granular fill in confined areas using a combination of manually operated vibratory plates and "wacker" compaction equipment.
 3. Qualitative tests shall be taken after the compaction of each layer of fill by testing agency.
- B. Tolerances:
1. Top surface of finish subgrade under paved areas: Plus or minus ¼ inch from required elevations.

3.12 BEDDING

- A. Place and compact bedding course on trench bottoms and where indicated on Drawings.
1. Install materials in continuous layers not exceeding 6 inches compacted depth.
- B. Shape bedding course to provide continuous support for bells, joints, and barrels of pipes and for joints, fittings, and bodies of conduits.
- C. Install bedding to a depth of 6 inches below bottom of pipe bell or conduit, to an elevation of 6 inches above pipe or conduit.

- D. Compact bedding materials by slicing with a shovel and compacting with vibratory plates and "wacker" compaction equipment.
- E. Support pipe and conduit during placement and compaction of bedding fill.

3.13 INSTALLATION OF BACKFILL

- A. Backfill excavations promptly, but not before completion of the following:
 - 1. Surveying location of underground utilities for Record Documents
 - 2. Testing, inspecting, and approval of underground utilities
 - 3. Removal of concrete forms
 - 4. Removal of lumber, rock, paper, and other debris from areas to be backfilled
 - 5. Removal of temporary shoring, bracing, and sheeting
- B. Backfill areas to contours and elevations indicated on Drawings, using unfrozen backfill material
 - 1. Do not backfill over porous, wet, frozen, thawing, or spongy surfaces
 - 2. Do not backfill during unfavorable weather conditions
 - 3. Moisture condition or dry backfill material as required to obtain specified moisture content limits
 - a. Material which is too wet to allow proper compaction, as determined by testing agency
 - 4. Place backfill material using equipment capable of obtaining uniform loose lift thickness
 - 5. Compact backfill material using equipment appropriate to the material being compacted, as determined by testing agency
 - 6. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed backfill areas is as specified
 - 7. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
 - 8. Compaction in lawn and planter areas is 85% maximum.
- C. Backfilling of curbs, slabs-on-grade, and other structures whose foundation is unprotected from water shall be accomplished as soon as forms are removed, to eliminate possibility of softening of subbase below structure
- D. Backfill foundation walls with granular material, not less than 24 inches in width, to an elevation of 2 feet below finish grade.
 - 1. Backfill simultaneously on each side of unsupported foundation walls.
 - 2. Backfill upper 2 feet using General Fill Material.
- E. Backfill trenches to contours and elevations indicated on Drawings, using unfrozen backfill material.
 - 1. Do not backfill over porous, wet, frozen, or spongy surfaces.
 - 2. Do not backfill during unfavorable weather conditions.
 - 3. Moisture condition or dry backfill material as required to obtain specified moisture content limits.
 - a. Material which is too wet to allow proper compaction, as determined by testing agency, may be spread and permitted to dry assisted by disking, harrowing, or pulverizing.
 - 4. Place backfill material using equipment capable of obtaining uniform loose lift thickness.
 - a. Employ a placement method of backfill operations which does not disturb or damage utilities in trenches.

- F. Backfill trenches that carry below or pass under footings and that are excavated within 18 inches of footings with concrete.
 - 1. Place concrete to elevation equal to bottom of footings.

- G. Compaction of General Backfill
 - 1. Maintain optimum moisture content of backfill materials to attain required compaction density.
 - 2. General Fill Materials used for backfill shall be placed in lifts not exceeding 9 inches in loose-depth-measure and compacted as specified for General Site Fill
 - 3. Granular Fill Materials used for backfill shall be placed in lifts not exceeding 6 inches in loose-depth-measure and compacted as specified for Granular Fill.
 - 4. Field density tests shall be taken after the compaction of each layer of backfill by testing agency.
 - a. When tests indicate that any layer of backfill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

- H. Compaction of Trench Backfill
 - 1. Compact backfill material using equipment appropriate to the material being compacted, as determined by testing agency.
 - 2. Maintain optimum moisture content of backfill materials to attain required compaction density.
 - 3. When Work is interrupted by rain, do not resume Work until testing agency indicates that moisture content and density of previously placed backfill area is as specified.
 - 4. Where soil has been softened or eroded by flooding or placement during unfavorable weather conditions, remove damaged areas and recompact to required density.
 - 5. General Fill Material used for backfill shall be placed in lifts not exceeding 4 inches in loose-depth-measure with each lift compacted as specified in this section.
 - 6. MoDOT Standard Specification for Highway Construction Type 5 aggregate used for backfill shall be placed in lifts not exceeding 6 inches in loose-depth-measure and compacted to a minimum of 97 percent of the material's maximum Standard Proctor dry density with a moisture content near optimum in accordance with ASTM D698.
 - 7. Field density tests shall be taken after the completion of each layer of backfill by testing agency.
 - a. When tests indicate that any layer of backfill or portion thereof does not meet the required compaction density or moisture content, rework non-complying area as required to achieve specified requirements.

- I. Slope grade away from building not less than 12 inches in 10 foot for a distance of not less than 6 feet outside of building lines.
 - 1. Make grade changes gradual.
 - 2. Blend slopes into level areas.
 - 3. Remove surplus materials from Site, at no increase in Contract Sum or extension of Contract Time
 - 4. Submit an acceptable agreement with the property owner on whose property the material is placed

- J. Tolerances:
 - 1. Top surface of finish subgrade under paved areas: Plus or minus ¼ inch from required elevations
 - 2. Top surface of finish subgrade under unpaved areas. Plus or minus ½ inch from required elevations

3.14 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- B. Allow testing agency to inspect and test subgrades and each fill or backfill layer. Proceed with subsequent earth moving only after test results for previously completed work comply with requirements.
- C. Footing Subgrade: At footing subgrades, at least one test of each soil stratum will be performed to verify design bearing capacities. Subsequent verification and approval of other footing subgrades may be based on a visual comparison of subgrade with tested subgrade when approved by Geotechnical Engineer.
- D. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 6938, and ASTM D 2937, as applicable. Tests will be performed at the following locations and frequencies:
 - 1. Paved and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 2000 sq. ft. or less of paved area or building slab, but in no case fewer than three tests.
 - 2. Foundation Wall Backfill: At each compacted backfill layer, at least one test for every 100 feet or less of wall length, but no fewer than two tests.
 - 3. Trench Backfill: At each compacted initial and final backfill layer, at least one test for every 150 feet or less of trench length, but no fewer than two tests.
- E. When testing agency reports that subgrades, fills, or backfills have not achieved degree of compaction specified, scarify and moisten or aerate, or remove and replace soil materials to depth required; recompact and retest until specified compaction is obtained.

3.15 PROTECTION

- A. Protect newly graded areas from freezing and erosion.
- B. Repair and reestablish grades in settled, eroded, and rutted areas to specified tolerances.
- C. Where completed compacted areas are disturbed by subsequent construction operations or adverse weather, scarify surface, reshape, and compact to required density prior to further construction.
 - 1. Testing agency shall be present during compaction of material.

END OF SECTION

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SECTION 31 23 19 – DEWATERING

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of the Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes construction dewatering.
- B. Related Sections include the following:
 - 1. "Earth Moving" for excavating, backfilling, site grading and for site utilities.

1.3 PERFORMANCE REQUIREMENTS

- A. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control ground-water flow into excavations and permit construction to proceed on dry, stable subgrades.
 - 1. Maintain dewatering operations to ensure erosion control, stability of excavations and constructed slopes, that excavation does not flood, and that damage to subgrades and permanent structures is prevented.
 - 2. Prevent surface water from entering excavations by grading, dikes, or other means.
 - 3. Accomplish dewatering without damaging existing buildings adjacent to excavation.
 - 4. Remove dewatering system if no longer needed.

1.4 QUALITY ASSURANCE

- A. Regulatory Requirements: Comply with water disposal requirements of authorities having jurisdiction.
- B. Preinstallation Conference: Conduct conference at Project site to comply with requirements in Division 1.

1.5 PROJECT CONDITIONS

- A. Existing Utilities: Do not interrupt utilities serving facilities occupied by Owner or others unless permitted in writing by Design Professional and then only after arranging to provide temporary utility services according to requirements indicated.
- B. Project-Site Information: A geotechnical report has been prepared for this Project and is available for information only. The opinions expressed in this report are those of geotechnical engineer and represent interpretations of subsoil conditions, tests, and results of analyses conducted by geotechnical engineer. Owner will not be responsible for interpretations or conclusions drawn from this data.
 - 1. Make additional test borings and conduct other exploratory operations necessary for dewatering.
 - 2. The geotechnical report is included elsewhere in the Project Manual.

PART 2 - PRODUCTS (Not Used)

PART 3 - EXECUTION

3.1 PREPARATION

- A. Protect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by dewatering operations.
 - 1. Prevent surface water and subsurface or ground water from entering excavations, from ponding on prepared subgrades, and from flooding site and surrounding area.
 - 2. Protect subgrades and foundation soils from softening and damage by rain or water accumulation.
- B. Install dewatering system to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.

3.2 INSTALLATION

- A. Provide an adequate system to lower and control ground water to permit excavation, and placement of fill materials on dry subgrades.
 - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
- B. Dispose of water removed by dewatering in a manner that avoids endangering public health, property, and portions of work under construction or completed. Dispose of water in a manner that avoids inconvenience to others. Provide sumps, sedimentation tanks, and other flow-control devices as required by authorities having jurisdiction.
- C. Provide standby equipment on-site, installed and available for immediate operation, to maintain dewatering on continuous basis if any part of system becomes inadequate or fails. If dewatering requirements are not satisfied due to inadequacy or failure of dewatering system, restore damaged structures and foundation soils at no additional expense to Owner.
- D. Damages: Promptly repair damages to adjacent facilities caused by dewatering operations.

END OF SECTION

SECTION 31 50 00 - EXCAVATION SUPPORT AND PROTECTION

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes temporary excavation support and protection systems.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.

1.3 ACTION SUBMITTALS

- A. Shop Drawings: For excavation support and protection system, prepared by or under the supervision of a qualified professional engineer.
- B. Delegated-Design Submittal: For excavation support and protection systems, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For the following:
 - 1. Professional Engineer: Experience with providing delegated-design engineering services of the type indicated, including documentation that engineer is licensed in the state in which Project is located.
- B. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- C. Existing Conditions: Using photographs and video recordings, show existing conditions of adjacent construction and site improvements that might be misconstrued as damage caused by inadequate performance of excavation support and protection systems. Submit before Work begins.

1.5 CLOSEOUT SUBMITTALS

- A. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

1.6 FIELD CONDITIONS

- A. Interruption of Existing Utilities: Do not interrupt any utility-serving facilities occupied by Owner or others unless permitted under the following conditions and then only after arranging to provide temporary utility according to requirements indicated:

1. Notify Owner no fewer than three days in advance of proposed interruption of utility.
 2. Do not proceed with interruption of utility without Owner's written permission.
- B. Survey Work: Engage a qualified land surveyor or professional engineer to survey adjacent existing buildings, structures, and site improvements; establish exact elevations at fixed points to act as benchmarks. Clearly identify benchmarks, and record existing elevations.

PART 2 - PRODUCTS

2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, to design excavation support and protection systems to resist all lateral loading and surcharge, including but not limited to, retained soil, groundwater pressure, adjacent building loads, adjacent traffic loads, construction traffic loads, material stockpile loads, and seismic loads, based on the following:
1. Compliance with OSHA Standards and interpretations, 29 CFR 1926, Subpart P.
 2. Compliance with AASHTO Standard Specification for Highway Bridges or AASHTO LRFD Bridge Design Specification, Customary U.S. Units.
 3. Compliance with requirements of authorities having jurisdiction.
 4. Compliance with utility company requirements.
 5. Compliance with railroad requirements.

2.2 MATERIALS

- A. Provide materials that are either new or in serviceable condition.
- B. Structural Steel: ASTM A 36/A 36M, ASTM A 690/A 690M, or ASTM A 992/A 992M.
- C. Steel Sheet Piling: ASTM A 328/A 328M, ASTM A 572/A 572M, or ASTM A 690/A 690M; with continuous interlocks.
- D. Wood Lagging: Lumber, mixed hardwood, nominal rough thickness of size and strength required for application.
- E. Shotcrete: Comply with shotcrete materials and mixes, reinforcement, and shotcrete application.
- F. Cast-in-Place Concrete: ACI 301, of compressive strength required for application.
- G. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (Grade 420), deformed.
- H. Tiebacks: Steel bars, ASTM A 722/A 722M.
- I. Tiebacks: Steel strand, ASTM A 416/A 416M.

PART 3 - EXECUTION

3.1 INSTALLATION - GENERAL

- A. Locate excavation support and protection systems clear of permanent construction, so that construction and finishing of other work is not impeded.
- B. Install excavation support and protection systems to ensure minimum interference with roads, streets, walks, and other adjacent occupied and used facilities.
 - 1. Do not close or obstruct streets, walks, or other adjacent occupied or used facilities without permission from Owner and authorities having jurisdiction.
 - 2. Provide alternate routes around closed or obstructed traffic ways if required by authorities having jurisdiction.
- C. Install excavation support and protection systems without damaging existing buildings, structures, and site improvements adjacent to excavation.

3.2 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation.
 - 1. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement.
 - 2. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging.
 - 3. Accurately align exposed faces of flanges to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- B. Install wood lagging within flanges of soldier piles as excavation proceeds.
 - 1. Trim excavation as required to install lagging.
 - 2. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

3.3 SHEET PILING

- A. Before starting excavation, install one-piece sheet piling lengths and tightly interlock vertical edges to form a continuous barrier.
- B. Accurately place the piling using templates and guide frames unless otherwise recommended in writing by the sheet piling manufacturer.
 - 1. Limit vertical offset of adjacent sheet piling to 60 inches.
 - 2. Accurately align exposed faces of sheet piling to vary not more than 2 inches from a horizontal line and not more than 1:120 out of vertical alignment.
- C. Cut tops of sheet piling to uniform elevation at top of excavation.

3.4 TIEBACKS

- A. Drill, install, grout, and tension tiebacks.
- B. Test load-carrying capacity of each tieback, and replace and retest deficient tiebacks.
 - 1. Have test loading observed by a qualified professional engineer responsible for design of excavation support and protection system.

- C. Maintain tiebacks in place until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.5 BRACING

- A. Locate bracing to clear columns, floor framing construction, and other permanent work. If necessary to move brace, install new bracing before removing original brace.
 - 1. Do not place bracing where it will be cast into or included in permanent concrete work unless otherwise approved by Architect.
 - 2. Install internal bracing if required to prevent spreading or distortion of braced frames.
 - 3. Maintain bracing until structural elements are supported by other bracing or until permanent construction is able to withstand lateral earth and hydrostatic pressures.

3.6 MAINTENANCE

- A. Monitor and maintain excavation support and protection system.
- B. Prevent surface water from entering excavations by grading, dikes, or other means.
- C. Continuously monitor vibrations, settlements, and movements to ensure stability of excavations and constructed slopes and to ensure that damage to permanent structures is prevented.

3.7 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during installation of excavation support and protection systems, excavation progress, and for as long as excavation remains open.
 - 1. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions.
 - 2. Promptly notify Architect if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.
- B. Promptly correct detected bulges, breakage, or other evidence of movement to ensure that excavation support and protection system remains stable.
- C. Promptly repair damages to adjacent facilities caused by installation or faulty performance of excavation support and protection systems.

3.8 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures.
 - 1. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
 - 2. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction, and abandon remainder.
 - 3. Fill voids immediately with approved backfill compacted to density specified in Section 312000 "Earth Moving."

4. Repair or replace, as approved by Design Professional, adjacent work damaged or displaced by removing excavation support and protection systems.
- B. Leave excavation support and protection systems permanently in place.

END OF SECTION

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SECTION 31 61 00 - FOOTINGS

PART 1 - GENERAL

1.1 SCOPE

The work covered by this Section shall include all labor, material, equipment, permits, engineering and other services necessary for the fabrication and installation of footings and related work, complete, in accordance with the Drawings and as specified herein.

1.2 RELATED WORK SPECIFIED IN OTHER SECTIONS

Submittals	Division 1
Quality Control	Division 1
Quality Assurance: Structural Testing and Inspection	Section 014500
Concrete Reinforcement and Embedded Assemblies	Section 032000
Cast-In-Place Concrete	Section 033000
Thermal and Moisture Protection	Division 7

1.3 CODES AND STANDARDS

- A. Building Code: Footing work shall conform to the requirements of the Building Code identified on the structural General Notes, and OSHA requirements, except where more stringent conditions or criteria occur in the standards referenced below and on the Drawings.
- B. Standards:
1. ACI 117 – Standard Specifications for Tolerances for Concrete Construction and Materials.
 2. ACI 301 – Standard Specifications for Structural Concrete.
 3. ACI 315 – Details and Detailing of Concrete Reinforcement.
 4. ACI 318 – Building Code Requirements for Reinforced Concrete.
 5. American Concrete Institute “Manual of Concrete Practice”, various committee reports as referenced herein.
 6. American Society for Testing and Materials "ASTM Standards in Building Codes", various standards as referenced herein.
 7. AWS D1.4 – Structural Welding Code-Reinforcing Steel.
- C. Definitions:
1. See Section 033000.

2. The term Owner's Geotechnical Engineer in this Specification is defined as the Owner's representative specifically authorized to perform the responsibilities defined herein.

1.4 CONTRACTOR QUALIFICATIONS

- A. The Footing Installer shall be a company which specializes in installing footings, with a minimum of 10 years of documented successful experience. Installation shall be performed by skilled workmen thoroughly experienced in the necessary execution.
- B. The Contractor's Field Supervisor shall have 10 years of experience in installing footings and provide full-time supervision.
- C. The Contractor's Professional Surveyor shall have 10 years of previous experience in laying out foundation locations to perform surveys, layouts, and measurements for footing work. The Contractor's Professional Surveyor shall be licensed in the state where the project is located. Conduct layout work for each footing to lines and levels required before excavation, and actual measurements of each footing's horizontal location, top elevations, deviations from specified tolerances, and other required data.

1.5 SUBMITTALS

- A. Required Submittals - Where the SUBMITTALS section of this Specification is in conflict with Division 1 Submittals, the more stringent requirements for the Contractor apply. Required submittal items are listed here; see below for detailed requirements. Do not submit items not requested.
 - a) Submittal Schedule
 - b) Footing Construction Methods
 - c) Installer Qualifications
 - d) Shop drawings
 - e) Construction Log
 - f) Contractor's Survey Report
 - g) Submittals required by Related Documents
 - h) Mill Certificates
 - i) Owner's Concrete Testing Agency Reports
 - j) Product Data
1. **Submittal Schedule:** See Section 033000.
2. **Footing Construction Methods:** Submit for record, footing construction procedures developed by the Footing Contractor.

3. **Installer Qualifications:** Submit proof of qualifications as stated in the CONTRACTOR QUALIFICATIONS section of this Specification.
4. Shop drawings in accordance with 032000 and 033000, and as noted.
 - a. Concrete mix designs in accordance with Section 033000.
 - b. Footing reinforcement in accordance with Section 032000 and 033000.
 - c. Footing layout drawing showing the location of each footing (with respect to building gridlines), size and depth of footing, and top of footing elevation.
5. **Construction Log:** Testing Agency shall document, sign, and submit for record, a record of each footing construction, including:
 - a. Footing designation, top and where possible bottom elevation, and size of footing.
 - b. Size, length, and location of installed reinforcement.
 - c. Deviation of centerline plan location.
 - d. Actual allowable soil bearing capacity
 - e. Inspection and testing
 - f. Method of concrete placement, time of beginning and ending concrete discharge for each truck, (including any delays in concreting and location of construction joints in shafts) and any deviation from planned construction methods.
 - g. Volume of concrete supplied to footing and ratio of actual volume to theoretical volume.
6. **Contractor's Survey Report:** Submit for record plans sealed and signed by a Professional Surveyor licensed in the state where the project is located, indicating as built plan locations of footing centerlines (with respect to building gridlines), top and where possible bottom elevations, and identifying deviations of footing centerlines from design plan locations. Footings that are outside of specified tolerances shall be specifically identified on the plan.
7. Submittals required by Related Documents.
8. **Mill Certificates:** Per Specification section 032000, submit for record certified reports for physical and chemical properties of following materials:
 - a. Reinforcement bars.
9. Owner's Concrete Testing Agency Reports: Submit for record
 - a. Reports of field observations.
 - b. Reports of field quality control tests, as related to concrete and reinforcement.

c. Immediately notify the Design Professionals of any deviations from the Drawings.

10. **Product Data:** Submit for record for each type of product identified in Part 2. Product Data shall be clearly marked to indicate all technical information which specifies full compliance with this section and Contract Documents, including published installation instructions and ICC reports, where applicable, for products of each manufacturer specified in this section.

- B. Submittal Process: See Section 033000.
- C. SER Submittal Review: See Section 033000.
- D. Substitution Request: See Section 033000.
- E. Request for Information (RFI): See Section 033000.

1.6 DELIVERY, STORAGE, AND HANDLING

- A. See Sections 032000 and 033000.

1.7 PRE-INSTALLATION CONFERENCE

- A. Conduct meeting at Project Site to comply with requirements in Division 1.

1.8 PROJECT SITE CONDITIONS

- A. Geotechnical Information: Contractor to examine site, records of test borings, soil samples, and Geotechnical Reports that are available from the Owner. Soil boring test results are provided by the Owner for information, and are not guaranteed to represent conditions that are present at footing locations. Soil boring test results are not intended as representations or warranties of the continuity of the reported conditions. It is expressly understood that the Owner will not be responsible for interpretation or conclusions drawn by Contractor from the Geotechnical Report. At no additional cost to the Owner, evaluate the available data and provide additional test borings and other investigations as necessary for installing footings.
- B. Site Survey: Survey of site, existing utilities, and existing construction available from the Owner represent conditions known to Owner. Other obstructions may be encountered.

1.9 QUALITY ASSURANCE BY OWNER'S TESTING AGENCY

- A. See Section 014500.

1.10 QUALITY CONTROL BY CONTRACTOR

- A. See Section 033000.
- B. The Contractor's Geotechnical Engineer shall be qualified to perform the type of work required by the Project. The Engineer shall be a Licensed **Geotechnical** Engineer in the state where the

project is located. The engineer shall develop a site dewatering plan and advise on footing construction techniques, including assistance in the development of construction procedures and the development of solutions to construction problems.

1.11 OBSERVATIONS AND CORRECTIONS BY DESIGN PROFESSIONALS

- A. See Section 033000.

1.12 PERMITS AND WARRANTY

- A. Permits: See Section 033000.
- B. Drawings and calculations prepared by the Contractor's Licensed **Structural** Engineer in the state where the project is located for temporary shoring and/or earth retention shall be submitted to the City, State, or other governing authority for review.
- C. Warranty: See Section 033000.

PART 2 - PRODUCTS

2.1 CONCRETE

- A. See Section 033000.

2.2 REINFORCEMENT

- A. See Section 032000.

PART 3 - EXECUTION

3.1 PROTECTION OF EXISTING UTILITIES AND STRUCTURES

- A. Before installing footings adjacent to known existing utilities, notify utility owner to ensure that protective work will be coordinated and performed by Contractor in accordance with requirements of the owner of utility or building. If any existing service lines, utilities, and utility structures to remain in service are uncovered or encountered during work, protect the uncovered element from damage and provide support where necessary.
- B. Should uncharted or incorrectly charted piping or other utilities be encountered during footing excavation, immediately notify the Owner, Design Professionals and utility owner. Cooperate with Owner and utility owner in keeping their respective services, utilities and facilities in operation. Repair damaged utilities to entire satisfaction of Owner and utility owner concerned.

- C. Do not interrupt existing utility service facilities occupied and used by Owner and others, except when permitted in writing by the Design Professionals and then only after acceptable temporary utility services have been provided.
- D. Protect structures, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, vibration, and other hazards created by footing operations.

3.2 SITE DEWATERING

- A. Before installing footings, provide site dewatering based on the Contractor's site dewatering plan.
- B. Provide and maintain pumping equipment to keep excavations free of water before placing concrete. If excessive water is encountered and drilling operations must be halted, consult the Geotechnical Engineer before using alternate methods of construction.
- C. If excessive seepage is coming in from below the bottom of the footing excavation, removal by pumping within the excavation is inappropriate, as this may loosen the bearing soils and reduce the bearing soil capacity; therefore, an alternate means of dewatering will be required.

3.3 GENERAL FOOTING EXCAVATION

- A. Tolerances: Plan location tolerance is 2% of footing dimension but no greater than 2 inches (50 mm), whichever is greater, If indicated tolerances are exceeded, see "Footing Corrective Measures" in Part 3.
- B. Forming Sides of Footings:
 - 1. Provide forms for footings and grade beams if soil or other conditions are such that earth trench forms are unsuitable.
 - 2. When trench forms are used, provide an additional 1" (25 mm) of concrete on each side of the minimum design profiles and dimensions indicated.
 - 3. Earth forming of concrete elements is not acceptable.
- C. Cleanup of Footing Bottom: Excavate bottom to a level plane. Remove loose materials or free water as determined by Owner's Geotechnical Engineer.
- D. Bottom of adjacent footings that are at different elevations should never result in an excavation slope between footings greater than 1.0 vertical to 1.5 horizontal unless otherwise noted in the drawings or geotechnical engineering report. If steeper slopes occur, the EOR should be notified before any concrete is placed.

3.4 ADDITIONAL EXCAVATION AND FOOTING DEPTH

- A. Do not excavate below elevations noted by Owner's Geotechnical Engineer without prior review by Owner's Geotechnical Engineer.

- B. Where Owner's Geotechnical Engineer determines that soil encountered at design bearing elevation is not capable of providing minimum design bearing capacity, perform additional excavation as recommended by Owner's Geotechnical Engineer.
- C. If obstructions are encountered that interfere with new construction, remove such existing elements or develop corrective methods. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. Efforts shall be made to address obstructions at no additional cost to the Owner.

3.5 DISPOSAL OF EXCAVATED MATERIALS

Dispose excavated materials off site in a manner that will not interfere with other construction activities. Keep construction site at all times clean and free of soil and other debris that could affect progress of other construction activities.

3.6 FOOTING REINFORCEMENT

- A. Fabrication in accordance with 032000 from approved shop drawings.

3.7 FOOTING BEARING STRATA

- A. Footing Bearing Stratum Criteria and Verification
 1. Footings shall be founded on soil strata with bearing capacity indicated on Drawings. Footings shall not be excavated until test results by Owner's Geotechnical Engineer confirm allowable bearing values indicated on Drawings, but shall be excavated immediately thereafter.
 2. Each footing bearing strata must be inspected and be acceptable to the Owner's Geotechnical Engineer before placing concrete
 3. Footing excavations to acceptable bearing strata shall not be left exposed to weather for more than 48 hours before footing concrete is placed.
 4. At no time before or after footing concrete is placed shall the soil below the footing be allowed to freeze. Adequate freeze protection must be sufficient depth to provide adequate frost protection per the geotechnical engineering report.

3.8 CORRECTIVE MEASURES

- A. If unforeseen field conditions require corrective installation methods, immediately notify the Design Professionals.
 1. Where a change to the construction installation method result in an as-built footing in compliance with the Contract Documents, submit installation method for record.

2. Where the as-built footing does not meet the design intent of the Contract Documents. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals.
 - B. If footings are installed outside allowable tolerances, develop and provide corrective methods at no extra cost to the Owner including calculations based on actual locations of footings, taking into account eccentricity between final centerline of footing and design location of column centerline. The Contractor shall propose corrective actions and their recommendations in writing and submit them for review by the Design Professionals. Calculations shall be sealed and signed by a **Structural** Engineer licensed in the state where the project is located.
 - C. Where the Contractor requests that the Design Professionals develop the corrective actions or review corrective actions developed by others, the Design Professional shall be compensated as outlined in Part 3 – CORRECTIVE MEASURES section of Specification 033000.

END OF SECTION

SECTION 31 66 16 - SOIL NAIL WALL

PART 1 - GENERAL

1.1 SECTION INCLUDES

- A. The work specified in this Section includes the design, furnishing, and installation of permanent earth retention systems shown on the contract drawings for excavations consisting of soil nail and shotcrete wall. In addition, work also includes any temporary soil nail systems required for construction that are required in addition to the permanent system. The design of the temporary soil nail systems shall be part of the contractor's responsibility. The support of excavation system shall be constructed in accordance with this specification and detailed design drawings.
- B. All soil nails required for the permanent earth retention system shown on the drawings and shall incorporate Class I corrosion in accordance with PTI
- C. Adjacent structures are those that are within a distance equal to twice the total depth of the excavation away from the closest edge of the excavation.
- D. Instrumentation to monitor the performance of the earth retention system shall be contractor's responsibility.

1.2 RELATED SPECIFICATIONS

- A. Section 31 20 00: Earth Moving
- B. Section 03 37 13: Shotcrete

1.3 REFERENCES

- A. American Society for Testing and Materials (ASTM):
 - 1. Standard Specification for Structural Steel
 - 2. A416: Specification for Uncoated Seven-Wire Stress-Relieved Steel Strand for Prestressed Concrete
 - 3. A615: Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement
 - 4. Grout: To be determined
- B. American Wood-Preserves Association (AWPA) Standards.
- C. American Welding Society (AWS) Code: DI.1.
- D. Federal Standard, FS TT-W-S71: Wood Preservation and Treating Practices.

- E. OSHA Standards and Interpretations: Subpart P - Excavations, Trenching, and Shoring.
- F. American Concrete Institute (ACI)
 - 1. ACI 304: Recommended Practice for Measuring, Mixing, Transporting and Placing Concrete.

1.4 SYSTEM DESCRIPTION

- A. The earth retention system provided under this Detailed Specification shall include vertical permanent and temporary soil nails and shotcrete wall to allow an open excavation suitable for the construction of the structures, utilities and pipes planned as part of the general contract.
- B. The earth retention system shall safely support all earth loads, water loads, equipment loads, foundation loads from adjacent structures and foreseeable surcharge loads.
- C. The earth retention system shall be installed such that no movement to adjacent structures occurs during drilling and installing any of soil nails and shotcrete wall
- D. The earth retention system shall allow drainage of groundwater during excavation and temporary construction conditions through the wall without loss of soil.
- E. The earth retention system shall allow additional safe excavation as required by the future building contract.

1.5 DESIGN REQUIREMENTS

- A. The Contractor shall engage the services of a geotechnical engineer licensed in the state of Missouri to design the permanent earth retention system. The permanent earth retention system shall be designed to safely retain all lateral earth pressures provided by owner's geotechnical engineer, loads from adjacent building and surcharge loads provided on contract documents.
- B. The Contractor shall engage the services of a geotechnical engineer to design the temporary earth retention system required for construction. The temporary earth retention system, if required, shall be designed to safely retain all anticipated loads. The temporary soldier piles and bracing shall not interfere with any of the permanent earth retention system.

1.6 SUBMITTALS

- A. In accordance with the procedures and requirements set forth in Article 4 of the General Conditions and in applicable provisions of Division 1 – General Requirements, the Contractor shall submit the following:

1. All qualifications as listed below. Include with all job/project references the name of the project and the names, current addresses and telephone numbers, of persons in charge of representing the owner or the owner at the time of excavation.
 - a. Earth Retention System Designer's qualifications.
 - b. Soil Nail installer's qualifications.
 - c. Contractor's independent soil nail testing firm's qualifications.
 - d. Earth retention system supervisor's qualifications.
2. List of all applicable laws, regulations, rules, and codes to which earth retention system design conforms.
3. Shop Drawings:
 - a. Show proposed permanent earth excavation support system(s), location and extent of differing types of support relative to existing features and structures and the permanent structures to be constructed.
 - b. Elevations, sections and profiles showing temporary bracing levels, bearing elevations, maximum excavation levels, and soil nail layout (spacing, angle, lengths, capacity).
 - c. Construction details of the permanent and temporary bracing system including materials, sizes, dimensions, connections and methods and sequence of installation and removal.
 - d. Monitoring schedule, installation procedures and location plans for geotechnical instrumentation and observation wells, to monitor ground, earth retention, and adjacent structure movements.
4. Complete Calculations to demonstrate that the permanent earth support systems will limit movement to the specified limits and support loads. Calculations shall include, but not limited to, the following:
 - a. Narrative description of system.
 - b. Design criteria.
 - c. Design notes including an explanation of symbols and computer programs used in the design.
 - d. Structural design calculation for shotcrete wall facing, including consideration for facing wall flexural and punching shear strength, headed stud tensile strength, upper cantilever, minimum reinforcement ratio, cover.
 - e. Other design calculations: Other items may include drainage evaluation and items not considered above.

5. Construction Contingency Plan specifying the methods and procedures to maintain earth retention system stability if tolerable movements are exceeded.
6. Sequence of installation and removal of any temporary earth retention system required in conjunction with excavation, backfilling and concrete placement.
7. Design lateral pressures used.
8. Soil Nail installation:
 - a. Description of equipment to be used for Soil nail installation, including grouting, testing and load transfer.
 - b. Tabulations of data for each soil nail to include: identification; location; dates of initial drilling, grouting testing, and final lock-off;; ; grouting pressures and any unusual events.
 - c. Results of soil nail testing.

1.7 QUALITY ASSURANCE AND QUALIFICATIONS

- A. Conform to the requirements of the OSHA Standards and Interpretations: "Subpart P - Excavation, Trenching, and Shoring".
- B. Prepare design, including calculations and drawings, under the direction of a Missouri Registered Professional Engineer.
- C. Qualifications of Earth Retention System Designer:
 1. Shall be a State of Missouri Registered Professional Engineer specializing in geotechnical construction.
 2. Shall have a minimum of ten (10) years' experience in the design of specific earth retention systems to be used.
 3. Shall have completed a minimum of five (5) successful earth retention system projects of equal type, size, and complexity.
- D. Earth Retention System Designer shall stamp and sign all earth retention system calculations, details, and drawings.
- E. Soil Nail Installer's Qualifications:
 1. Shall have a minimum of three (3) years experience in the installation of tieback systems of similar type and equal complexity as the proposed system.
 2. Shall have completed a minimum of three (3) successful soil nail systems of similar type and equal complexity as the proposed system.
- F. Work performed in the installation of earth retention systems without the Owner's Geotechnical Engineer being present will not be accepted. Remove and reinstall such rejected systems, at no additional cost to the City.

- G. Employ an independent testing laboratory to test the soil nail system with the following qualifications:
 - 1. Be accredited by the American Association of State Highway and Transportation Officials (AASHTO) Accreditation Program.
 - 2. Employ personnel conducting testing who are trained in the methods and procedures to test and monitor soil nail systems of similar type and equal complexity, as the proposed system.
 - 3. Shall have a minimum of five (5) years' experience in testing of soil nail systems of similar type and equal complexity as the proposed system.
 - 4. Shall have successfully tested a minimum of three (3) soil nail systems of similar type and equal complexity as the proposed system.
- H. Obtain and comply with all applicable permits, laws, regulations and codes.
- I. All welding shall be performed in accordance with AWS DI.1.

1.8 DELIVERY, STORAGE AND HANDLING

- A. Store structural steel and soil nail materials to prevent sagging which would produce permanent deformation. Keep concentrated loads which occur during stacking or lifting below the level which would produce permanent deformation of the material.

1.09 SITE CONDITIONS

- A. For boring logs, field and laboratory test results, refer to the Geotechnical Report appended to the Contract Documents.
- B. Locations of borings shall be as indicated.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Provide structural steel plates, and accessory steel shapes.
- B. Soil nails shall be T40/20 hollow bar with a minimum yield stress of 84.6 ksi.
- C. Cement grout materials and admixtures for tieback anchorages: Grout cube strength shall be a minimum 3500 psi at 7 days and 5000 psi at 28 days.
- D. Provide concrete in accordance with Detailed Specification 03 30 00 – Cast-in-Place Concrete when used for support of excavation.

- E. Provide shotcrete in accordance with specification 03 37 13 Shotcrete.
- F. Provide reinforcement in accordance with Detailed Specification 03 20 00 – Concrete Reinforcement

PART 3 - EXECUTION

3.1 GENERAL

- A. Carry out program of earth retention in such a manner as to prevent undermining or disturbing foundations of existing structures or of work ongoing or previously completed.
- B. Begin no excavation involving earth retention until the earth retention submittal has been accepted by the Engineer.
- C. Continuously monitor the performance of the system, including horizontal and vertical movement and groundwater levels. In the event measured wall movements approach or exceed the specified and indicated levels, take immediate steps to arrest further movement by revising procedures, providing supplementary bracing or other measures (Construction Contingency Plan) as required, at no additional cost to the Owner.
- D. A monitoring plan, including location of measurement points and the frequency of recording measurements shall be submitted to the Engineer as part of the construction Plan. Monitoring shall begin with a base-line measurement, a minimum of three (3) readings on three different days, recorded no less than 10 calendar days prior to construction of the wall. In addition to monitoring for movement, the condition of the adjacent structure, including cracks and crack widths, before and after construction of the wall, shall be documented by visual inspection, photographs, and/or video. Structures owned by Owner shall be monitored for movement. As soon as the movements measured exceed thresholds established for adjacent structures, the Contractor shall stop construction, notify the Engineer, and take any immediate remedial measures required to prevent damage to the adjacent structures. The Contractor and Earth Retention System Engineer shall then review the current installation procedures. If revisions to the installation procedures are deemed necessary, the Contractor shall submit a revised installation plan for approval by the Engineer before resuming work.
- E. Install and read geotechnical instrumentation in accordance with approved shop drawings. Cooperate fully with the Engineer in providing access to instrument locations. Notify the Engineer immediately if any geotechnical instrumentation is damaged. Repair or replace damaged geotechnical instrumentation at the sole option of the Engineer and at no additional cost to the Owner
- F. Adoption of the indicated design or approval by the Engineer of the Contractor's design will in no way relieve the Contractor of responsibility for the successful performance of construction or any method of protection for adjoining property. Contractor shall bear the entire cost and responsibility of correcting any failure, damages, subsidence, upheaval or cave-ins as a result of improper installation, maintenance or design. Contractor shall pay for all claims, costs and damages that arise as a result of the work performed at no additional cost to the City. Protect all existing utilities affected by construction from damage.
- G. Expose active utilities by hand, where they lie within work area.

- H. Notify utility owners if existing utilities interfere with the earth retention system. Modify the existing utility with the utility owner's permission or have the utility owner make the modifications at no additional cost to Owner.

3.2 SOIL NAIL INSTALLATION

- A. Install soil nails in soil in accordance with approved shop drawings.
- B. Drill holes for soil nails at maximum spacing of 5' feet oc or as required to engineering analysis and advance to lengths required.
- C. Drill equipment shall be suitable for the strata encountered. Drilling may be accomplished by rotary or percussion methods. The method selected shall not cause cavitation or subsidence of the soils in and around the site.
- D. Confirm alignment and location of soil nail is within tolerance.
- E. The grouting equipment shall include a mixer capable of producing a grout free of lumps and undispersed cement. The grout pump shall be equipped with a pressure gauge to monitor grout pressures. The grouting equipment shall be sized to enable the entire soil nail anchor to be grouted in one continuous operation. Grout shall be screened to removed lumps. The maximum size of the screen openings shall be 0.25 inches. Mixing and storage times shall not cause excessive temperature build up in the grout. The mixer shall be capable of continuously agitating the grout.
- F. Soil nails shall be grouted for the total length of the nails as required by engineering analysis and shown on the approved shop drawings.
- G. When the grout has attained the minimum compressive strength, load test the soil nails in accordance with section 3.07.

3.3 ALLOWABLE GROUND DEFORMATION

- A. Notify the Engineer when the following hazard warning levels are exceeded:
 - 1. Vertical movement (heave/settlement): 1/2 inch.
 - 2. Lateral movement (walls): 1/2 inch.
- B. Monitoring personnel shall use a procedure for reading and recording geotechnical instrumentation data which compares the current reading to the last reading during data collection to avoid mis-readings.
- C. Plot the observed ground deformation readings versus time. Annotate the plots with construction loading and excavation events having an impact on the readings. Evaluate plots by means of secondary rate-of-change plots to provide early warning of accelerating ground movements.
- D. Implement Construction Contingency Plan under direction of the earth retention system designer and Engineer.

3.4 ALLOWABLE VIBRATION

- A. Peak particle velocity measured at the nearest structure construction activities that cause noticeable ground vibrations shall not exceed 1/2 in./sec.

3.5 TESTS AND INSPECTIONS

- A. SOIL NAILS:

1. If soil nails are used, perform the number of on-site tests as specified below to demonstrate the performance of tiebacks.
2. Install instruments to monitor the performance of the tieback system.
3. Perform the performance tests described below initially on a minimum of four (4) tiebacks selected by the Engineer for each system design to verify the tieback design. Thereafter perform such performance tests on five (5) percent of all tiebacks installed, as selected by the Engineer. Tiebacks grouted into different soil strata or rock will be considered a different design.

a. Verification Tests:

Conduct verification tests by incrementally loading and unloading the soil nail in accordance with the following sequence. At each load increment, record the movement of the end of the soil nail along the axis of the soil nail with a micrometer dial reading to 0.001 inch. A minimum of 5% of all soil nails shall be verification tested, the remainder of the soil nails shall be proof tested in accordance with section 4 below.

<u>Load Increment (% of Design Load)</u>	<u>Hold Period</u>
0.05	1 Min
0.25	10 Min
0.5	10 Min
0.75	10 Min
1.0	10 Min
1.25	10 Min
1.5	60 Min
1.75	10 Min
2.0	10 Min
2.25	10 Min
2.5	10 Min
2.75	20 Min
3.0	10 Min

4. Perform proof tests on each soil nail not otherwise verification tested by incrementally loading the tieback in accordance with sequence listed below. The creep period shall start as long as the 1.33 test load is applied, and the nail movement shall be measured and recorded at 1, 2, 3, 5, 6, and 10 Minutes. Where the nail movement between 1 minute and 10 minute exceeds 0.04 inches, maintain the maximum test load for an additional 50 minutes, and record movements at 20 min, 30, 50, and 60 minutes. Maintain all load increments within 5% of the intended load.

<u>Load Increment (% of Design Load)</u>	<u>Hold Period</u>
0.05	Until Stabilized
0.25	Until Stabilized
0.5	Until Stabilized
0.75	Until Stabilized
1.0	Until Stabilized
1.25	Until Stabilized
1..33	Creep

5. Criteria for acceptance of soil nails for verification and proof tests will be based on the following:
 - a. Rate of movement at 1.33 DL load increment has stabilized to less than 0.004 inches in the last five (5) minutes.
 - b. Measured extension at 1.33 DL shall exceed eighty (80) percent of the theoretical elastic elongation of the unbonded length and shall be less than the theoretical elastic elongation of unbonded length plus fifty (50) percent of the bonded length.
 - c. The creep amount shall not exceed 0.04 inches at test load during the period of 1 to 10 minutes. If this value is exceeded, then the total creep movement within the period of 6 to 60 minutes shall not exceed 0.08 inches.
6. Perform all testing in the presence of Owner's Geotechnical Engineer. Testing performed without the Engineer present will not be accepted. Repeat testing in the Owner's Geotechnical Engineer's presence at no additional cost.
7. Perform additional tests when any changes are made in the soil nail assembly or installation procedures at no additional cost.

END OF SECTION

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SECTION 32 12 16 - ASPHALT PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Hot-mix asphalt paving.
 - 2. Asphalt traffic-calming devices.
 - 3. Asphalt surface treatments.
- B. Related Requirements:
 - 1. Section 312000 "Earth Moving" for subgrade preparation, fill material, unbound-aggregate subbase and base courses, and aggregate pavement shoulders.

1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site.
 - 1. Review methods and procedures related to hot-mix asphalt paving including, but not limited to, the following:
 - a. Review proposed sources of paving materials, including capabilities and location of plant that will manufacture hot-mix asphalt.
 - b. Review requirements for protecting paving work, including restriction of traffic during installation period and for remainder of construction period.

1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
 - 1. Include technical data and tested physical and performance properties.
 - 2. Job-Mix Designs: Certification, by authorities having jurisdiction, of approval of each job mix proposed for the Work.
 - 3. Job-Mix Designs: For each job mix proposed for the Work.

1.4 QUALITY ASSURANCE

- A. Manufacturer Qualifications: A paving-mix manufacturer registered with and approved by authorities having jurisdiction or Missouri Department of Transportation (MoDOT).
- B. Testing Agency Qualifications: Qualified according to ASTM D 3666 for testing indicated.
- C. Regulatory Requirements: Comply with materials, workmanship, and other applicable requirements of MoDOT for asphalt paving work.
 - 1. Measurement and payment provisions and safety program submittals included in standard specifications do not apply to this Section.

1.5 FIELD CONDITIONS

- A. Environmental Limitations: Do not apply asphalt materials if subgrade is wet or excessively damp, if rain is imminent or expected before time required for adequate cure, or if the following conditions are not met:
1. Prime Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
 2. Tack Coat: Minimum surface temperature of 60 deg F (15.6 deg C).
 3. Slurry Coat: Comply with weather limitations in ASTM D 3910.
 4. Asphalt Base Course: Minimum surface temperature of 40 deg F (4.4 deg C) and rising at time of placement.
 5. Asphalt Surface Course: Minimum surface temperature of 60 deg F (15.6 deg C) at time of placement.

PART 2 - PRODUCTS

2.1 AGGREGATES

- A. Aggregate base for asphaltic pavements shall be a granular compacted crushed limestone with a gradation and quality conforming to the requirements of MoDOT Standard Specification 1007 for either Type 1 or Type 5 aggregate.
- B. The maximum lift thickness for granular base shall be 4 inches.
- C. Granular base thickness in excess of 4 inches shall be placed in multiple lifts with each lift being of approximate equal thickness.
- D. Granular base shall be compacted to at least 100% of Standard Proctor Compaction (ASTM D-698)
- E. Coarse Aggregate: Comply with MoDOT Standard Specification for Highway Construction, Division 400.
- F. Fine Aggregate: Comply with MoDOT Standard Specification for Highway Construction, Division 400.
- G. Mineral Filler: ASTM D 242, rock or slag dust, hydraulic cement, or other inert material.

2.2 ASPHALT MATERIALS

- A. Asphalt Binder: AASHTO M 320, PG 64-22.
- B. Asphalt Cement: ASTM D 946/D 946M for penetration-graded material.
- C. Cutback Prime Coat: ASTM D 2027, medium-curing cutback asphalt, MC-30 or MC-70.
- D. Tack Coat: ASTM D 977 emulsified asphalt, slow setting, diluted in water, of suitable grade and consistency for application.
- E. Water: Potable.
- F. Undersealing Asphalt: ASTM D 3141/D 3141M; pumping consistency.

2.3 MIXES

- A. Hot-Mix Asphalt: Dense-graded, hot-laid, hot-mix asphalt plant mixes approved by MoDOT; and complying with the following requirements:
 - 1. Provide mixes with a history of satisfactory performance in geographical area where Project is located.
 - 2. Base Course: Comply with MoDOT Standard Specification for Highway Construction, Section 401, BP-1.
 - a. Thickness: As shown in drawing.
 - 3. Surface Course: Comply with MoDOT Standard Specification for Highway Construction, Section 401, BP-2.
 - a. Thickness: As shown in drawing.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verify that subgrade is dry and in suitable condition to begin paving.
- B. Proof-roll subgrade below pavements with heavy pneumatic-tired equipment to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
 - 1. Completely proof-roll subgrade in one direction, repeating proof-rolling in direction perpendicular to first direction. Limit vehicle speed to 3 mph (5 km/h).
 - 2. Proof roll with a loaded 10-wheel, tandem-axle dump truck weighing not less than 15 tons (13.6 tonnes).
 - 3. Excavate soft spots, unsatisfactory soils, and areas of excessive pumping or rutting, as determined by Testing Agency, and replace with compacted backfill or fill as directed.
- C. Proceed with paving only after unsatisfactory conditions have been corrected.

3.2 SURFACE PREPARATION

- A. General: Immediately before placing asphalt materials, remove loose and deleterious material from substrate surfaces. Ensure that prepared subgrade is ready to receive paving.
- B. Cutback Prime Coat: Apply uniformly over surface of compacted unbound-aggregate base course at a rate of 0.15 to 0.50 gal./sq. yd. (0.7 to 2.3 L/sq. m). Apply enough material to penetrate and seal, but not flood, surface. Allow prime coat to cure.
 - 1. If prime coat is not entirely absorbed within 24 hours after application, spread sand over surface to blot excess asphalt. Use enough sand to prevent pickup under traffic. Remove loose sand by sweeping before pavement is placed and after volatiles have evaporated.
 - 2. Protect primed substrate from damage until ready to receive paving.
- C. Tack Coat: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m).
 - 1. Allow tack coat to cure undisturbed before applying hot-mix asphalt paving.
 - 2. Avoid smearing or staining adjoining surfaces, appurtenances, and surroundings. Remove spillages and clean affected surfaces.

3.3 PLACING HOT-MIX ASPHALT

- A. Machine place hot-mix asphalt on prepared surface, spread uniformly, and strike off. Place asphalt mix by hand in areas inaccessible to equipment in a manner that prevents segregation of mix. Place each course to required grade, cross section, and thickness when compacted.
 - 1. Place hot-mix asphalt base course in number of lifts and thicknesses indicated.
 - 2. Place hot-mix asphalt surface course in single lift.
 - 3. Spread mix at a minimum temperature of 250 deg F (121 deg C).
 - 4. Begin applying mix along centerline of crown for crowned sections and on high side of one-way slopes unless otherwise indicated.
 - 5. Regulate paver machine speed to obtain smooth, continuous surface free of pulls and tears in asphalt-paving mat.

- B. Place paving in consecutive strips not less than 10 feet (3 m) wide unless infill edge strips of a lesser width are required.
 - 1. After first strip has been placed and rolled, place succeeding strips and extend rolling to overlap previous strips. Overlap mix placement about 1 to 1-1/2 inches (25 to 38 mm) from strip to strip to ensure proper compaction of mix along longitudinal joints.
 - 2. Complete a section of asphalt base course before placing asphalt surface course.

- C. Promptly correct surface irregularities in paving course behind paver. Use suitable hand tools to remove excess material forming high spots. Fill depressions with hot-mix asphalt to prevent segregation of mix; use suitable hand tools to smooth surface.

3.4 JOINTS

- A. Construct joints to ensure a continuous bond between adjoining paving sections. Construct joints free of depressions, with same texture and smoothness as other sections of hot-mix asphalt course.
 - 1. Clean contact surfaces and apply tack coat to joints.
 - 2. Offset longitudinal joints, in successive courses, a minimum of 6 inches (150 mm).
 - 3. Offset transverse joints, in successive courses, a minimum of 24 inches (600 mm).
 - 4. Construct transverse joints at each point where paver ends a day's work and resumes work at a subsequent time. Construct these joints using either "bulkhead" or "papered" method according to AI MS-22, for both "Ending a Lane" and "Resumption of Paving Operations."
 - 5. Compact joints as soon as hot-mix asphalt will bear roller weight without excessive displacement.
 - 6. Compact asphalt at joints to a density within 2 percent of specified course density.

3.5 COMPACTION

- A. General: Begin compaction as soon as placed hot-mix paving will bear roller weight without excessive displacement. Compact hot-mix paving with hot, hand tampers or with vibratory-plate compactors in areas inaccessible to rollers.
 - 1. Complete compaction before mix temperature cools to 185 deg F (85 deg C).

- B. Breakdown Rolling: Complete breakdown or initial rolling immediately after rolling joints and outside edge. Examine surface immediately after breakdown rolling for indicated crown, grade, and smoothness. Correct laydown and rolling operations to comply with requirements.

- C. Intermediate Rolling: Begin intermediate rolling immediately after breakdown rolling while hot-mix asphalt is still hot enough to achieve specified density. Continue rolling until hot-mix asphalt course has been uniformly compacted to the following density:
 - 1. Average Density: 96 percent of reference laboratory density according to ASTM D 6927 or AASHTO T 245, but not less than 94 percent or greater than 100 percent.
 - 2. Average Density: 92 percent of reference maximum theoretical density according to ASTM D 2041, but not less than 90 percent or greater than 96 percent.
- D. Finish Rolling: Finish roll paved surfaces to remove roller marks while hot-mix asphalt is still warm.
- E. Edge Shaping: While surface is being compacted and finished, trim edges of pavement to proper alignment. Bevel edges while asphalt is still hot; compact thoroughly.
- F. Repairs: Remove paved areas that are defective or contaminated with foreign materials and replace with fresh, hot-mix asphalt. Compact by rolling to specified density and surface smoothness.
- G. Protection: After final rolling, do not permit vehicular traffic on pavement until it has cooled and hardened.
- H. Erect barricades to protect paving from traffic until mixture has cooled enough not to become marked.

3.6 ASPHALT TRAFFIC-CALMING DEVICES

- A. Construct hot-mix asphalt speed bumps, humps, cushions, and tables over compacted pavement surfaces. Apply a tack coat unless pavement surface is still tacky and free from dust. Spread mix at a minimum temperature of 250 deg F (121 deg C).
 - 1. Tack Coat Application: Apply uniformly to surfaces of existing pavement at a rate of 0.05 to 0.15 gal./sq. yd. (0.2 to 0.7 L/sq. m.)
 - 2. Asphalt Mix: Same as pavement surface-course mix.
 - 3. Before installation, mill pavement that will be in contact with bottom of traffic-calming device. Mill to a depth of 1 inch (25 mm) from top of pavement to a clean, rough profile.
- B. Place and compact hot-mix asphalt to cross section indicated, by machine or by hand in wood or metal forms. Tamp hand-placed materials and screed to smooth finish. Remove forms after hot-mix asphalt has cooled.

3.7 INSTALLATION TOLERANCES

- A. Pavement Thickness: Compact each course to produce the thickness indicated within the following tolerances:
 - 1. Base Course: Plus or minus 1/2 inch (13 mm).
 - 2. Surface Course: Plus 1/4 inch (6 mm), no minus.
- B. Pavement Surface Smoothness: Compact each course to produce a surface smoothness within the following tolerances as determined by using a 10-foot (3-m) straightedge applied transversely or longitudinally to paved areas:
 - 1. Base Course: 1/4 inch (6 mm).
 - 2. Surface Course: 1/8 inch (3 mm).

3. Crowned Surfaces: Test with crowned template centered and at right angle to crown. Maximum allowable variance from template is 1/4 inch (6 mm).
- C. Asphalt Traffic-Calming Devices: Compact and form asphalt to produce the contour indicated and within a tolerance of plus or minus 1/8 inch (3 mm) of height indicated above pavement surface.

3.8 FIELD QUALITY CONTROL

- A. Testing Agency: Owner will engage a qualified testing agency to perform tests and inspections.
- B. Thickness: In-place compacted thickness of hot-mix asphalt courses will be determined according to ASTM D 3549.
- C. Surface Smoothness: Finished surface of each hot-mix asphalt course will be tested for compliance with smoothness tolerances.
- D. Asphalt Traffic-Calming Devices: Finished height of traffic-calming devices above pavement will be measured for compliance with tolerances.
- E. In-Place Density: Testing agency will take samples of uncompacted paving mixtures and compacted pavement according to ASTM D 979 or AASHTO T 168.
 1. Reference maximum theoretical density will be determined by averaging results from four samples of hot-mix asphalt-paving mixture delivered daily to site, prepared according to ASTM D 2041, and compacted according to job-mix specifications.
 2. In-place density of compacted pavement will be determined by testing core samples according to ASTM D 1188 or ASTM D 2726.
 - a. One core sample will be taken for every 1000 sq. yd. (836 sq. m) or less of installed pavement, with no fewer than three cores taken.
 - b. Field density of in-place compacted pavement may also be determined by nuclear method according to ASTM D 2950 and correlated with ASTM D 1188 or ASTM D 2726.
- F. Replace and compact hot-mix asphalt where core tests were taken.
- G. Remove and replace or install additional hot-mix asphalt where test results or measurements indicate that it does not comply with specified requirements.

3.9 WASTE HANDLING

- A. General: Handle asphalt-paving waste according to approved waste management plan required in Section 017419 "Construction Waste Management and Disposal."

END OF SECTION

SECTION 32 13 13 - CONCRETE PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Driveways.
 - 2. Roadways.
 - 3. Parking lots.
 - 4. Curbs and gutters.
 - 5. Walks.

- B. Work in public right-of-way: All work in public right-of-way shall be performed per City Standards and Specifications.

1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product indicated.

- B. Samples: For each exposed product and for each color and texture specified.

- C. Other Action Submittals:
 - 1. Design Mixtures: For each concrete paving mixture. Include alternate design mixtures when characteristics of materials, Project conditions, weather, test results, or other circumstances warrant adjustments.
 - 2. Aggregates: Aggregates must be supplied from a source previously tested and certified by MoDOT as meeting "Aggregates for Concrete" requirements in Section 1005 of MoDOT Standard Specifications. Aggregate shall be sound and durable and meet ASTM C586.

1.3 QUALITY ASSURANCE

- A. Ready-Mix-Concrete Manufacturer Qualifications: A firm experienced in manufacturing ready-mixed concrete products and that complies with ASTM C 94/C 94M requirements for production facilities and equipment.

- B. ACI Publications: Comply with ACI 301 (ACI 301M) unless otherwise indicated.

PART 2 - PRODUCTS

2.1 STEEL REINFORCEMENT

- A. Epoxy-Coated Welded-Wire Reinforcement: ASTM A 884/A 884M, Class A, plain steel.

- B. Epoxy-Coated Reinforcing Bars: ASTM A 775/A 775M or ASTM A 934/A 934M; with ASTM A 615/A 615M, Grade 60 (Grade 420) deformed bars.
- C. Epoxy-Coated-Steel Wire: ASTM A 884/A 884M, Class A; coated, deformed.
- D. Epoxy-Coated, Joint Dowel Bars: ASTM A 775/A 775M; with ASTM A 615/A 615M, Grade 60 (Grade 420) plain-steel bars.
- E. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars, welded wire reinforcement, and dowels in place. Manufacture bar supports according to CRSI's "Manual of Standard Practice" from steel wire, plastic, or precast concrete of greater compressive strength than concrete specified.

2.2 CONCRETE MATERIALS AND MIXTURES

- A. Portland cement concrete shall conform to MoDOT 501 and 1005 with the following modifications:
 - 1. All portland cement concrete shall be air entrained with 6% (\pm 1%) minimum air content.
 - 2. The use of calcium chloride is not permitted.
 - 3. The allowable slump shall be not more than 4 inches.
 - 4. The minimum 28-day compressive strength shall be 4,000-psi.
 - 5. Aggregate:
 - a. The combined maximum weight of flint and chert shall be 1% of the weight of coarse aggregate.
 - b. The maximum weight of lignite shall be 0.07% of the weight of the fine aggregate.

2.3 CURING MATERIALS

- A. Clear, Waterborne, Membrane-Forming Curing Compound: ASTM C 309, Type 1, Class B, dissipating.

2.4 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber.

2.5 WHEEL STOPS

- A. Wheel Stops: Precast, air-entrained concrete.
 - 1. Dowels: Galvanized steel, 3/4 inch (19 mm) in diameter, 10-inch (254-mm) minimum length.
 - 2. Adhesive: As recommended by wheel stop manufacturer for application to concrete pavement.

PART 3 - EXECUTION

3.1 EXAMINATION AND PREPARATION

- A. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
- B. Remove loose material from compacted subbase surface immediately before placing concrete.
- C. Prior to concrete paving, Contractor shall prepare mockup for concrete pavement and sidewalks. Mockup to include a minimum of 100 square feet of paving. Mockup may be installed "in-place" and must demonstrate the proposed joint types, reinforcement, sealant, and saw-cutting. Prepare mockup for Owner review and approval, prior to concrete paving.

3.2 EDGE FORMS AND SCREED CONSTRUCTION

- A. Set, brace, and secure edge forms, bulkheads, and intermediate screed guides to required lines, grades, and elevations. Install forms to allow continuous progress of work and so forms can remain in place at least 24 hours after concrete placement.
- B. Clean forms after each use and coat with form-release agent to ensure separation from concrete without damage.

3.3 STEEL REINFORCEMENT

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.

3.4 JOINTS

- A. General: Form construction, isolation, and contraction joints and tool edges true to line, with faces perpendicular to surface plane of concrete. Construct transverse joints at right angles to centerline unless otherwise indicated.
- B. Construction Joints: Set construction joints at side and end terminations of paving and at locations where paving operations are stopped for more than one-half hour unless paving terminates at isolation joints.
- C. Isolation Joints: Form isolation joints of preformed joint-filler strips abutting concrete curbs, catch basins, manholes, inlets, structures, other fixed objects, and where indicated.
- D. Contraction Joints: Form weakened-plane contraction joints, sectioning concrete into areas as indicated. Construct contraction joints for a depth equal to at least one-fourth of the concrete thickness, to match jointing of existing adjacent concrete paving.
- E. Edging: After initial floating, tool edges of paving, gutters, curbs, and joints in concrete with an edging tool to a 1/4-inch (6-mm) radius. Repeat tooling of edges after applying surface finishes. Eliminate edging-tool marks on concrete surfaces.

3.5 CONCRETE PLACEMENT

- A. Moisten subbase to provide a uniform dampened condition at time concrete is placed.

- B. Comply with ACI 301 (ACI 301M) requirements for measuring, mixing, transporting, placing, and consolidating concrete.
- C. Deposit and spread concrete in a continuous operation between transverse joints. Do not push or drag concrete into place or use vibrators to move concrete into place.
- D. Screed paving surface with a straightedge and strike off.
- E. Commence initial floating using bull floats or darbies to impart an open-textured and uniform surface plane before excess moisture or bleed water appears on the surface. Do not further disturb concrete surfaces before beginning finishing operations or spreading surface treatments.

3.6 FLOAT FINISHING

- A. General: Do not add water to concrete surfaces during finishing operations.
- B. Float Finish: Begin the second floating operation when bleed-water sheen has disappeared and concrete surface has stiffened sufficiently to permit operations. Float surface with power-driven floats or by hand floating if area is small or inaccessible to power units. Finish surfaces to true planes. Cut down high spots and fill low spots. Refloat surface immediately to uniform granular texture.
 - 1. Medium-to-Fine-Textured Broom Finish: Draw a soft-bristle broom across float-finished concrete surface perpendicular to line of traffic to provide a uniform, fine-line texture.
 - 2. Medium-to-Coarse-Textured Broom Finish: Provide a coarse finish by striating float-finished concrete surface 1/16 to 1/8 inch (1.6 to 3 mm) deep with a stiff-bristled broom, perpendicular to line of traffic.

3.7 COLD AND HOT WEATHER CONCRETE PLACEMENT

- A. Cold Weather Concrete:
 - 1. Unless authorized in writing by the Engineer, mixing and concreting operations shall be discontinued when the descending air temperature in the shade and away from artificial heat reaches thirty-five (35°) degrees F. Concrete operations may be resumed when the ascending air temperature in the shade and away from artificial heat reaches thirty five (35°) degrees F.
 - 2. When concrete work is authorized during cold weather, the concrete may be heated in accordance with ACI specifications. The temperature of the concrete shall be not less than sixty (60°) degrees F and not more than eighty (80°) degrees F at the time of placement in the forms.
 - 3. No concrete shall be placed on frozen subgrade. Sudden cooling of concrete shall not be permitted. Concrete exposed to frost action or freezing weather shall be removed and replaced at the Contractor's expense.
 - 4. A sufficient supply of approved blanketing material shall be provided and placed on all concrete placed between November 1 and April 1 and at other times when the ambient air temperature is expected to drop below forty (40°) degrees F. Blanketing materials shall protect the concrete and maintain a minimum temperature of forty (40°) degrees F in the concrete as measured on the surface. Concrete shall be covered for at least four days.
- B. Hot Weather Concrete:

1. The provisions of this section shall apply to all concrete work, which is done when the air temperature is above eighty (80°) degrees F at the time of placement. The temperature of the concrete, when placed, shall not be high enough to cause excessive loss of slump, flash set or cold joints. Forms, reinforcing and sub-grade surfaces against which the concrete is to be placed shall be wetted down immediately before placement. In no case shall the temperature of the concrete, when placed, exceed ninety (90°) degrees F.
2. When the air temperature exceeds ninety (90°) degrees F and as soon as practicable without causing damage to the surface finish, all exposed concrete shall be kept continuously moist by means of fog sprays, wet burlap, cotton mats, or other means acceptable to the Engineer at no expense to the Owner. This cooling with water shall be in addition to the initial sealing by membrane curing compound.
3. No concrete shall be placed when the air temperature is above ninety-five (95°) degrees F.

3.8 CONCRETE PROTECTION AND CURING

- A. General: Protect freshly placed concrete from premature drying and excessive cold or hot temperatures.
- B. Comply with ACI 306.1 for cold-weather protection.
- C. Evaporation Retarder: Apply evaporation retarder to concrete surfaces if hot, dry, or windy conditions cause moisture loss approaching 0.2 lb/sq. ft. x h (1 kg/sq. m x h) before and during finishing operations. Apply according to manufacturer's written instructions after placing, screeding, and bull floating or darbying concrete but before float finishing.
- D. Begin curing after finishing concrete but not before free water has disappeared from concrete surface.
- E. Curing Methods: Cure concrete by curing compound.

3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
 1. Elevation: 3/4 inch (19 mm).
 2. Thickness: Plus 3/8 inch (10 mm), minus 1/4 inch (6 mm).
 3. Surface: Gap below 10-foot- (3-m-) long, unlevelled straightedge not to exceed 1/2 inch (13 mm).
 4. Joint Spacing: 3 inches (75 mm).
 5. Contraction Joint Depth: Plus 1/4 inch (6 mm), no minus.
 6. Joint Width: Plus 1/8 inch (3 mm), no minus.

3.10 WHEEL STOPS

- A. Install wheel stops in bed of adhesive applied as recommended by manufacturer.
- B. Securely attach wheel stops to paving with not less than two [galvanized]-steel dowels located at one-quarter to one-third points. Install dowels in drilled holes in the paving and bond dowels to wheel stop. Recess head of dowel beneath top of wheel stop.

3.11 REPAIRS AND PROTECTION

- A. Remove and replace concrete paving that is broken, damaged, or defective or that does not comply with requirements in this Section. Remove work in complete sections from joint to joint unless otherwise approved by Design Professional.
- B. Protect concrete paving from damage. Exclude traffic from paving for at least 14 days after placement. When construction traffic is permitted, maintain paving as clean as possible by removing surface stains and spillage of materials as they occur.
- C. Maintain concrete paving free of stains, discoloration, dirt, and other foreign material. Sweep paving not more than two days before date scheduled for Substantial Completion inspections.

3.12 FIELD QUALITY CONTROL

- A. Delivery Tickets: For each load delivered, submit 3 copies indicating quantity, mix identification, admixtures, design strength, aggregate size, design air content, and design slump at time of batching.
- B. Tests: Owner will retain the services of an engineering inspection and testing firm. Contractor will be responsible for coordinating and scheduling inspection. Tests will include the following: strength, air entrainment, temperature, and slump tests. Test results will be specified to be sent directly to the Contractor, Engineer and Owner's representative.
 - 1. Testing agency shall perform sampling and testing of concrete specified in ACI 301 Sections 16.3, 16.4, and as follows:
 - a. Test data from concrete cylinder breaks will be evaluated using procedures of the American Concrete Institute (latest edition of ACI 214) to determine if the compressive strength of the concrete tested is acceptable.
 - b. Concrete will be tested at the minimum rate of one test for the first 25 cubic yards [CY] placed each day, and one test for each additional 50 CY placed. Concrete may be tested more often at the discretion of the Owner's Representative.
 - 1) One additional set of test cylinders will be taken during cold weather, and as directed by Engineer, cured at Project Site under same conditions as concrete it represents.
 - c. Slump, ASTM C143: 1 per each set of compressive cylinders.
 - d. Air content, ASTM C173: 1 per every 50 cubic yards, or portion thereof.
 - e. Unit weight, ASTM C138: 1 per every 50 cubic yards, or portion thereof.
 - f. Concrete temperature, ASTM C1064: 1 measurement for every slump test.
 - g. Casting of compressive cylinders, ASTM C39: 1 set of 4 cylinders for every 50 cubic yards, or portion thereof.
 - h. Concrete delivery: Check batch ticket from every truck.
- C. Batch plant inspection: Random basis as determined by Engineer.

END OF SECTION 321313

SECTION 32 13 73 - CONCRETE PAVING JOINT SEALANT

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Cold-applied joint sealants.
- B. Related Sections:
 - 1. Division 32 Section "Concrete Paving" for constructing joints in concrete pavement.

1.2 ACTION SUBMITTALS

- A. Product Data: For each joint-sealant product indicated.
- B. Samples for Verification: For each kind and color of joint sealant required, provide Samples with joint sealants in 1/2-inch- (13-mm-) wide joints formed between two 6-inch- (150-mm-) long strips of material matching the appearance of exposed surfaces adjacent to joint sealants.
- C. Pavement-Joint-Sealant Schedule: Include the following information:
 - 1. Joint-sealant application, joint location, and designation.
 - 2. Joint-sealant manufacturer and product name.
 - 3. Joint-sealant formulation.
 - 4. Joint-sealant color.

1.3 INFORMATIONAL SUBMITTALS

- A. Product Certificates: For each type of joint sealant and accessory, from manufacturer.
- B. Product Test Reports: Based on evaluation of comprehensive tests performed by a qualified testing agency, for joint sealants.
- C. Preconstruction Compatibility and Adhesion Test Reports: From joint-sealant manufacturer, indicating the following:
 - 1. Materials forming joint substrates and joint-sealant backings have been tested for compatibility with and adhesion to joint sealants.
 - 2. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.

1.4 QUALITY ASSURANCE

- A. Installer Qualifications: Manufacturer's authorized representative who is trained and approved for installation of units required for this Project.
- B. Source Limitations: Obtain each type of joint sealant from single source from single manufacturer.

- C. Product Testing: Test joint sealants using a qualified testing agency.
 - 1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated.
- D. Preinstallation Conference: Conduct conference at Project site.

1.5 PROJECT CONDITIONS

- A. Do not proceed with installation of joint sealants under the following conditions:
 - 1. When ambient and substrate temperature conditions are outside limits permitted by joint-sealant manufacturer or are below 40 deg F (5 deg C)
 - 2. When joint substrates are wet.
 - 3. Where joint widths are less than those allowed by joint-sealant manufacturer for applications indicated.
 - 4. Where contaminants capable of interfering with adhesion have not yet been removed from joint substrates.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backing materials, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by joint-sealant manufacturer based on testing and field experience.
- B. Colors of Exposed Joint Sealants: As selected by Design Professional from manufacturer's full range color.

2.2 COLD-APPLIED JOINT SEALANTS

- A. Multicomponent, Pourable, Traffic-Grade, Urethane Joint Sealant for Concrete: ASTM C 920, Type M, Grade P, Class 25, for Use T.
 - 1. Products: Subject to compliance with requirements provide the following:
 - a. Pecora Corporation; Urexpan NR-200.
 - b. Sika Corporation: Sikaflex-2C SL and Sikaflex-2C NS TG
 - c. BASF: Sonolastic SL2.

2.3 JOINT-SEALANT BACKER MATERIALS

- A. General: Provide joint-sealant backer materials that are nonstaining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by joint-sealant manufacturer based on field experience and laboratory testing.
- B. Round Backer Rods for Cold-Applied Joint Sealants: ASTM D 5249, Type 3, of diameter and density required to control joint-sealant depth and prevent bottom-side adhesion of sealant.

2.4 PRIMERS

- A. Primers: Product recommended by joint-sealant manufacturer where required for adhesion of sealant to joint substrates indicated, as determined from preconstruction joint-sealant-substrate tests and field tests.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine joints indicated to receive joint sealants, with Installer present, for compliance with requirements for joint configuration, installation tolerances, and other conditions affecting joint-sealant performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint-sealant manufacturer's written instructions.
- B. Joint Priming: Prime joint substrates where indicated or where recommended in writing by joint-sealant manufacturer, based on preconstruction joint-sealant-substrate tests or prior experience. Apply primer to comply with joint-sealant manufacturer's written instructions. Confine primers to areas of joint-sealant bond; do not allow spillage or migration onto adjoining surfaces.

3.3 INSTALLATION OF JOINT SEALANTS

- A. General: Comply with joint-sealant manufacturer's written installation instructions for products and applications indicated unless more stringent requirements apply.
- B. Joint-Sealant Installation Standard: Comply with recommendations in ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install joint-sealant backings of kind indicated to support joint sealants during application and at position required to produce cross-sectional shapes and depths of installed sealants relative to joint widths that allow optimum sealant movement capability.
 - 1. Do not leave gaps between ends of joint-sealant backings.
 - 2. Do not stretch, twist, puncture, or tear joint-sealant backings.
 - 3. Remove absorbent joint-sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install joint sealants using proven techniques that comply with the following and at the same time backings are installed:
 - 1. Place joint sealants so they directly contact and fully wet joint substrates.
 - 2. Completely fill recesses in each joint configuration.

3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- E. Tooling of Nonsag Joint Sealants: Immediately after joint-sealant application and before skinning or curing begins, tool sealants according to the following requirements to form smooth, uniform beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint:
 1. Remove excess joint sealant from surfaces adjacent to joints.
 2. Use tooling agents that are approved in writing by joint-sealant manufacturer and that do not discolor sealants or adjacent surfaces.
- F. Provide joint configuration to comply with joint-sealant manufacturer's written instructions unless otherwise indicated.

3.4 CLEANING

- A. Clean off excess joint sealant or sealant smears adjacent to joints as the Work progresses, by methods and with cleaning materials approved in writing by manufacturers of joint sealants and of products in which joints occur.

3.5 PROTECTION

- A. Protect joint sealants, during and after curing period, from contact with contaminating substances and from damage resulting from construction operations or other causes so sealants are without deterioration or damage at time of Substantial Completion. If, despite such protection, damage or deterioration occurs, cut out and remove damaged or deteriorated joint sealants immediately and replace with joint sealant so installations in repaired areas are indistinguishable from the original work.

END OF SECTION

SECTION 32 14 00 - UNIT PAVING

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following:
 - 1. Concrete pavers set in sand setting beds.
- B. Related Sections include the following:
 - 1. Division 2 Section "Earthwork" for compacted subgrade and subbase course, under unit pavers.
 - 2. Division 2 Section "Portland Cement Concrete Pavement" for concrete base course under unit pavers.

1.2 SUBMITTALS

- A. Product Data: For the following:
 - 1. Precast Concrete pavers.
 - 2. Sand setting bed materials.
- B. Samples for Verification: Full-size units of each type of unit paver indicated; in sets for each color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
 - 1. Provide Samples showing the full range of colors to be expected in the completed Work.
 - 2. Include Samples of exposed edge restraints.
- C. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.
- D. The approval of shop drawings, submittals or samples does not relieve the contractor of responsibility for any deviation from the requirements of the Contract Documents, unless the Contractor has informed the Architect in writing of such deviation at the time of submission, has noted the deviation on the shop drawings, and the Architect has given written approval of the specific deviation. The Architect's approval also does not relieve the Contractor from responsibility for errors or omissions in the shop drawings, submittals or samples.

1.3 QUALITY ASSURANCE

- A. Installer Qualifications: An experienced installer who has completed unit paver installations similar in material, design, and extent to that indicated for this Project and

whose work has resulted in construction with a record of successful in-service performance.

- B. Source Limitations: Obtain each type of unit paver, joint material, and setting material from one source with resources to provide materials and products of consistent quality in appearance and physical properties.
- C. Mockups: Before installing unit pavers, build mockups for each form and pattern of unit pavers required to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution. Build mockups to comply with the following requirements, using materials indicated for the completed Work, including same base construction, special features for expansion joints, and contiguous work as indicated:
 - 1. Build mockups in the location and of the size indicated or, if not indicated, as directed by Architect. The mockups shall include a 10'x10' square area and setting system as indicated on the drawings.
 - 2. Notify Architect seven days in advance of dates and times when mockups will be constructed.
 - 3. Demonstrate the proposed range of aesthetic effects and workmanship.
 - 4. Obtain Architect's approval of mockups before starting unit paver installation.
 - 5. Maintain mockups during construction in an undisturbed condition as a standard for judging the completed Work.
 - 6. Demolish and remove mockups when directed.
 - 7. Approved mockups may become part of the completed Work if undisturbed at time of Substantial Completion.
- D. ADA Compliance: Running and cross slopes at curb ramps, sidewalks, accessible parking spaces and access aisles as indicated on the drawings and details are maximum slopes and cannot be exceeded. The project ADA Consultant will observe and check every instance and all locations. Work in place that exceeds maximum slopes will need to be replaced at contractor's expense.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Protect unit pavers and aggregate during storage and construction against soiling or contamination from earth and other materials.
 - 1. Cover pavers with plastic or use other packaging materials that will prevent rust marks from steel strapping.

1.5 PROJECT CONDITIONS

- A. Cold-Weather Protection: Do not use frozen materials or materials mixed or coated with ice or frost. Do not build on frozen subgrade or setting beds. Remove and replace unit paver work damaged by frost or freezing.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated below or comparable products by another manufacturer.

2.2 UNIT PAVERS

- A. Precast Concrete Pavers: Solid, paving units, ASTM C 936, made from normal-weight aggregates in sizes and shapes indicated.
- B. Basis of Design Product: Subject to compliance with requirements, provide the following or comparable products by other manufacturers to be approved by Landscape Architect:
 - 1. Techo-Bloc, 5255, Albert-Millichamp, St-Hubert, QC J3Y 8Z8
 - a. Size: 300 mm x 300 mm (3 15/16" x 11 13/16" x 11 13/16")
 - b. Style: Industria Smooth
 - c. Color: Onyx Black

2.3 CURBS AND EDGE RESTRAINTS

- A. Job-Built Concrete Edge Restraints: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, ready-mixed concrete with minimum 28-day compressive strength of 3000 psi.

2.4 AGGREGATE SETTING-BED MATERIALS

- A. Sand for Leveling Course: Sound, sharp, washed, natural sand or crushed stone complying with gradation requirements in ASTM C33/C33M for fine aggregate.
- B. Sand for Joints: Polymer modified fine, sharp, washed, natural sand or crushed stone with 100 percent passing No. 16 sieve and no more than 10 percent passing No. 200 sieve. Color as selected by the Architect.
 - 1. Manufacturers/Products:
 - a. Alliance Design Products, Inc., "Super Sand Bond".
 - b. Pakage Paverment, "Joint Lock Sand"
 - c. Pave Tech, "Sand Lock"
- C. Drainage Geotextile: Nonwoven needle-punched geotextile fabric, manufactured for subsurface drainage applications, made from polyolefins or polyesters; with elongation

greater than 50 percent; complying with AASHTO M 288 and the following, measured per test methods referenced:

- a. Survivability: Class 2, AASHTO M 288.
 - b. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum; ASTM D4751.
 - c. Permittivity: 0.5 per second, minimum; ASTM D4491.
 - d. UV Stability: 50 percent after 500 hours' exposure, ASTM D4355.
- D. Herbicide: Commercial chemical for weed control, registered with the EPA. Provide in granular, liquid, or wettable powder form.

2.5 SEALER

- A. Factory apply one coat of penetrating sealer to all surfaces of precast concrete pavers.
- B. Sealer shall be non-staining, penetrating material, suitable for exterior use, type which does not discolor or darken the surface.
- C. Conform to sealer manufacturer's recommendations for application of sealer.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas indicated to receive paving, with Installer present, for compliance with requirements for installation tolerances and other conditions affecting performance. Proceed with installation only after unsatisfactory conditions have been corrected.
 - 1. Where pavers are to be installed over waterproofing, examine waterproofing installation, with waterproofing Installer present, for protection from paving operations. Examine areas where waterproofing system is turned up or flashed against vertical surfaces and horizontal waterproofing. Proceed with installation only after protection is in place.

3.2 PREPARATION

- A. Sweep concrete substrates to remove dirt, dust, debris, and loose particles.
- B. Proof-roll prepared subgrade according to requirements in Section 312000 "Earth Moving" to identify soft pockets and areas of excess yielding. Proceed with unit paver installation only after deficient subgrades have been corrected and are ready to receive subbase and base course for unit pavers.

3.3 INSTALLATION, GENERAL

- A. Do not use unit pavers with chips, cracks, voids, discolorations, and other defects that might be visible or cause staining in finished work.

- B. Mix pavers from several pallets or cubes, as they are placed, to produce uniform blend of colors and textures.
- C. Cut unit pavers with motor-driven masonry saw equipment to provide clean, sharp, unchipped edges. Cut units to provide pattern indicated and to fit adjoining work neatly. Use full units without cutting where possible. Hammer cutting is not acceptable.
- D. Joint Pattern: Stack Bond. See drawings.
- E. Tolerances: Do not exceed 1/32-inch (0.8-mm) unit-to-unit offset from flush (lippage) nor 1/8 inch in 10 feet (3 mm in 3 m) from level, or indicated slope, for finished surface of paving.
- F. Isolation Joints: Provide joint filler at locations and of widths indicated. Install joint filler before setting pavers. Make top of joint filler flush with top of pavers. Sealant materials and installation are specified in Division 2 Section "Pavement Joint Sealants."
- G. Edge Restraints: Provide edge restraints as indicated. Install edge restraints before placing unit pavers.
 - 1. Install job-built concrete edge restraints to comply with requirements in Section 03 30 00 "Cast-in-Place Concrete."

3.4 CONCRETE SUB BASE APPLICATIONS

- A. Core drill 2" diameter weep holes located every 48 inches on center, beginning at the edges and working toward the center of the slab. No weep hole shall be drilled within 6" of the elevated integral edge curb.
- B. Place 12" by 12" square drainage geotextile over weep holes.

3.5 AGGREGATE SETTING-BED APPLICATIONS

- A. Place leveling course and screed, taking care that moisture content remains constant and density is loose and uniform until pavers are set and compacted.
- B. Treat leveling course with herbicide to inhibit growth of grass and weeds.
- C. Set pavers with a minimum joint width of 1/16 inch (1.5 mm) and a maximum of 1/8 inch (3 mm), being careful not to disturb leveling base. If pavers have spacer bars, place pavers hand tight against spacer bars. Use string lines to keep straight lines.
- D. Vibrate pavers into leveling course with a low-amplitude plate vibrator. Use vibrator with neoprene mat on face of plate or other means as needed to prevent cracking and chipping of pavers. Perform at least three passes across paving with vibrator.
 - 1. Compact pavers when there is sufficient surface to accommodate operation of vibrator, leaving at least 36 inches (900 mm) of uncompacted pavers adjacent to temporary edges.
 - 2. As work progresses to perimeter of installation, compact installed pavers that are adjacent to permanent edges unless they are within 36 inches (90 mm) of laying face.

3. Before ending each day's work and when rain interrupts work, cover pavers that have not been compacted and cover leveling course on which pavers have not been placed with nonstaining plastic sheets to protect them from rain.
- E. Spread dry sand and fill joints immediately after vibrating pavers into leveling course. Vibrate pavers and add sand until joints are completely filled, then remove excess sand. Wet sand as in accordance with manufacturer's directions.
- F. Do not allow traffic on installed pavers until sand has been vibrated into joints.
- G. Repeat joint-filling process 30 days later.

3.6 REPAIR, CLEANING, AND PROTECTION

- A. Remove and replace unit pavers that are loose, chipped, broken, stained, or otherwise damaged or that do not match adjoining units as intended. Provide new units to match adjoining units and install in same manner as original units, with same joint treatment and with no evidence of replacement.

END OF SECTION 32 14 00

SECTION 32 17 23 - PAVEMENT MARKINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
1. Pavement markings for parking areas and roadways.
 2. Accessible parking symbols.
 3. Traffic direction arrows.

1.2 SUBMITTALS

- A. Submit in accordance with Division 1 unless otherwise indicated.
- B. Product Data: Manufacturer's specifications and technical data including the following.
1. Product data sheet on each product.
 2. Material safety data sheet on each product.
 3. Manufacturer's installation instructions.
- C. Quality Control Submittals:
1. Manufacturer's certificate and test reports indicating that traffic marking material complies with requirements of this Section.
 2. Manufacturer's certificate indicating that glass beads comply with requirements of this Section, including test reports indicating roundness, refractive index, flow characteristics, and gradation.
- D. Color Samples: Two sets of samples of the following.
1. 2 inch by 3 inch sample of pavement marking material illustrating manufacturers full range of standard colors.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
- B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following.
1. Not less than 3 years experience with systems.
 2. Successfully completed not less than 5 comparable scale projects using this system.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.

- B. Labeling: Include manufacturer's name, type of material, brand name, brand code, date of manufacturer, surface preparation, color designation, analysis of contents, instructions for application, and instructions for cleanup.
- C. Storage and Protection: Comply with manufacturer's recommendations.

1.5 PROJECT CONDITIONS

- A. Environmental Requirements:
 - 1. Proceed with pavement marking only on clean, dry surfaces and at a minimum ambient or surface temperature of 40 degrees F for oil-based materials, 50 degrees F for water-based materials, and not exceeding 95 degrees F.
 - 2. Do not apply materials during rain or snow, or when relative humidity is above 50 percent, unless required otherwise by manufacturer's instructions.

1.6 SEQUENCING

- A. Sequence Work of this Section to occur immediately prior to Substantial Completion, except as otherwise approved by Design Professional.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Pavement-Marking Paint: latex, water-base emulsion; ready mixed; complying with FS TT-P-1952.
 - 1. Color: As determined by Owner from manufacturer's full range.
- B. Glass Beads: AASHTO M247, Type 1, including packaging and marking requirements.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
 - 1. Verify surfaces to receive traffic markings is dry and pavements are free of moisture.
 - 2. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Protection: Protect surfaces not being marked and finished Work of other Sections.
- B. Surface Preparation:
 - 1. Prepare surfaces in accordance with manufacturer's instructions.

2. Clean surfaces to receive pavement markings free of dust, dirt, concrete curing compounds, and other surface contaminants which may adversely affect adhesion or appearance.

3.3 APPLICATION

- A. Do not apply pavement-marking paint until layout, colors, and placement have been verified with Design Professional.
- B. Allow paving to age for 30 days before starting pavement marking.
- C. Sweep and clean surface to eliminate loose material and dust.
- D. Apply paint with mechanical equipment to produce pavement markings, of dimensions indicated, with uniform, straight edges. Apply at manufacturer's recommended rates to provide a minimum wet film thickness of 15 mils (0.4 mm).
 1. Broadcast glass spheres uniformly into wet pavement markings at a rate of 6lb/gal. (0.72 kg/L).

3.4 PROTECTION

- A. Protect installed markings from damage until Substantial Completion.

3.5 DEFECTIVE TRAFFIC MARKINGS

- A. Traffic markings which, in the opinion of the Design Professional, do not provide initial nighttime reflectivity or do not have the specified thickness shall be repaired and replaced at no increase in Contract Sum or extension in Contract Time.
- B. Traffic markings which, in the opinion of the Design Professional, do not conform to required dimensions or specified requirements shall be completely removed and replaced at no increase in Contract Sum or extension in Contract Time.

END OF SECTION 32 17 23

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SECTION 32 18 23.29 - SYNTHETIC TURF PLAYING FIELD SYSTEM

PART 1 - GENERAL

1.1 INFORMATION PROVIDED FROM THE OWNER

- A. The Owner shall make available:
1. Subsurface engineering analysis for the Playing Field System.
 2. Survey of site including but not limited to boundaries, contours and spot elevations, existing structures and utilities.
 3. A Topological Survey of sites including contours and spot elevations and utilities is included with the Documents.

1.2 WORK INCLUDED

- A. Provide equipment, materials and labor necessary to construct the synthetic field system, as indicated on the Drawings and as specified. Work shall include but shall not be limited to:
1. Earthwork Requirements
 - a. Excavation, trenching, grading, backfilling, compaction to achieve subgrade.
 - b. Laser grading
 - c. Disposal of spoil materials.
 - d. Acceptance of Subgrade - Site Contractor must certify sub-grade.
 - e. Grade elevation verification of Finish Subgrade
 2. Drainage System Requirements
 - a. Filter Fabric
 - b. Gravel drainage trench fill material.
 - c. Perforated drain pipe, Solid collector pipe and fittings
 - d. Base Stone
 - e. Finish Stone
 - f. Grade elevation certification of finished Base Stone installation
 3. Playing Field Requirements
 - a. Installation of perimeter turf anchor / nailer system.
 - b. Installation of Synthetic Turf including.
 - 1) Inlay graphics and lines
 - 2) Infill material
 - 3) Related finish work
 - c. Installation of shock pad
- B. Materials direct purchased by the Owner
1. Synthetic Turf w/ infill materials (Indoor)
 2. Synthetic Turf (Outdoor)
 3. Shock Pad
 4. Field Equipment
 - a. Synthetic Turf Maintenance Equipment (purchased by Owner)
 - b. Other fixed or portable equipment. (purchased by Owner)

1.3 RELATED WORK

- A. Examine Contract Documents for requirements that affect work of this Section.
 - 1. Earthwork
 - 2. Concrete Curbing
 - 3. Outdoor Sports Equipment

1.4 REFERENCES

- A. Comply with applicable requirements of the following standards. Where these standards conflict with other specified requirements, the most restrictive requirement shall govern.
 - 1. American Association of State Highway and Transportation Officials (AASHTO):
 - a. T 89 - Determining the Liquid Limit of Soils
 - b. T 90 - Determining the Plastic Limit and Plasticity Index of Soils
 - 2. Occupational Safety and Health Administration (OSHA)
 - 3. Department of Transportation Standard Specifications
 - 4. American Society for Testing and Materials (ASTM):
 - a. D 395 - Rubber Property – Compression Test
 - b. D 418 - Pile Yarn Floor Covering Construction
 - c. D 2256 - Breaking Load (Strength) and Elongation of Yarn by the Single-Strand Method
 - d. D 3776 - Mass Per Unit Area (Weight) of Woven Fabric
 - e. D 3786 - Hydraulic Bursting Strength of Knitted Goods and Non-Woven Fabrics: Diaphragm Bursting Strength Tester Method,
 - f. D 4491 - Water Permeability of Geotextiles by Permittivity
 - g. D 4533 - Trapezoid Tearing Strength of Geotextiles
 - h. D 4632 - Breaking Load and Elongation of Geotextiles (Grab Method)
 - i. D 4833 - Index Puncture Resistance of Geotextiles, Geo-membranes, & Related Products
 - j. F 355 - Shock Absorbing Properties of Playing Surface Systems and Materials
 - k. F 405 - Corrugated Polyethylene (PE) Tubing and Fittings
 - l. F 449 - Subsurface Installation for Agricultural Drainage or Water Table Control
 - m. F 667 - 8, 10, 12 and 15-inch Corrugated Polyethylene Tubing and Fittings
 - 5. American Wood Preservers' Association (AWPA):
 - a. C2 Lumber, Timbers, Bridge Ties and Mine Ties
 - b. Preservation Treatment by Pressure Processes
 - 6. Current NCAA Football Rules and Interpretations

1.5 DEFINITIONS

- A. Excavation: Removal of material encountered to subgrade elevations indicated and subsequent disposal or placement of materials removed.
- B. Unauthorized Excavation: Inadvertent or purposely removing materials beyond indicated subgrade elevations or dimensions without specific direction of the Architect. Unauthorized excavation, as well as remedial work resulting from unauthorized excavation directed by Architect shall be at Contractor's expense.
 - 1. Unauthorized excavation, including disposition of additional excavated materials and other work resulting from slides, cave-ins or remedial work shall be at Contractor's expense.

- C. Additional Excavation: When excavation has reached required subgrade elevations; the Engineer will be notified and will make an observation of conditions. If Engineer/Testing Lab determines that the bearing materials at required subgrade elevations are unsuitable, excavation shall be continued until suitable bearing materials are encountered and excavated material shall be replaced as directed by the Engineer.
 - 1. Removal of unsuitable material and its replacement as directed will be paid on basis of Conditions of the Contract relative to changes in work.
- D. Subgrade: The undisturbed earth or the compacted soil layer immediately below proposed playing field drainage or soil materials.
- E. Finish subgrade: Final elevations and grading modifications to be performed in this Contract on the subgrade elevations. Playing field system shall be installed above finish subgrade to finished field elevations.
- F. Gravel Drainage material: Stone material that may be used in drainage trenches surrounding perforated drainage piping. When used below and with the Base Stone, this material should bridge with the Base Stone as described herein.
- G. Base Stone: Approved stone material with the sizing and performance characteristics described herein. This stone material is installed immediately on top of the finished subgrade surface. Material could also be used in the drainage trenches if approved by the Engineer and certified by the Owners Testing Agent.
- H. Finish Stone: Approved stone material with the sizing and performance characteristics described herein. This stone material is installed immediately on top of the Base Stone to create a smooth surface for the placement of the synthetic turf as well as to aid in achieving finish grade tolerances of the playing field subsurface

1.6 SUBMITTALS

- A. Manufacturer's Product Data: Submit manufacturer's specifications and installation instructions for all products in the playing field system, including certifications and other data as may be required to show compliance with the Contract Documents. Included but not limited to the following; geotextile fabric, perimeter turf anchoring system.
- B. Material Certifications: Manufacturer's or vendor's certified analysis for rubber and sand infill amendments.
- C. Material samples. Submit three samples each of the following:
 - 1. Geotextile fabric approximately 7"x11".
 - 2. Gravel Materials – See Section 1.8, "Quality Control"
- D. Synthetic Turf Material Samples and Test Reports:
 - 1. Synthetic Turf – Three samples, approximately 7" x 11"
 - 2. Main and Inlay Seams: Two samples each, sewn (main) and glued (inlay) per vendors/manufacturers instructions
 - a. 7" x 11"
 - 3. Synthetic Turf Colors: Two samples of each color used for markings (white and yellow)
 - 4. Rubber/Sand Mix with proper ratio - three samples, approximately 8-ounces each.
 - 5. Infill material: Submit sieve analysis of infill materials to be used for turf product
 - 6. Submit to Owner for approval - quality assurance information as delineated in paragraphs 1.7 Quality Assurance below.
 - 7. Certified list of successful existing installations, including Owner representative and telephone number, attesting compliance with quality assurance information.

8. Certified copies of independent (third-party) laboratory reports on ASTM tests as follows:
 - a. ASTM D72 - Specific Gravity
 - b. ASTM D418 - Pile Height, Tuft Spacing, Face Weight & Total Fabric Weight
 - c. ASTM D418 - Primary & Secondary Backing Weights
 - d. ASTM D418 - Backing and Perforation Diameter and Spacing
 - e. ASTM D1335 - Tuft Bind
 - f. ASTM D5034 - Grab Breaking Strength and Elongation
 - g. ASTM F-355 – Impact Attenuation (G-max), Procedure A (system)
 - h. ASTM D2859 - Flammability (Pill Burn Test)
- E. Supplier List: Submit list of procured and contracted suppliers of all materials required for the Playing Field System.
- F. Schedule: Work schedule for all work described in these documents. This schedule shall be regularly updated and submitted as progress continues throughout ultimate completion.
- G. Shop Drawings:
 1. Sample Warranty
 2. Playing Field Drainage Structures
 3. Underdrain Collection system pipe materials.
 4. Seam layout of the field
 5. Striping plan:
 6. Layout for Owner designated field lines, markings, boundaries and logos.
 7. Construction detail sketches, especially those that may deviate from the plans and specifications. Including but not limited to the following; perimeter turf anchor details, details at valve boxes, other inserts or fixed features, etc.
- H. Subcontractor List: Submit list of key subcontractors for the project. Briefly describe the role of each as well as their experience with similar types of facilities such as being constructed in these Documents. This list should include but is not limited to:
 1. Turf Vendor / Manufacturer
 2. Turf Installer / Contractor
 3. Playing Field Base Installer / Contractor
- I. Manufacturer's Review: submit written statement, signed by Contractor and synthetic field surfacing installer stating that the Drawings and Specifications have been reviewed by qualified representatives of the materials manufacturer, and that they are in agreement that the materials and system to be used for synthetic field surfacing are proper and adequate for the applications shown
- J. Warranty: Provide a copy of the Turf Vendor's standard Warranty noting any exceptions to the Warranty information included in this Specification Section.
- K. Grade Verification: A certified survey by a State licensed surveyor shall be made of the in-place condition at the subgrade, gravel drainage blanket, and finished synthetic turf surface with infill installed for conformance to specified elevations. The playing field contractor shall not proceed until the all grades, inverts, manholes, have been approved by the Engineer of record based on the signed and sealed State licensed surveyors As-Built documents.
- L. Turf Product System Hold Harmless: The Turf Vendor shall submit a document holding the Owner and it's representatives harmless as to any liability and or costs of any type, including but not limited to legal costs, royalties, replacement costs, etc. associated with any claim by the Turf Vendor or others associated and with any patents or infringements of any current or future patent issued for the synthetic turf product, infill materials, installation methods or drainage characteristics. It is not the intent of these documents to promote or induce the use of

intellectual property belonging to others or promote infringement of any known or currently not known patents, licenses or rights of others.

- M. Statement of Supervision: Upon completion of the Work, Contractor to submit a written statement signed by the synthetic turf manufacturer stating that the field supervision by the manufacturer's representative was sufficient to insure proper application of the complete system and materials, that the Work was installed in accordance with the Contract Documents, and that the installation is acceptable to the manufacturer.

1.7 QUALITY ASSURANCE

- A. The synthetic field system work shall be performed by a firm and crew meeting the following criteria:
1. It is the University preference that the playing field contractor holds a current certification by the American Sports Builders Association for the construction of synthetic turf field construction.
 2. It is the University preference that the finished playing field meet the One Turf Concept certification. The Owner will pay for the One Turf Concept testing.
 3. A minimum of ten (10) successful fields in the last three (3) years on projects comparable to this project.
 - a. The firm installing the turf product shall have the approval of the synthetic field surfacing materials manufacturer.
 4. The resume of the synthetic field installation superintendent who will be on-site during the installation shall be provided showing a list of the (5) successful projects for which he/she was responsible.
 5. Firms must have been in business under the same Ownership for at least three years and shall have been installing similar sports fields for that entire period.
- B. Installation of synthetic field system shall be done only after excavation and construction work, which might injure it, has been completed. Damage caused during construction shall be repaired prior to acceptance/Substantial Completion.
- C. The Playing Field Contractor shall be responsible for the protection of the synthetic field system and product after its installation through Substantial Completion.
- D. Grade Verification: Certified surveys by a State Licensed land surveyor shall be made at finished subgrade, Base Stone layer using a Robotic Total Station or similar equipment. All As-Built surveys and lab testing certification must be submitted for approval to the Engineer of record prior to proceeding to the next phase of construction.

1.8 QUALITY CONTROL

- A. Pre-bid: Materials Inspection and Testing:
1. Bidders are encouraged to:
 - a. Pre-test gravel drainage materials with an independent Testing Agent prior to submitting a bid. This does not guarantee that the materials or source will be approved for construction.
 - b. Pre-qualify any material deviating from that specified.
 - c. All costs associated with pre-bid testing shall be borne by the bidder.
- B. After Bid Award and Prior to construction: Submit samples of each of the following materials to establish Baseline specification and ratios for the remainder of the testing process.

1. Gravel Drainage Material: Provide a one-gallon sample of each gravel drainage source and for each type of gravel material to be used for testing. This could include:
 - a. Gravel trench drainage material
 - b. Base Stone
 - c. Finish Stone
 2. Infill Materials: Provide a one-gallon sample of each infill material to be used for testing. This shall include but is not limited to:
 - a. Ambient or cryogenic rubber
 - b. Sand or gravels
 - c. Alternative infill
- C. During Construction: Submit samples of each of the following during mass production of gravel materials for performance testing and prior to shipping.
1. Earthwork Material Qualification and Testing
 - a. If found necessary, submit the following test data for each potential borrow source.
 - 1) Particle Size Analysis:
 - a) Method: AASHTO D422.
 - b) Number of Tests: Three (3) per potential source.
 - c) Acceptance Criteria: Gradation within specified limits.
 - 2) Maximum Density Determination:
 - a) Method: Modified Proctor Test - ASTM D 1557.
 - b) Number of Tests: Three (3) per potential source.
 - b. Re-establish gradation and maximum density of fill material if source is changed during construction.
 2. Earthwork/Compaction Testing
 - a. All compaction testing shall be performed by the Owner's geotechnical testing agency. The Contractor shall coordinate all work with the Owner's geotechnical testing agency and the Playing Field Designer/Engineer. Notify the geotechnical agency and the Engineer at least one (1) working day in advance of all phases of filling and backfilling operations. Playing field contractor shall not proceed until the Engineer of record receives approved certification from the geotechnical testing agency that the compaction is within allowable testing limits.
 - b. Compaction testing shall be performed to ascertain the compacted density of the fill and backfill materials in accordance with the Earthwork specification included in the Documents or as per the following methods:
 - 1) In-place relative density:
 - a) Method: ASTM D-1556, Sand Cone Method
 - b) ASTM D-2922, Nuclear Method
 - 2) Number of Tests:
 - a) One (1) per 5,000 SF in each vertical lift with a minimum of one (1) test per each vertical lift in each of the three areas of depressions shown on the Contract Drawings.
 - c. The Engineer may direct additional tests to establish gradation, maximum density, and in-place density as required by working conditions, at the Contractor's expense.

- d. Acceptance Criteria: The sole criterion for acceptability of in-place fill shall be in situ dry density. Minimum dry density for all fill or backfill shall be 95 percent of the maximum dry density as determined by the Modified Proctor Test (ASTM D-1557). If a test fails to qualify, the fill shall be further compacted and re-tested. Subsequent test failures shall be followed by removal, replacement of the material and retesting.
 3. Gravel Drainage / Base Stone / Finish Stone Material:
 - a. A minimum of one-gallon sample for every 500 cubic yards of each material used shall be tested by the Testing Agent for general compliance with the established Baseline specifications. All material shall be tested and certified against the baseline sample prior to being placed on the field.
 4. Infill Materials:
 - a. Random samples shall be pulled from bulk packages or piles on-site. Number of samples at the Owners discretion. The samples shall be tagged and marked from the packages for future reference after testing is complete. Sieve analysis testing results shall be compared to Vendor's previously submitted analysis for the infill materials for approval. Packages that do not meet approval shall be removed from site. Initial testing shall be paid for by the Owner. Retesting shall be at the Contractors expense. Additional screening of rubber materials by Contractor to remove fines may be required at Owners sole discretion at no additional cost to Owner.
 - b. Heavy Metals Ingestion Test Method – One test per field from the final supplier of rubber infill materials using ASTM F963 Toxic Heavy Metals method. Test to be performed by Northwest Laboratories, 241 South Holden St., Seattle, WA 98108 (206) 763-6252 or equal.
 5. Synthetic Turf Material Testing: Prior to shipment to the project site, one 7" x 11" sample from each fifth roll shall be randomly taken and tested by an independent laboratory with experience testing these materials. Test results shall be submitted simultaneously to the Owner, Engineer and Contractor. Samples/Rolls not meeting approval shall not be shipped. Testing shall be paid for by the Contractor. Samples used for testing shall be tagged and marked and submitted to the Engineer after testing is complete. The following shall be tested/reported:
 - a. ASTM D418 - Pile Height, Face Weight & Total Fabric Weight
 - b. ASTM D418 - Primary & Secondary Backing Weights
 - c. ASTM D418 - Backing and Perforation Diameter and Spacing
 - d. ASTM D1335 - Tuft Bind
 - e. ASTM D1682 - Grab Tear Strength
 6. Synthetic Turf Product Safety Statement
 - a. The Contractor shall submit a signed statement with documents from the turf manufacturer that provide information on the safety of their product regarding lead, heavy metals and other chemicals used in their product.
- D. Testing Agents
1. Sitework and Materials Testing Agents:
 - a. The Owner shall hire in a separate contract, a Testing Agent to certify and make recommendations regarding compaction, concrete, geotechnical and other items required by the Work. The Playing Field Contractor shall notify the Owner regarding timing, scheduling and use of these agents.
 2. Playing Field Testing Agent:

- a. The Owner shall hire a Testing Agent to perform testing of the field system material components, including but not limited to Base Stone, and infill materials, as well as to certify the capability of the Base Stone course to meet permeability and stability requirements before construction. Agent shall be independent, accredited and insured.
 - b. The Playing Field Testing Agent is to report/submit test results as they are known and simultaneously to the Playing Field Contractor, the Owner and its representatives.
 - c. The Engineer shall solely make a recommendation for the owner's approval or rejection based on the certification of the Owners Testing Agent.
- E. In situ percolation testing of Base Stone: Upon completion of installation of Base Stone and Finish Stone, the testing lab shall perform 6 random percolation tests for the field. Minimum percolation rate shall be 14 inches per hour. The Contractor and Turf Installer (if different) shall be present at these tests. Upon successful completion, the turf installation shall begin. Areas that do not meet the drainage standards shall be repaired by the Contractor and retested prior to turf installation.
- F. In situ percolation testing of Synthetic Turf surface: Upon completion of installation of turf surface, inlays and infill materials, the testing lab shall perform 6 random percolation tests for the field. The Contractor and Turf Installer (if different) shall be present at these tests. Minimum percolation rate shall be 6 inches per hour. Areas that do not meet the drainage standards shall be repaired by the Contractor and retested prior to acceptance of the installed turf.
- G. It is the University preference that the finished playing field meet the One Turf Concept certification. The Owner will pay for the One Turf Concept testing.

1.9 DELIVERY, STORAGE AND HANDLING

- A. All materials shall be delivered and stored within the Contractor's work limits or in an area approved by the Owner.
- B. All material shall be stored in strict accordance with the manufacturer's recommendations.
- C. Special care shall be exercised during delivery and storage to avoid damage to the products.
- D. Products that are damaged will be removed and replaced, unless the product can be repaired in an acceptable manner by the Contractor, at his expense.
- E. Packaged Materials:
 - 1. Deliver packaged materials in containers showing weight, analysis, and name of manufacturer. Protect materials from deterioration during delivery, and while stored at site. Store out of low lying or drainage areas.
- F. Drainage Gravel and Base Stone:
 - 1. Deliver tested and approved lots in clean, washed and covered trucks to eliminate contamination during transportation. Place directly on playing field. Do not stockpile on site. All material must be approved by the testing lab and given to the General Contractor or Project Architect.

1.10 COMPLETION AND ACCEPTANCE

- A. General: Field completion shall be separated into 2 phases, "Punch List" and "Substantial Completion."

- B. Punch List: Scheduled date for Punch List shall be at least 15 calendar days before Substantial Completion. Notify the Playing Field Designer/Engineer and Owner in writing, 3 days prior to scheduled date for the Punch List. To be considered ready for this Punch List the following items shall be provided:
1. Base Stone in place, compacted and to grade.
 2. Field curbing installed
 3. Synthetic turf installed inclusive of infill materials, field markings, inlays and logos.
 4. In situ percolation tests performed for the synthetic turf surface.
- C. Substantial Completion: After "Preliminary Completion" observation, the Playing Field Designer/Engineer shall prepare and submit to the Contractor, a punch list of items to be completed to achieve "Substantial Completion". Contractor shall notify the Playing Field Designer/Engineer and Owner in writing, 5 days prior to a requested date for a site observation to meet "Substantial Completion." To be considered "Substantially Complete" or "Playable" the following items shall be provided:
1. All Punch List items are complete.
 2. Submit five (5) copies of written operating and maintenance instructions. Provide format and contents as directed by the Engineer.
 3. Submit (5) copies of all certified surveys performed during construction for Quality Control.
 4. Submit all copies of certified geotechnical playing field testing reports for all related sub-grade, gravel material, compaction, density and certification of total percolation rate for the complete playing field system.
 5. Smooth, level playing surface compacted and level to grading tolerances.
 6. Written warranties/guarantees.
 7. Upon completion of the synthetic field surface, the Contractor shall provide the Owner with 2 hours of maintenance training that shall be recorded on a video tape and supplied to the Owner.
 8. Upon completion, Contractor shall provide Owner with project as-built / record drawings.

1.11 WARRANTY/GUARANTEE

- A. General: Warranties / Guarantees specified in this Article shall not deprive the Owner of other rights the Owner may have under other provisions of the Contract Documents and are in addition to and run concurrent with other warranties/guarantees made by the Contractor under requirements of the Contract Documents.
- B. The following are inclusive of the term "Playing Field System" for provisions of the guarantee:
1. Final grade tolerances to one-quarter inch in the length of 25' of finish grade in any direction.
 2. Synthetic turf product as specified and represented by the Turf manufacturer/vendor also including seams and adhesives used in the installation.
 3. Working functions of the drainage system.
 4. All materials and products specified.
 5. Drainage thru the turf system (including the turf, infill and Base Stone system), shall be guaranteed to have a percolation rate of 10 inches per hour
- C. Statement of Supervision: Upon completion of the Work, Contractor to submit a written statement signed by the Synthetic Turf Vendor stating that the field supervision by the Vendor's representative was sufficient to insure proper application of the complete system and materials, that the Work was installed in accordance with the Contract Documents, and that the installation is acceptable to the Vendor.

- D. G-Max Testing: The synthetic surface manufacturer shall retain a third-party certified testing laboratory and shall perform G-Max testing during each year of the life of the Guarantee.
1. Testing shall be performed at the field center, at the goal locations for all sports, and at 10 yards inside the corners. Testing interval is the anniversary date of Owner acceptance/Substantial Completion. This results in a total of 13 tests per year per field.
 2. Testing shall consist of shock attenuation per ASTM F-355-A (full system). Testing shall be in accordance with ASTM Test Method F-1936 or as described in these documents.
 - a. Initial test shall not exceed 125G's nor shall it be less than 90G's at any one point on the field.
 - b. G-Max shall not change more than 5% (five percent) at any one location per year over the life of the Guarantee.
 - 1) In cases where the results of the above testing exceed the specified values, the condition shall be corrected by the synthetic surface manufacturer. The synthetic surface manufacturer shall provide adequate information to confirm that the mitigation measures were effective.
 - c. At no time in the life of the Guarantee shall the G-Max exceed 175G's at any one point on the field. Results of this testing shall be provided to the Owner, Engineer and other assigns each year after testing.
 3. The depth of the infill material shall be measured at the point of each test location.
 4. The testing shall be performed by a certified independent lab and paid for by the Contractor.
 5. If the Contractor does not perform the tests within 30 days of the dates noted, the Owner shall at its discretion order this work performed and the Contractor shall bear this cost.
- E. Contractor shall not be held liable for incidental or consequential damages. The Synthetic Turf Warranties described shall be conditioned upon:
1. Owner shall make all minor repairs to the synthetic turf system as discovered.
 2. Owner shall maintain field as described in the Owners Manual submitted by the Contractor to the Owner.
- F. The Warranty does not cover any defect, failure, damage caused by or connected with abuse, neglect, deliberate acts, acts of God, casualty or loads exceeding the Contractor's recommendations.
- G. Total warranty length shall be 8 year minimum.

1.12 SPARE PARTS/ATTIC STOCK

- A. Stockpile Materials (Attic Stock): Provide the following additional materials stored as directed by the Owner.

Material	Quantity
Rubber Infill	1 ton

- B. Turf: Material may be end of rolls or cutoffs. Minimum size of turf shall be 10 x 10. Provide the following minimum materials and store as directed by the Owner.
1. Green Turf: 2500 square feet

- a. If more than one color lot is used, each color lot shall be represented proportionately in the total.
2. Yellow and White Turf for Lines 500 linear feet each of 4 inch width

PART 2 - PRODUCTS

2.1 EARTHWORK MATERIALS

- A. Suitable Material: Soils classified by ASTM as GW, GP, GM, GC, SW or SP, free from organic, frozen, or other deleterious materials. When approved by the Playing Field Designer/Engineer on a case-by-case basis, Select Fill is an acceptable alternate.
- B. Structural Fill: non-plastic, sound, durable, granular particles consisting of sand, gravel, stone or blends with these materials, free from organic, frozen, or other deleterious materials, conforming to the following gradation requirements:

Sieve	Percent Passing
4"	100
No. 40	0-70
No. 200	0-10

- C. All stone shall be angular. Rounded or river stone is not allowed.
- D. The existing natural or fill subgrade soils on-site do not meet the requirements for Suitable Material or Structural Fill.

2.2 DRAINAGE SYSTEM MATERIALS

- A. Underdrain Collector Pipe and Fittings
 1. General
 - a. Review drawings for locations of perforated and non-perforated piping.
 - b. Solid wall pipe shall be high-density polyethylene pipe (HDPE) and shall conform to the requirements of AASHTO M252 Type S for 4 to 10 inch diameters and AASHTO M294 or ASTM F2306 Type S for 12 to 60 inch diameters.
 - c. Perforated pipe shall be double wall high-density polyethylene pipe (HDPE) and shall conform to the requirements of AASHTO M252 Type SP for 4 inch to 10 inch diameters and AASHTO M294, Type SP or ASTM F2306 for 12 inch to 60 inch diameters.
 - d. HDPE Perforated pipe shall have Class 2 slotted perforations in accordance with AASHTO M252 and M294.
 - e. Virgin material for pipe and fitting production shall be high-density polyethylene conforming to the minimum requirements of cell classification 424420C for 4-inch to 10-inch diameters, and 435400C for 12-inch to 60-inch diameters, as defined and described in the latest version of ASTM D3350, except that carbon black content should not exceed 5%.
 - f. Provide drainage pipe complete with bends, reducers, adapters, couplings, collars, and joint materials.
 - g. Solid wall pipe joints and fittings shall meet the watertight joint performance requirements of AASHTO M252, AASHTO M294, or ASTM F2306. 4-inch through 60-inch shall be watertight according to the requirements of ASTM D3212. Gaskets shall be made of polyisoprene meeting the requirements of ASTM F477.

- Gaskets shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly.
- h. Solid wall HDPE 12-inch through 60-inch diameters shall have a reinforced bell with a bell tolerance device. The bell tolerance device shall be installed by the manufacturer.
 - i. Provided drainage pipe complete with all fittings such as bends, reducers, adapters, couplings, collars, and joint materials. Fittings and couplers for perforated HDPE pipe shall be split couplings or snap couplings manufactured by the same manufacturer as the corrugated HDPE.
 - j. Manufacturer's certification according to AASHTO M252 and M294 shall be submitted to the Engineer prior to installation of the pipe.
- 2. Products
 - a. Advanced Drainage Systems (ADS)
 - b. Approved Equal
- B. Under drain Piping, Drains and Fittings
- 1. General
 - a. Corrugated and solid round drainage pipe shall conform to the requirements as defined in Section 2.2. This product shall be composed of a round pipe design consisting of a full circumference polyethylene core.
 - b. All materials and fittings shall conform to the requirements as defined in Section 2.2.
 - c. Geotextile shall not be used on drainage piping system.
 - d. Provided playing field under drain collection system shall be complete with all fittings such as bends, reducers, adapters, couplings, collars, and joint materials. The same manufacturer as the under drain collection drainage piping shall supply all fittings.
 - 2. Products
 - a. "N-12" Pipe – Advanced Drainage Systems (ADS)
 - 1) www.ads-pipe.com/us
 - b. Approved Equal
- C. Clean Out: Provide clean out fittings fabricated from ASHTO-M252 polyethylene pipe that includes threaded polyethylene cap.
- D. Collector Pipe Inline Drainage Structures / clean outs and sized as per drawings:
- 1. General
 - a. Inline structures only are to be used. Risers with fittings are not allowed.
 - 2. Products:
 - a. Cleanouts
 - 1) Nyloplast Drain Basin
 - 2) Nyloplast Inline Drain
 - b. Grate
 - 1) Solid, Ductile Iron
 - 3. Suppliers

- a. Nyloplast-ADS
 - 1) www.ads-pipe.com/us
- b. National Diversified Sales
 - 1) www.ndspro.com
- c. Approved equal.

E. Suppliers:

- a. Nyloplast-ADS
 - 1) www.ads-pipe.com/us
- b. National Diversified Sales
 - 1) www.ndspro.com
- c. Approved equal

2.3 DRAINAGE SYSTEM MATERIALS

A. Geotextile Fabric:

1. General:

- a. Provide on playing field subgrade and playing field drainage trenches.
- b. The geotextile shall be a nonwoven sheet of plastic yarn as defined by ASTM D123 and conform to the criteria presented in the following table. These requirements shall be based on the Minimum Average Roll Value (MARV) which is defined as the value that can be expected, with 95% confidence, to be the minimum test average obtained on a roll sampled and tested in accordance with ASTM D4759.
- c. Geotextile shall meet the requirements of AASHTO M288 except as modified herein.

Geotextile Class 1			
Physical Property	ASTM Procedure	Minimum Acceptance Criteria	
		English	Metric
Grab Tensile Strength	D 4632	200 lbs	890 N
Grab Elongation at Break	D 4632	50%	50%
Puncture Strength	D 4833	80 lbs	355 N
Mullen Burst Strength	D 3786	260 psi	1790 Kpa
Trapezoidal Tear	D 4533	80 lbs	355 N
Apparent Size Opening (AOS)	D 4551	70-100 US Std Sieve	150 – 212 um

2. Product

- a. Mirafi
 - 1) www.mirafi.com
- b. Amoco

- 1) www.geotextile.com
- c. Approved equal

Base Stone and Finish Stone

- 3. The Base Stone shall conform to the turf vendor's standard specifications subject to the Engineer's approval based on the Owners testing labs certification and meet the following requirements using ASTM Method C136:

Base Stone 3/4 inch minus		Finish Stone (1/4 chip minus)	
Sieve Size	% Passing by Weight	Sieve Size	% Passing
1-1/2"	100		
1"	100		
3/4"	95-100		
1/2"	55-85	1/2"	100
3/8"	40-75	3/8"	100
1/4"	25-65	1/4"	85-100
No. 8	0-40	No. 8	35-75
No. 16	0-20	No. 16	10-55
No. 30	0-10	No. 30	0-30
No. 60	0-8	No. 60	0-15
No. 100	0-4	No. 100	0-5
No. 200	0-2	No. 200	0-4

- 4. All stone shall be angular. Rounded or river stone is not acceptable.
- 5. In no instance shall multiple quarry sources be used within a single playing field area.
- 6. Bridging Characteristics:

$$a) \quad 3 < \frac{D50 \text{ Base Stone}}{D50 \text{ Finish Stone}} < 6 \quad b) \quad \frac{D85 \text{ Finish Stone}}{D15 \text{ Base Stone}} < 2$$

- 7. Drainage Characteristics
 - a. Permeability for Base Stone shall be greater than 50"/hr.
 - b. Permeability for Finish Stone shall be greater than 12"/hr.
 - c. Porosity for Finish Stone and Base Stone shall be greater than 25% when compacted and saturated.
- 8. Finish Stone is allowed for use to level the finished surface of the Base Stone. Total depth allowable per plans.
- 9. The gravel materials should minimally meet either:
 - a. Micro-Deval as described below:
 - or
 - b. LA Abrasion and Sulfate Soundness as described below:

Test Method	ASTM #	Criteria
Micro-Deval	ASTM D6928	Not to exceed a loss of 18%

LA Abrasion	ASTM C131	Not to exceed 40
Sulfate Soundness	ASTM C88	Not to exceed 12% (Magnesium sulfate)

2.4 FIELD CURB

- A. The field curb / nailer shall be located at the field perimeter or turf edges and shall be as per drawings or approved equal.
- B. Wood Nailer (If Used)
 - 1. Yella Wood
 - a. 2" x 4"
 - 2. Or approve equal
- C. Anchors Nails for Wood Nailers attached to Field Curb (If Used)
 - 1. Stainless Steel Ramset/RedHead
 - a. At 48" on center maximum and
 - b. 4 inches from each end of board
- D. Anchor Nails for Wood Nailers formed into Field Curb
 - 1. Galvanized Spiral Nails
 - a. Use 3 nail groups on 18 inch centers.
 - b. Do not oil board being used as the permanent nailer when forming curb

2.5 SHOCK PAD

- A. Shock Pad / Product
 - 1. Brock USA – PowerBASE / YSR

2.6 SYNTHETIC TURF INFILL PRODUCT

- A. Turf Fiber / Product:
 - 1. A tufted, slit film or monofilament polyolefin, grass-like fabric coated with an acrylic secondary backing.
 - 2. The fibers shall be tufted to a minimum finished pile height of
 - a. 2 inches
 - 3. Pile yarn shall be provided by a single source.
 - 4. All inlaid lines will be tufted in the factory to the extent practical. The use of field inlaid lines shall be kept to a minimum.
 - 5. Minimum 15 foot widths.
 - 6. 60oz. minimum pile weight.
- B. Appearance/Feel:
 - 1. The finished playing surface shall appear as mowed grass with no irregularities and shall afford excellent traction for conventional athletic shoes of all types.
 - 2. The finished surface shall resist abrasion and cutting from normal use.
- C. Infill Materials

1. A mixture of ground rubber or sand/rubber fill in specific mix ratios per manufacturer.
2. Infill material shall be provided at a depth leaving 3/4 height of visible synthetic turf fabric or as recommended by the manufacturer based on weight and/or as agreed to by the Owner/Engineer.
3. The infill material shall be rubber granules or a sand/rubber granule mixture/blend. The sand component if utilized shall not be less than 25% or more than 35% by volume.
4. Infill materials shall be supplied by a single source.
5. Rubber shall be clean without recycled materials such as tire fiber or metal.
6. The infill materials shall conform to the Synthetic turf vendor's standard specifications subject to the Engineer's approval or as shown below:
 - a. Rubber infill Material Characteristics:
 - 1) Majority of particles between #8 to #16 mesh
 - 2) Minority of particles between #10 to #20 mesh
 - 3) Not more than 0.5% passing #30 sieve
 - b. Sand Infill Material Characteristics
 - 1) Clean round particles
 - 2) Majority of particles between 0.50 and 1 mm
 - 3) < 5% retained on a #100 sieve (.15 mm)
 - 4) Not more than 0.5% particles passing the #200 sieve
 - 5) Silica sand needs to be tested for particle size, distribution and physical properties including CU value to be reviewed by the Engineer of Record.
7. The initial testing and approval of the infill materials and the appropriate mix ratio (if used) shall set the baseline for all following tests of the material.
8. Synthetic Turf Vendor shall verify and approve the test results of the infill materials for the initial and all following testing.
9. 6 lbs / SF minimum combined total infill weight.
10. Synthetic Turf Manufacturer shall submit silica sand and crumb rubber mix to certified testing lab for total combined CU value, to be reviewed and approved by the EOR prior to installation.

D. Glued seams

1. Adhesives for bonding tufted synthetic turf shall be one-part moisture cured polyurethane obtained from a single manufacturer. Modify the adhesive as recommended by the Manufacturer during adverse weather conditions.
2. Supplemental backing material shall be used if inlay seams are cut thru the turf product.
3. Product
 - a. Nordot Adhesive #34G
 - b. Sopracolle "E", Manufacturer – Soprema USA, Wadsworth, Ohio
 - c. Approved equal
4. Supplier
 - a. Synthetic Surfaces, Scotch Plains, NJ, (908) 233-6803
 - b. Approved equal

E. Sewn Seams

1. Cord for sewing seam turf shall be high strength polyester fiber or nylon as recommended by the synthetic turf manufacturer, utilizing the flap method for joining seams.

F. Turf Perforations

1. Turf products with a coated or impermeable backing must include perforations in the backing.
2. Perforations shall be a minimum of 3/16 inch diameter clear opening with a uniform maximum spacing of 4 inches on center.
3. Perforations shall be full diameter with no residue or hanging fibers remaining.
4. Turf products with permeable backing do not require perforations.
5. A minimum percolation rate for all turf products of 20 inches per hour shall be provided for the backing as verified by an independent testing agent.

G. Vendors

1. Each vendor shall bid their respective premier products meeting NCAA Football requirements. Acceptable turf systems or approved equal as follows:
 - a. Interior basis of design – AstroTurf LLC
 - 1) Rootzone 3D3 Blend
 - b. Or Approved Equal

2.7 SYNTHETIC TURF NON-INFILL PRODUCT

A. Vendors

1. Each vendor shall bid their respective premier products. Acceptable turf systems or approved equal as follows:
 - a. Exterior basis of design – SYNLawm
 - 1) SYNPro 60 with 5mil pad, solid green (color to be approved by ICA)
 - b. Or Approved Equal

2.8 ADHESIVE FOR NON-INFILL SYNTHETIC TURF

- A. Synthetic turf installed over concrete base to be a full glue down / trowel application.
1. Mapei Ultrabond Turf PU 2K

2.9 SYNTHETIC INFILL TURF MAINTENANCE EQUIPMENT

- A. Equipment to be included as an Add On to project pricing.

PART 3 - EXECUTION

3.1 EXAMINATION AND PROTECTION

- A. Previous Documents: Playing Field Contractor to review Earthwork specifications from previous work to become familiar with and understand the extent of the previous work in regards to earthwork and sub-grade conditions.
- B. Verification of Conditions: Examine areas and conditions under which all work of this Section is being performed. Do not proceed with any work until unsatisfactory conditions have been corrected. Commencement of work implies acceptance of all areas and conditions.
- C. Protection of Work: Protect all on-going work, so as not to delay work due to weather or project related construction. This includes but is not limited to the use of tarps, geotextile, plywood and other protective measures.

- D. Protection of Persons and Property: Provide all necessary measures to protect workmen and passersby. Barricade open excavations occurring as part of the work, as required by municipal or other authorities having jurisdiction.
 - 1. Protect adjacent construction throughout the entire operation. Protect newly graded areas from destruction by weather or runoff. Protect structures, utilities, pavements, and other improvements from damage caused by settlement, lateral movement, undermining and washout.
- E. Unanticipated Conditions: Notify the Engineer immediately upon finding evidence of previous structures, filled materials that penetrate below designated excavation levels, or other conditions which are not shown, or which cannot be reasonably assumed from existing surveys and geotechnical reports. Secure the Engineer's instruction before proceeding with further work in such areas.

3.2 EARTHWORK EXECUTION / PLAYING FIELD SUBGRADE

- A. Preparation
 - 1. Establish required lines, levels, contours and datum. Contractor responsible for work shall coordinate and ensure that the final grade of various materials such as the Base Stone, turf infill, etc., will result in the final field grades shown on the Contract Drawings when the complete system is installed.
 - 2. Maintain benchmarks and other elevation control points. Re-establish, if disturbed or destroyed, at no additional cost to the Owner.
 - 3. Establish location and extent of utilities before commencement of grading operations.
 - 4. Groundwater Control
 - a. Where groundwater levels are sufficiently high, provide pumps in sumps as required maintaining groundwater at a minimum depth of two feet below excavation bottom at all times. Maintain dry conditions until completion and acceptance of the base, prior to synthetic turf placement.
 - b. Provide standpipes or other means of monitoring groundwater levels during groundwater control operations. Sumps shall be lined with geotextile drainage fabric. Conduct dewatering operations in a manner which will limit the withdrawal of fines.
 - 5. Surface Water Control
 - a. All earthwork operations shall be conducted in a manner to prevent surface water from infiltrating into the subgrade and base. Drainage is to be maintained in all parts of the site to drain surface water without ponding at all times. The Contractor, at his own expense, shall undercut soils saturated by ponding and backfill per this Section at the direction of the Engineer.
- B. Excavation
 - 1. Excavation shall consist, in general, of the excavation of whatever substance is encountered to the lines, grades and sections shown on the Drawings, including excavation as necessary for grading and other similar features.
 - 2. During construction, the grading operations shall be executed in such a manner that the excavation will be well drained at all times. All grading shall be finished on neat, regular lines conforming to the sections and contours shown on the Plans.
 - 3. Removal of materials beyond the indicated subgrade elevations, without authorization by the Engineer, shall be classified as unauthorized excavation and shall be performed at no additional cost to the Owner.
 - 4. Excavation shall be performed in proper sequence with all other associated operations.

5. Maintain the slopes of excavation in a safe condition until completion of the grading operation.
6. All excavation work shall be reviewed and approved by the Engineer before proceeding with construction.
7. Any excess excavation shall be removed from the site to disposal areas at the Contractor's expense.

C. Fill

1. All site fill shall be "Structural Fill" unless otherwise shown on the Drawings, or directed by the Engineer. "Structural Fill" shall be placed in lieu of "Suitable Material" where directed by the Engineer.
2. Remove vegetation, debris, unsatisfactory soil materials, obstructions, and deleterious materials from ground surface prior to placement of fills.
3. Prior to placing fill over undisturbed material, scarify to a minimum depth of six (6) inches.
4. The original ground or subgrade shall be proof rolled until the underlying soil is thoroughly compacted to the satisfaction of the Engineer. A steel-wheel tandem roller weighing 8 to 10 tons or equipment capable of obtaining the same compactive effort shall be used to obtain a thoroughly compacted subgrade. The subgrade shall be inspected prior to any fill operations or construction of improvements. Remove or re-compact any soft or loose soils as determined by the Engineer prior to filling. Remove any material determined to be unsuitable by the Engineer and replace with compacted suitable material.
5. A thoroughly and satisfactorily compacted subgrade is defined as having a minimum dry density of 95 percent of the maximum density of the material used as determined by the Standard Proctor test (ASTM D 698). The subgrade material shall be compacted at moisture content suitable for obtaining the required density.
 - a. When existing subgrade ground surface has a density less than that specified under "Compaction" for particular area classification, break up ground surface. Scarify existing subgrade to depth of 8 inch prior to compacting. Moisture condition between 3 percent below and 2 percent above optimum moisture content, and re-compact to at least 95 percent of standard Proctor density (ASTM D698).
6. Place backfill and fill materials in layers not more than six (6") in loose depth. Lift height shall be governed by the ability of the compaction equipment to obtain the required compaction with six (6") as a maximum lift height. Before compaction, moisten or aerate each layer as necessary to facilitate compaction to the required density. Do not place backfill or fill material on surfaces that are muddy, frozen, or contain frost, ice, ponded water or extraneous debris.
7. When work is suspended during periods of freezing weather, measures shall be taken to prevent fill already in place from freezing. Upon resumption of work after any inclement weather, prepare the exposed surface by proof rolling to identify any zones of soft/loose soils. Soft/loose materials or frozen soils shall be removed and replaced by compacted select fill.

D. Moisture Control:

1. Where subgrade soil material, fill or backfill must be moisture conditioned before compaction, uniformly apply water to the surface and to each layer of fill or backfill as necessary to provide optimum moisture content. Prevent ponding or other free water on surface subsequent to, or during, compaction operations.
2. Remove and replace, or scarify and air dry, soil that is too wet to permit compaction to specified density. Soil that has been removed because it is too wet to permit compaction may be stockpiled or spread and allowed to dry. Assist drying by discing, harrowing or pulverizing, until moisture content is reduced to a value which will permit compaction to the percentage of maximum density specified.

E. Grading

1. The finished grade lines are shown on the contract drawings. Upon completion of this work, all debris shall be cleaned out and removed from the premises.
2. All cutting, filling, backfilling and grading necessary shall be done to bring the area to the following grade or subgrade levels:
 - a. The final elevation of the Subgrade shall be within one-half inch on a 25 foot by 25 foot grid of the finished grades indicated on the Contract Drawings. Laser controlled or indicated equipment shall be used for this part of the work.
 - b. Subgrade shall mirror the final finish elevation of the field surface in regards to slope except where noted on the drawings.
 - c. All surfaces shall be graded to drain to drainage structures with no ponding. Grading tolerances given above do not relieve the Contractor from this requirement.
3. Sufficient grading must be done during the progress of the work so that the entire site shall be well drained and free from water pockets.
4. Finish grading, including dressing swales, disposing of excess material and all other work necessary to prepare the site for final surfacing shall be done after construction of structures is complete.

F. Compaction Equipment

1. Compaction equipment used for the Work is subject to approval by the Engineer. Any equipment not originally manufactured for compaction purposes and equipment which is not in proper working order will not be approved. Furnish manufacturer's specifications covering data not obvious from a visual inspection of the equipment and necessary to determine its classification and performance characteristics.

3.3 EARTHWORK EXECUTION / FINISH PLAYING FIELD SUBGRADE

A. Playing Field Sub-grade Requirements

1. Trim to finish playing field sub-grade meeting the finish elevation tolerances as described in herein.
2. All cutting, filling, backfilling and grading necessary shall be done to bring the playing field areas to the following tolerances:
 - a. The final elevation of the finish playing field sub-grade shall be plus or minus one-tenth inch at any point on the field and on a 25 foot by 25-foot grid of the finished grades indicated on the Contract Drawings. Laser controlled or indicated equipment shall be used for this part of the work.
 - b. Finish playing field sub-grade shall mirror the final finish elevation of the field surface in regards to slope except where noted on the drawings.

- B. Playing Field Sub-grade elevation verification: A certified survey by a State licensed land surveyor shall be performed at 25-foot centers for each field to verify grade and elevation of the sub-grade. The survey shall indicate spot elevations and tenth of foot contours. Must be reviewed and approved by the Engineer of record before placement of any additional materials.

C. Layout and Control

1. The Contractor shall be responsible for furnishing, setting and marking of all line, grade and location stakes, including offsets and general construction staking.
2. Playing Field Contractor to establish required lines, levels, contours and datum in preparation of achieving finish playing field surface grade. Contractor responsible for work shall coordinate and ensure that the final elevations of various materials such as the

Base Stone, turf infill, etc., will result in the final playing surface turf elevations shown on the Contract Drawings when the complete system is installed.

3. Maintain benchmarks and other elevation control points. Re-establish, if disturbed or destroyed, at no additional cost to the Owner.
4. Establish location and extent of utilities before commencement of grading operations.
5. Surface Water Control
 - a. All earthwork operations shall be conducted in a manner to prevent surface water from infiltrating into the sub-grade and base. Drainage is to be maintained in all parts of the site to drain surface water without ponding at all times. The Contractor, at his own expense, shall undercut soils saturated by ponding and backfill per this Section at the direction of the Engineer.

D. Playing Field Finish Sub-Grading

1. After approval of sub-grade, trenching
2. All cutting, filling, backfilling and grading necessary shall be done to bring the playing field areas to the following tolerances:
 - a. The final elevation of the finish playing field subgrade shall be plus or minus one-quarter inch at any point on the field and on a 25 foot by 25 foot grid of the finished grades indicated on the Contract Drawings. Laser controlled or indicated equipment shall be used for this part of the work.
 - b. Finish playing field subgrade shall mirror the final finish elevation of the field surface in regards to slope except where noted on the drawings.

E. Playing Field Finish Subgrade elevation verification: A certified survey by a State licensed land surveyor shall be performed at 25-foot centers for each field to verify grade and elevation of the subgrade. The survey shall indicate spot elevations and tenth of foot contours.

F. Finish grading outside of the playing field areas:

1. Includes but not limited to disposing of excess material and all other work necessary to prepare the site for final surfacing shall be done after construction of structures is complete.
2. All surfaces shall be graded to drain to drainage structures with no ponding.
3. Shall be graded to a tolerance of one tenth inch.

3.4 FIELD CURB/TURF NAILER

- A. Install approved anchoring / nailing system(s) at entire perimeter / edges of turf installation.
1. Building perimeter grade beam will be used as the ballast / curb for the field attachment system.

3.5 DRAINAGE SYSTEM INSTALLATION

A. Drainage and Pipe Trenching in Finished Subgrade

1. Contractor to connect playing field drainage system where shown on drawings to site storm drainage.
2. Excavate trenches for collector and header pipe to a uniform width, sufficiently wide to provide ample working room.
 - a. Minimum width of twice the pipe diameter and as indicated on drawings.
 - b. Abnormal conditions such as large cobbles or unstable conditions that may cause trench to lose integrity shall be reported to Engineer immediately.

3. Excavate trenches and conduit to depth indicated or required to establish indicated slope and invert elevations and to support bottom of pipe or conduit on undisturbed soil.
 4. Contractor to remove or manipulate spoils from trenching excavation so that integrity of finished grade requirements is maintained prior to placing filter fabric.
- B. Installation of Geotextile Filter Fabric:
1. Fabric shall be placed as recommended by the manufacturer and approved by the Engineer on surfaces which have been prepared to conform to these Specifications and found acceptable for fabric installation.
 2. All overlaps/seams in the field area shall be at least twelve inches in width without tension, stress, folds, or creases. Overlap in the direction of the runoff flow.
 3. Install geotextile fabric onto entire extent of subgrade, bottom and sides of trenches.
 - a. Extend fabric a minimum of 12 inches past each side of top of trench on top of the subgrade.
 4. Sandbags or other devices may be used as required to hold the fabric in position during installation. Materials, equipment or other items shall not be dragged across the fabric or be allowed to slide down slopes on the fabric.
 5. Smoking shall not be permitted by personnel working on the fabric.
 6. All areas of fabric damaged during installation as determined by the Engineer shall be repaired by the Contractor as specified at no additional cost to the Owner.
 7. At time of installation, fabric will be rejected if it has defects, ribs, holes, flaws, deterioration, or damage incurred during manufacture, transportation, handling, or storage. Damaged materials shall be removed and replaced at no additional cost to the Owner.
 8. Fabric shall be covered as soon as possible after placement to minimize exposure to sunlight and to other types of contamination such as surface run-off.
 - a. Fabric shall not be exposed for more than 10 days.
 - b. Fabric which becomes overly contaminated shall be removed and replaced with new fabric.
 9. Contractor to temporarily fold fabric over at the tops of the trenches during construction to eliminate migration of soil materials into the gravel trench. Just prior to installation of Base Stone, this fold shall be undone and fabric shall be laid over the finished subgrade. Should contamination of the gravel trench occur, Contractor shall remove contaminated material and replace with clean approved materials at no cost to the Owner.
- C. Installation of Collector/Header Pipe
1. After installation of the geotextile fabric, place collector pipe directly on bottom of trench. (A 2 inch gravel bed on the bottom of the trench can be placed first at the Contractor's option.)
 2. Lay perforated collector pipe in accordance with pipe manufacturer's recommendations. Provide collars and couplings as required for installation of this line and for connection with the under drain collection piping system and trench drains.
 3. Install locator tape around or on the drainage pipe for future detection.
 4. Pipe laying work shall commence at the main collector line and shall proceed from low point of system to high point.
 - a. Pipe shall be laid true to line and grade in such a manner as to assure a close concentric joint with the adjoining pipe.
 5. Install collector as indicated on drawings so that it connects to structures or extends to limits indicated on drawings.

- a. Protect any exposed ends of pipe until connected to detention or storm sewer system by playing field Contractor or others.
6. After pipe installation has been observed by the Playing Field Designer/Engineer, approved drainage material shall be placed around and over the pipe to the top of the trench.
 - a. If observation indicates poor alignment, debris, displaced pipe, infiltration or other defects, Contractor to take whatever steps are necessary to correct such defects prior to proceeding.

3.6 INSTALLATION OF BASE STONE / FINISH STONE

- A. Install only tested and approved material at a uniform depth as indicated on drawings.
- B. Placement of the Base Stone shall proceed from a stable area next to the geotextile fabric and systematically worked outward onto the field area.
 1. The cover material shall be pushed forward and not dumped onto the liner.
 2. Laser operated equipment shall be utilized.
 3. All equipment used in spreading or traveling on the cover layer shall exert low ground pressures and shall be approved by the manufacturer and Engineer.
 4. During placement and spreading,
 - a. A minimum depth of 4 inches of granular material shall be maintained at all times between the fabric and wheels of trucks or spreading equipment.
 - b. Dozer blades, etc. shall not make direct contact with the fabric. If tears occur in the fabric during the spreading operation, the granular material shall be cleared from the fabric and the damaged area repaired as previously described.
 - c. All equipment traveling on the cover layer shall avoid making sharp turns, quick stops or quick starts.
 - d. Care shall be taken to not disturb, displace or damage the geotextile fabric or the drainage system.
 - e. Contractor shall install Base Stone layer in such a way as to reduce separation of the fines and larger particles in the stone blend.
- C. Placement of the Finish Stone: This stone layer shall be placed over the Base Stone at a finished depth as shown on the drawings to produce a level/smooth surface prior to the placement of the synthetic turf. Due to possible drifting of this finish stone material into the Base Stone layer below, more material may be required than the finished depth to eventually achieve finished grade elevations at the top of the finish stone layer and shall be considered as part of the overall quantities necessary.
 1. Contractor shall install Finish Stone layer in such a way as to reduce separation of the fines and larger particles in the stone blend.
- D. Finish grade for Base Stone and Finish Stone
 1. Shall be verified using laser operated survey instrument with a tolerance of +/- one-quarter inch over 25 feet in any direction.
- E. A survey of the finished spot grades is to be developed by a State licensed surveyor over the entire surface in a 25 foot grid. The survey shall be certified (signed) and submitted to the Owner and its representatives for approval prior to installing the synthetic turf. The survey shall indicate spot elevations and tenth of foot contours.

3.7 INSTALLATION OF SYNTHETIC TURF

-
- A. Prior to beginning turf installation on the field, the Turf Installer shall submit a written statement accepting the playing field area conditions as described earlier in this Specification.
- B. Synthetic turf shall be installed by crews approved by the Synthetic Turf manufacturer and employed by the Field Contractor, in strict accordance with manufacturer's recommendations and instructions including but not limited to fabric, adhesives, seaming and abutting or attaching to adjacent materials.
- C. Field Markings and layout:
1. Field shall be temporarily secured at the edges with ballast or other similar means as reasonably possible to prevent wind from misaligning or moving the turf installation prior to and throughout the installation of the infill materials.
 2. The field lines shall be tufted or inlaid for field sports as shown on the drawings.
 3. All lines, and markings shall be tufted in or installed as inlays. Wherever possible, lines shall be tufted into turf panels in lieu of inlays. All markings shall have distinct edges and shall not vary more than 1/4 inch in width and location.
 4. The synthetic turf shall be of sufficient length to permit full cross field installation. No head or cross seams shall be allowed except where required for lining.
 5. Any painted lines shall be by Owner.
 6. Final field markings and lining of synthetic field surfacing shall be laid out as shown on the drawings, shop drawings and as approved by the Engineer and Owner.
 7. Owner to make final determination of colors, markings, etc.
- D. Seams and inlays:
1. All sewn seams (main seams) shall be sewn with high strength polyester or nylon cord using a double loop stitch or glued with an adhesive as recommended by the synthetic turf manufacturer and installed per manufacturer's instructions.
 2. All seams shall be flat, tight and permanent with no separation or fraying.
 3. The width between fiber rows at seams shall be equal to that of the tufting gauge of the turf product.
 4. All sewn seams shall be brushed and fibers trimmed as necessary so as to appear "seamless".
 5. All sewn seams shall be rolled prior to infill material installation for smooth surface appearance and feel.
 6. All glued seams (inlays) shall be brushed to eliminate adhesive materials from turf fibers.
 7. Supplemental backing used at glued seams (inlays shall bridge the seam or edges a minimum of 4 inches).
 8. All inlaid lines shall be backed using seaming tape with a width of 12 inches or shaved in and glued to backing as per Turf Vendors premium installation methods.
- E. Application of adhesive materials or infill materials shall not be applied when:
1. Air or material temperatures are below 10 degrees C.
 2. Rain is falling or conditions exist or are pending that will be unsuitable to the installation.
- F. Infill materials:
1. Do not begin installation of the infill materials until the field has been observed in the presence of the Engineer/Owner. Debris from turf installation shall be removed, seams and inlays shall be observed. Inlays using glue shall be properly set up before infill is added.
 2. Apply dry materials when the turf is dry.
 3. The path from the stored on-site infill materials shall be kept clean and clear to eliminate contamination onto the playing field area.

4. For installations utilizing 100% rubber infill, the infill shall be applied in numerous uniform layers over the entire surface with industry standard broadcasting equipment.
5. For installations utilizing sand and rubber infill, the infill shall be applied in numerous uniform layers over the entire surface with industry standard broadcasting equipment.
6. The Contractor shall utilize a combination of rolling and watering the surface after infill materials have been installed to settle the materials into the turf. After this process, the Engineer/Owner shall inspect the surface for footing and stability and possible settlement or unevenness of infill depth. Additional treatments may be required to achieve approval by the Owner and Engineer to achieve footing, stability and uniformity of infill depth.
7. Infill materials shall be applied at a uniform depth and at an ultimate finish grade tolerance of 1/4 inch at any point over the entire playing field area.
8. Fiber shall not be buried or trapped below infill material when complete.

G. Anchor turf edges at field curb at field perimeter using wood nailer as shown on drawings.

3.8 FIELD MARKINGS

- A. The field lines shall be tufted or inlaid per Owner
1. General
 - a. The final field markings shall meet NCAA standards and as shown on the drawings.
 - b. Owner to make final determination of colors and logos, etc...
 2. Football field:
 - a. These line markings tufted to be white.
 - 1) Side lines
 - 2) End lines
 - 3) Yard lines
 - 4) Hash marks
 - b. Logos
 - 1) Mid Field Logo will be inlaid according to artwork supplied by the Owner or its' representative to the Playing Field Contractor.
 - 2) SEC logos to match game field
 - 3) End zone graphics to match game field
 - 4) Yards line numbers

3.9 SPORTS EQUIPMENT INSTALLATION

- A. Football goals posts and Standards
1. Goal posts are hung from structure and specified elsewhere.

3.10 CLEAN UP

- A. At the end of each day, remove all scraps and other debris created by the synthetic turf installation from the playing field area.
- B. At end of turf installation and just prior to punch list, contractor to use magnetic device/equipment to remove all metallic materials on field caused by construction.
- C. Remove all surplus excavated material not required for filling and backfilling, trash, and debris and dispose of it properly off of the Owner's property at Contractor's expense.
- D. Leave the premises and work in clean, satisfactory condition.
- E. Drainage grates shall be cleaned, trash baskets clean and free of debris and trenches flushed with water prior to turning over project to Owner.

3.11 PROTECTION

- A. Protection of materials and work shall be the responsibility of the Contractor during installation and thru acceptance/substantial completion. All material damaged prior to acceptance shall be replaced at no cost to the Owner.

END OF SECTION

SECTION 32 31 17 - SITE FURNISHINGS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes the following site furnishings:
 - 1. Fixed Bollard
 - 2. Removable Bollard
 - 3. Removable Bollard Rack
 - 4. Bicycle Racks
 - 5. Trash Receptacles
 - 6. Benches
- B. Related Sections include the following:
 - 1. Division 31, Section "Earthwork" for excavation for installation of concrete footings.
 - 2. Division 32, Section "Concrete Paving" for installation of anchor bolts cast in concrete footings.
- C. Products furnished, but not installed under this Section, include anchor bolts to be cast in concrete footings.

1.2 SUBMITTALS

- A. Product Data: For each type of product indicated. Include construction details, material descriptions, dimensions of individual components and profiles, finishes, field-assembly requirements, and installation details.
- B. Samples for Verification: For each type of exposed finish required, prepared on Samples of size indicated below.
 - 1. Size: Not less than 6-inch- (150-mm-) long linear components and 4-inch- (100-mm-) square sheet components.
- C. Product Schedule: For site and street furnishings. Use same designations indicated on Drawings.
- D. Material Certificates: For site and street furnishings, signed by manufacturers.
- E. Maintenance Data: For site and street furnishings to include in maintenance manuals.
- F. Shop Drawings: Shop details of fabrication and installation for each type and material required including plans, sections, connections and anchors.
- G. The approval of shop drawings, submittals or samples does not relieve the contractor of responsibility for any deviation from the requirements of the Contract Documents, unless the Contractor has informed the Architect in writing of such deviation at the time of submission, has noted the deviation on the shop drawings, and the Architect has given written approval of the specific deviation. The Architect's approval also does not relieve

the Contractor from responsibility for errors or omissions in the shop drawings, submittals or samples.

1.3 QUALITY ASSURANCE

- A. Source Limitations: Obtain each type of site and street furnishings through one source from a single manufacturer.
- B. Warranty: Structural integrity of all metal bollards shall be warranted for a period of 5 years from date of delivery against defects in materials and workmanship except for finishes of any kind.

1.4 EXTRA MATERIALS

- A. Furnish extra materials described below that match products installed and that are packaged with protective covering for storage and identified with labels describing contents.
 - 1. Trash Receptacle Inner Containers: Full-size units equal to 10 percent of amount installed for each size indicated, but no fewer than 2 units.

PART 2 - PRODUCTS

2.1 PRODUCTS

- A. Basis-of-Design Products: Subject to compliance with requirements, provide products indicated below or comparable products by another manufacturer.
 - 1. Fixed Bollard:
 - a. Manufacturer or Approved Comparable: Calpipe
 - b. Model: SSF05040
 - c. Finish: Stainless Steel
 - 2. Removable Bollard:
 - a. Manufacturer or Approved Comparable: Calpipe
 - b. Model: SSP05040
 - c. Finish: Stainless Steel
 - 3. Removable Bollard Rack:
 - a. Manufacturer or Approved Comparable: Traffic Guard
 - b. Model: 2 Unit Removable Bollard Rack
 - c. Installation: Per Manufacturer's Recommendations
 - d. Finish: Hot Dipped Galvanized
 - 4. Bike Rack:
 - a. Manufacturer or Approved Comparable: Forms and Surfaces
 - b. Model: Trio
 - c. Mounting Type: Surface Mounted to Embedded Anchors
 - d. Finish: Powdercoat
 - e. Color: Black
 - 5. Trash Receptacles:

- a. Manufacturer or Approved Comparable: Forms and Surfaces
 - b. Model: Dispatch Littler and Recycling Receptacle: Single Stream
 - c. Size: 45 Gallon
 - c. Finish: Powdercoat
 - d. Color: Black
6. Benches:
- a. Manufacturer or Approved Comparable: QCP Concrete Solutions
 - b. Model: Slab: Q2-SLAB-36B
 - c. Length: 60"
 - d. Color: French Gray
- B. Steel: Free from surface blemishes and complying with the following:
1. Plates, Shapes, and Bars: ASTM A 36/A 36M.
 2. Steel Pipe: Standard-weight steel pipe complying with ASTM A 53, or electric-resistance-welded pipe complying with ASTM A 135.
 3. Tubing: Cold-formed steel tubing complying with ASTM A 500.
 4. Mechanical Tubing: Cold-rolled, electric-resistance-welded carbon or alloy steel tubing complying with ASTM A 513, or steel tubing fabricated from steel complying with ASTM A 569/A 569M and complying with dimensional tolerances in ASTM A 500; zinc coated internally and externally.
 5. Sheet: Commercial steel sheet complying with ASTM A 569/A 569M.
- C. Anchors, Fasteners, Fittings, and Hardware: Manufacturer's standard, corrosion-resistant-coated or non-corrodible materials; commercial quality; tamperproof, vandal and theft resistant; concealed, recessed, and capped or plugged. Provide as required for site and street furnishings' assembly, mounting, and secure attachment.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions, with Installer present, for compliance with requirements for correct and level finished grade, mounting surfaces, installation tolerances, and other conditions affecting performance.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION, GENERAL

- A. Comply with manufacturer's written installation instructions, unless more stringent requirements are indicated. Complete field assembly of site and street furnishings, where required.
- B. Unless otherwise indicated, install site and furnishings after landscaping and paving have been completed.

- C. Install site and furnishings level, plumb, true, and securely anchored at locations indicated on Drawings.

3.3 CLEANING & PROTECTION

- A. Protect installed products until completion of project.
- B. After completing site and street furnishing installation, inspect components. Remove spots, dirt, and debris. Repair damaged finishes to match original finish or replace component.

END OF SECTION 32 31 17

SECTION 32 31 23 - VINYL COATED CHAIN LINK FENCE

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. Drawings and general provisions of Contract, including General and Supplementary Conditions and Division 1 Specification Sections, apply to this Section.

1.2 SUMMARY

- A. This Section includes the following:
 - 1. Polyvinyl Chloride (PVC) coated steel chain link fence and gates and galvanized steel chain link fence

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Conditions of Contract and Division 1 Specification Sections.
- B. Product data in the form of manufacturer's technical data, specifications, and installation instructions for fence and gate posts, fabric, gates, and accessories.
- C. Shop drawings showing location of fence, gates, each post, and details of post installation, extension arms, gate swing, hardware, and accessories.
- D. Samples for verification of PVC color in form of 6-inch lengths of actual fabric wire to be used in color selected.
- E. Include similar samples of PVC applied on posts, rails, and accessories in color selected.

1.4 QUALITY ASSURANCE

- A. Single-Source Responsibility: Obtain chain link fences and gates as complete units, including necessary erection accessories, fittings, and fastenings from a single source or manufacturer.

PART 2 - PRODUCTS

2.1 MANUFACTURERS

- A. Available Manufacturers: Subject to compliance with requirements, manufacturers offering products that may be incorporated in the Work include, but are not limited to the following:
- B. Manufacturers: Subject to compliance with requirements, provide products by one of the following:

1. PVC Coated Galvanized Steel Fencing and Fabric:
 - a. Anchor Fence, Inc.
 - b. BWF Fence Systems
 - c. MMI

2.2 FABRIC

- A. Steel Fabric: Comply with Chain Link Fence Manufacturers Institute (CLFMI) Product Manual. Furnish one-piece fabric widths for fencing up to 12 feet high.
1. Size: 2-inch mesh.
 2. Galvanized Steel Finish: ASTM A 392, Class 1, with not less than 1.2 oz. zinc per sq. ft. of uncoated wire surface.
 3. Polyvinyl Chloride (PVC) Finish: Comply with ASTM F 668, with core wire diameter (gage) measured prior to application of PVC coating with not less than 0.40 oz. zinc per sq. ft. of uncoated surface on 6 gage wire and not less than 0.30 oz. zinc per sq. ft. of uncoated surface on 9 and 11 gage wire. Color - Black.
 4. Class 2b, 0.006- to 0.010-inch-thick PVC coating fused and adhered to zinc-coated steel wire.

FUSED AND BONDED
 VINYL-COATED WIRE SPECIFICATIONS

Use	(Core Wire)		Vinyl Coated Wire		Tolerance		Minimum Vinyl Thickness		Minimum Galvanized Coating		Minimum Breaking Strength		Minimum Tensile Strength	
	ga.	in.	Mm	Gage	in.	mm	in.	mm.	oz/ft ²	g/m ²	lbf	N	Kai	Mpa
For detention facilities only	6	0.19	4.9	5	+/- .005	0.1	0.01	0.15	0.4	122	2170	9660	75	15
All other applications	9	0.15	3.8	8	1.005	0.1	0.01	0.15	0.3	92	1290	5740	75	515
For mesh size of 1-3/4 or less	11	0.12	3.1	10	1.006	0.1	0.01	0.15	0.3	92	860	3760	75	616

TYPICAL VINYL PROPERTIES

	TEST METHOD	VALUE
Specific Gravity	ASTM D 7921	1.30 Max +/- .03
Hardness Durometer	ASTM 0 676	A90 +/- 5
Tensile Strength	ASTM 0 412	2600 +/- 5%
Ultimate Elongation	ASTM 0412	275% +/- 5%
Mandrel Bend 10 X Mandrel (for Vinyl-Clad Wire)		
5 RPM 5 lb. wt. -20 degrees C		
Dialectic Strength volt/ml	AxTM6149	750
Compression Cut through lbs.	Bell Labs	1500
Accelerated Aging Test	ASTM D 1489 1500 hrs. @ 148degrees F	

- B. Aluminum Fabric: 9-gage (0.148-Inch diameter) mill-finished aluminum wires, ASTM B 211, alloy 6061-T94, 2-inch mesh, complying with ASTM F 1183.

2.3 FRAMING

- A. Strength requirements for posts and rails conforming to ASTM F 669.
- B. Pipe shall be straight, true to section, material, and sizes specified, and shall conform to the following weights per foot:

NPS in inches	Outside Diameter (OD) in inches	Type I Steel	Type II	
			Steel	Aluminum
1	1.315	1.68	1.35	0.435
1-1/4	1.660	2.27	1.84	0.786
1-1/2	1.900	2.72	2.28	
2	2.375	3.65	3.12	1.260
2-1/2	2.875	5.79	4.64	2.004
3	3.500	7.58	5.71	
3-1/2	4.000	9.11	6.56	3.151
4	4.500	10.79		
6	6.625	18.97		6.564
8	8.625	28.55		9.878

- C. Steel Framework, General: Posts, rails, braces, and gate frames.
- D. Type I Pipe: Hot-dipped galvanized steel pipe conforming to ASTM F 1083, plain ends, standard weight (schedule 40) with not less than 1.8 oz. zinc per sq. ft. of surface area coated.
- E. Polyvinyl Chloride (PVC) Finish: Provide framework, fittings, and accessories with manufacturer's standard polyvinyl chloride (PVC) plastic resin finish thermally bonded and adhered to a cured primer applied over zinc-coated steel, not less than 10 mils (0.010-inch) thick. Color: Black.
- F. Up to 6 feet: 2.375-inch OD Type I steel pipe, 2-inch square galvanized steel tubing weighing 2.60 lb. per lin. ft., or 3.5-inch by 3.5-inch roll-formed sections weighing 4.85 lb. per lin. ft.
- G. Over 6 Feet: 2.875-inch OD Type I steel pipe, 2.50-inch-square steel tubing weighing 5.10 lbs. per lin. ft., or 3.5-inch by 3.5-inch roll-formed sections weighing 4.85 lbs. per lin. ft.
- H. Up to 6 feet: 1.90-inch OD Type I steel pipe, 1.875- inch by 1.625-inch C section weighing 2.28 lb. per un. ft., or 2.25- inch x 1.70-inch galvanized steel H section weighing 3.26 lb. per lin. ft.
- I. Over 6 feet: 2.375-inch OD Type I steel pipe, 2.25-inch by 1.70-inch C section weighing 2.70 lbs. per un. ft., or 2.25-inch by 1.70-inch galvanized steel H section weighing 3.26 lb. per un. ft.

- J. Up to 6 feet: 2.875-inch OD Type I steel pipe, 2.50-inch square galvanized steel tubing weighing 5.10 lbs. per un. ft., or 3.5-inch x 3.5-inch roll-formed sections weighing 4.85 lbs. per un. ft.
- K. Over 6 feet to 13 feet: 4.00-inch OD Type I steel pipe.
- L. Top Rail: 1-5/8" OD Sch-40 pvc; manufacturer's longest lengths, with expansion-type couplings, approximately 6 inches long, for each joint. Provide means for attaching top rail securely to each gate corner, pull, and end post.
- M. Galvanized Steel: 1-1/4-inch NPS (1.66-inch OD) Type I steel pipe

2.4 FITTINGS AND ACCESSORIES

- A. Material: Comply with ASTM F 626. Mill-finished aluminum or galvanized iron or steel, to suit manufacturer's standards. Fittings and accessories are coated with matching vinyl (PVC) by the same process as the posts and rails. Painted fittings area not acceptable.
- B. Zinc Coating: Unless specified otherwise, galvanize steel fence fittings and accessories in accordance with ASTM A 153, with zinc weights per Table I.
- C. Tension Wire: 0.177-inch-diameter metallic-coated steel marcelled tension wire conforming to ASTM A 824 with finish to match fabric.
- D. Post Brace Assembly: Manufacturers standard adjustable brace at end and gate posts and at both sides of corner and pull posts, with horizontal brace located at midheight of fabric. Use same material as top rail for brace, and truss to line posts with 3/8-inch-diameter rod and adjustable tightener. Provide manufacturers standard galvanized steel or cast iron or cast aluminum cap for each end.
- E. Bottom and Center Rail: Same material as top rail. Provide manufacturers standard galvanized steel or cast iron or cast aluminum cap for each end.
- F. Post and Line Caps: Provide weathertight closure cap for each post. Provide line post caps with loop to receive tension wire or top rail.
- G. Tension or Stretcher Bars: Hot-dip galvanized steel with minimum length 2 inches less than full height of fabric, minimum cross-section of 3/16 inch by 3/4 inch and minimum 1.2 oz. zinc coating per sq. ft. of surface area. Provide one bar for each gate and end post, and two for each corner and pull post, except where fabric is integrally woven into post.
- H. Tension and Brace Bands: Minimum 3/4-inch-wide hot-dip galvanized steel with minimum 1.2oz. zinc coating per sq. ft. of surface area.
- I. Tension Bands: Minimum 14 gage (0.074 Inch) thick.
- J. Tension and Brace Bands: Minimum 12 gage (0.105 Inch) thick.
- K. 3000 psi minimum strength for foundation concrete.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. General: Install fence in compliance with ASTM F 567. Do not begin Installation and erection before final grading is completed, unless otherwise permitted.
- B. Setting Posts: Center and align posts in sleeves. Space maximum 10 feet o.c., unless otherwise indicated.
- C. Top Rails: Run rail continuously through line post caps. bending to radius for curved runs and at other posts terminating into rail end attached to posts or post caps fabricated to receive rail. Provide expansion couplings as recommended by fencing manufacturer.
- D. Center Rails Provide center rails where indicated. Install in one piece between posts and flush with post on fabric side, using rail ends and special offset fittings where necessary.
- E. Brace Assemblies: Install braces so posts are plumb when diagonal rod is under proper tension.
- F. Bottom Tension Wire: Install tension wire within 6 inches of bottom of fabric before stretching fabric and tie to each post with not less than same gage and type of wire. Pull wire taut, without sags. Fasten fabric to tension wire with 11-gage hog rings of same material and finish as fabric wire, spaced maximum 24 inches o.c.
- G. Fabric: Leave approximately 2 inches between finish grade and bottom selvage unless otherwise indicated. Pull fabric taut and tie to posts, rails, and tension wires. Install fabric on security side of fence, and anchor to framework so that fabric remains in tension after pulling force is released.
- H. Tension or Stretcher Bars: Thread through or clamp to fabric 4 inches o.c., and secure to end, corner, pull, and gate posts with tension bands spaced not over 15 inches o.c.
- I. Tie Wires: Use U-shaped wire of proper length to secure fabric firmly to posts and rails with ends twisted at least 2 full turns. Bend ends of wire to minimize hazard to persons or clothing.
- J. Maximum Spacing: Tie fabric to line posts 12 inches o.c. and to rails and braces 24 inches o.c.
- K. Fasteners: Install nuts for tension bands and hardware bolts on side of fence opposite fabric side. Peen ends of bolts or score threads to prevent removal of nuts.

END OF SECTION 32 31 23

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SECTION 32 32 23 - SEGMENTAL RETAINING WALLS

PART 1 - GENERAL

1.1 SUMMARY

- A. This Section includes single- and multiple- depth segmental retaining walls with soil reinforcements.
- B. Related Sections:
 - 1. Section 312000 Earth Moving

1.2 SYSTEM DESCRIPTION

- A. Basis of Design: Design of segmental retaining walls is based on products indicated. If comparable products of other manufacturers are proposed, provide engineering design for proposed products, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- B. Delegated Design: Design segmental retaining walls, including comprehensive engineering analysis by a qualified professional engineer, using performance requirements and design criteria indicated.
- C. Design Requirements
 - 1. Design retaining wall system in accordance with NCMA Design Manual for Segmental Retaining Walls.
 - 2. Design retaining wall system, including geotextile fabric, to not encroach on or impact subgrades supporting adjacent retaining walls and building foundations.
 - a. Subgrades supporting adjacent retaining walls and building foundations are defined by a line projecting vertically down from the outside edge of the foundation bottom outside corners.
 - 3. Design retaining wall system to incorporate design surcharge potentially applied by adjacent retaining walls and building foundations.
 - 4. Design retaining wall system to accommodate the following.
 - a. External stability, including base sliding, overturning, bearing capacity, and settlement.
 - b. Internal stability, including pullout and tensile overstress of soil reinforcement and internal of sliding between courses.
 - c. Local stability of segmental units including facing connection and bulging.
 - d. Global stability.
 - e. Connection design between masonry units and Geotextile fabric.
 - f. Withstand effects of loads due to soil pressures resulting from grades indicated on Drawings.
 - 1) Include the effects of sloped backfill as indicated on Drawings
- D. Work consists of furnishing and construction of an Anchor Diamond Pro Retaining Wall System in accordance with these specifications and in general conformity with the lines, grades, design, and dimensions shown on the plans.
- E. Earthwork includes:

1. Preparing Foundation Soil and Retained Soil to the lines and grades shown on the construction drawings;
 2. Furnishing and installing Leveling Pad, Reinforced Fill (where required) and Low Permeability Soil (where required) to the lines and grades shown on the construction drawings; and,
- F. Installation work includes:
1. Furnishing and installing Diamond Pro Concrete Facing Units and Unit Fill to achieve the lines and grades shown on the construction drawings.
 2. Furnishing and installing Geosynthetic Reinforcement and Separation Geotextile of the type, size, location and lengths designated on the construction drawings (if required).
 3. Furnishing and installing Subsurface Drainage System, including necessary fittings, of the type, size, and location designated on the construction drawings.

1.3 REFERENCES

- A. National Concrete Masonry Association (NCMA)
1. NCMA Design Manual for Segmental Retaining Walls, Third Edition, 2010

1.4 DEFINITIONS

- A. Segmental Retaining Wall (SRW) Units: Dry-stacked concrete masonry units used as the retaining wall fascia.
- B. Reinforced Fill: Soil which is used as fill behind the SRW unit and within the reinforced soil mass (if applicable).
- C. Unit Fill and Drainage Aggregate: Material used (if applicable) within, between, and directly behind the concrete retaining wall units.
- D. Geotextile Separation Fabric: Material used for separation and filtration of dissimilar soil types.
- E. Foundation Soil: Soil mass supporting the leveling pad and reinforced soil zone of the retaining wall system.
- F. Retained Soil: The soil mass located behind the reinforced soil zone, either undisturbed native soils or compacted fill.
- G. Leveling Pad: A level surface consisting of crushed stone, sand and gravel or unreinforced concrete placed to provide a working surface for placement of the SRW unit.
- H. Geosynthetic Reinforcement: Polymeric material designed specifically to reinforce the soil mass.
- I. Pre-fabricated Drainage Composite: three-dimensional geosynthetic drainage medium encapsulated in a geotextile filter, used to transport water.
- J. Subsurface Drainage System: horizontal pipe encapsulated within drainage aggregate at or near the base of the reinforced soil to facilitate removal of water from the wall system.

- K. Low Permeability Soil: Clay soil or low permeability geosynthetic used to prevent water percolation into the drainage zone and reinforced backfill behind the wall.
- L. Global Stability: The general mass movement of a soil reinforced segmental retaining wall structure and adjacent soil mass.
- M. Project Geotechnical Engineer: A registered engineer who provides site observations, recommendations for foundation support/global stability, and verifies soil shear strength parameters.

1.5 SUBMITTALS / CERTIFICATION

- A. Product Data
 - 1. Product Data: Material description and installation instructions for each manufactured product specified
 - 2. Name and address of the production facility where the proposed facing units will be manufactured. All units shall be manufactured at the same facility.
 - 3. Notarized letter from the facing unit manufacturer stating that the units supplied for this project are manufactured in complete compliance with this specification. The letter shall state that the units shown in the attached test reports are representative samples of the plants normal mix design and regular production runs.
 - 4. Notarized letter from the reinforcement manufacturer stating that the geosynthetic reinforcement has been manufactured in complete compliance with the reinforcement manufacturer's current NTPEP report.
- B. Samples:
 - 1. Contractor shall submit to the Design Professional for approval, and retain for the balance of the project, a minimum of one SRW unit that represents the range of texture and color permitted.
- C. Test Reports:
 - 1. Independent Laboratory reports indicating compressive strength, moisture absorption and freeze-thaw durability of the concrete retaining wall units from the proposed production facility.
 - 2. Independent test reports verifying the long-term design strength properties (creep, installation damage, and durability) and soil interaction properties of the geosynthetic reinforcement.
 - 3. Independent test reports verifying the connection capacity between the geosynthetic reinforcement and the concrete retaining wall units.
- D. Wall Design Engineer Qualifications:
 - 1. Current insurance policy verifying professional liability and errors and omissions insurance coverage for an aggregate and per claim limit of at least one million dollars (\$1,000,000).
 - 2. Notarized letter certifying the proposed retaining wall Design Engineer is a licensed professional engineer in the state of wall installation and has a minimum of 4 years and 200,000 square feet of retaining wall system design experience.
- E. Retaining Wall Contractor Qualifications:
 - 1. Notarized statement showing that the retaining wall contractor has installed a minimum of 100,000 square feet of segmental retaining walls.

2. The Retaining Wall Installer shall furnish five (5) project references of similar size and scope to this project including the wall(s) height and square footage. References shall include the contact information of Owner or General Contractor.

F. Retaining Wall Design:

1. Shop Drawings: One digitally signed set of the retaining wall system design, including wall elevation views, geosynthetic reinforcement layout, pertinent details, and drainage provisions. A registered professional engineer licensed in the state of wall installation shall sign and certify that the shop drawings are designed in accordance with the project civil plans and specifications.
2. Design Calculations: One digitally signed set of engineering design calculations prepared in accordance with the NCMA Design Manual for Segmental Retaining Walls, 3rd Edition or the AASHTO Standard Specifications for Highway Bridges (whichever is applicable). Analysis shall include Internal, External and Bearing Capacity Calculations and include the short term and long term loading conditions on the wall. A Global Stability analysis should be coordinated with the project geotechnical engineer and incorporated into the wall design.

1.6 DELIVERY, STORAGE AND HANDLING

- A. SRW Units and Accessories: Deliver, store, and handle materials in accordance with manufacturer's recommendations, in such a manner as to prevent damage. Check the materials upon delivery to assure that proper material has been received. Store SRW units above ground on wood pallets or blocking. Remove damaged or otherwise unsuitable material, when so determined, from the site.
- B. Exposed faces of SRW units shall be relatively free of chips, cracks, stains, and other imperfections detracting from their appearance, when viewed from a distance of 20 feet under diffused lighting.
- C. Prevent mud, wet cement, adhesives and similar materials that may harm appearance of SRW units, from coming in contact with system components.
- D. Geosynthetics (including geosynthetic reinforcement, geotextile filter, pre-fabricated drainage composite) shall be delivered, stored, and handled in accordance with ASTM D4873.

1.7 EXTRA MATERIALS

- A. Furnish Owner with 3 replacement SRW units identical to those installed on the Project.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. SRW Units: Anchor Diamond Pro Retaining Wall Units" as manufactured under license from Anchor Wall Systems.
 1. Physical Requirements
 - a. Meet requirements of ASTM C1372, except the unit height dimensions shall not vary more than plus or minus 1/16 inch from that specified in the ASTM reference, not including textured face.

- b. Unit Face Area: Not less than 1.0 square foot.
 - c. Color: Selected by the Owner's Representative from manufacturer's full range of standard colors.
 - d. Face Pattern Geometry: Straight
 - e. Texture: Split Rock Face.
 - f. Batter: Include an integral concrete shear connection flange/locator to provide a 1 inch setback for each wall course.
- B. Geosynthetic Reinforcement: Polyester fiber geogrid or geotextile, or polypropylene woven geotextile, as shown on the Drawings.
- C. Leveling Pad
- 1. Aggregate Base: Crushed stone or granular fill meeting the following gradation as determined in accordance with ASTM D448:
 - a. 1 inch sieve size, 100 percent passing
 - b. No. 4 sieve size, 35 to 70 percent passing
 - c. No. 40 sieve size, 10 to 35 percent passing
 - d. No. 200 sieve size, 3 to 10 percent passing
 - e. Base Thickness: 6 inches (minimum compacted thickness).
 - 2. Concrete Base: Non-reinforced lean concrete base.
 - a. Compressive Strength: 3,000 psi (maximum).
 - b. Base Thickness: At least 3 inches.
- D. Unit Fill and Drainage Aggregate:
- 1. Clean crushed stone or granular fill meeting the following gradation as determined in accordance with ASTM D448:
 - a. 1 inch sieve size, 100 percent passing
 - b. 3/4 inch sieve size, 75 to 100 percent passing
 - c. No. 4 sieve size, 0 to 60 percent passing
 - d. No. 40 sieve size, 0 to 50 percent passing
 - e. No. 200 sieve size, 0 to 5 percent passing
- E. Reinforced Fill:
- 1. Soil free of organics and debris and consisting of either GP, GW, SP, SW, or SM type, classified in accordance with ASTM D2487 and the USCS classification system and meeting the following gradation as determined in accordance with ASTM D448:
 - a. 1 inch sieve size, 100 percent passing
 - b. No. 4 sieve size, 20 to 100 percent passing
 - c. No. 40 sieve size, 0 to 60 percent passing
 - d. No. 200 sieve size, 0 to 35 percent passing
 - 2. Plasticity Index (PI) < 6 per ASTM D4318.
 - 3. Maximum particle size for backfill is 1 inch unless field tests have been performed to evaluate potential strength reduction to the geosynthetic reinforcement due to damage during construction per ASTM D5818.
 - 4. Unsuitable soils are organic soils and those soils classified as SC, CL, ML, CH, OH, MH, OL, or PT.
- F. Low Permeability Soil: Clayey soil or other similar material which will prevent percolation into the drainage zone behind the wall.
- G. Drainage Pipe: Perforated or slotted PVC or corrugated HDPE pipe manufactured in accordance with D3034 and/or ASTM F405. All connectors and fittings shall match the piping material.

- H. Geotextile Separation Fabric: Geotextile Separation fabric shall be minimum 4.0 oz/sy, polypropylene, needle-punched nonwoven fabric.
- I. Construction Adhesive: Exterior grade adhesive as recommended by the retaining wall unit manufacturer.

PART 3 - PART 3 – EXECUTION

3.1 EXAMINATION

- A. Prior to commencing work, the retaining wall contractor shall examine the areas and conditions under which the retaining wall system is to be erected, and notify the Design Professional in writing of conditions detrimental to the proper and timely completion of the work. Do not proceed with the work until unsatisfactory conditions have been corrected.
- B. Promptly notify the wall design engineer of site conditions which may affect wall performance, soil conditions observed other than those assumed, or other conditions that may require a reevaluation of the wall design.
- C. Verify the location of existing structures and utilities prior to excavation.

3.2 PREPARATION

- A. Ensure surrounding structures are protected from the effects of wall excavation.
- B. Excavation support, if required, is the responsibility of the Contractor, including the stability of the excavation and its influence on adjacent properties and structures.

3.3 EXCAVATION

- A. Excavate to the lines and grades shown on the Drawings. Over-excavation not approved by the Geotechnical Engineer will not be paid for by the Owner. Replacement of these soils with compacted fill and/or wall system components will be required at the Contractor's expense. Use care in excavating to prevent disturbance of the base beyond the lines shown.

3.4 FOUNDATION PREPARATION

- A. Excavate foundation soil as required for footing or base dimension shown on the Drawings, or as directed by the Project geotechnical engineer.
- B. The Project geotechnical engineer will examine foundation soil to ensure that the actual foundation soil strength meets or exceeds that indicated on the Drawings. At the direction of the project geotechnical engineer, remove soil not meeting the required strength. Oversize resulting excavation sufficiently from the front of the block to the back of the reinforcement, and backfill with suitable compacted backfill soils.

- C. The Project geotechnical engineer will determine if the foundation soils will require special treatment or correction to control total and differential settlement.
- D. Fill over-excavated areas with suitable compacted backfill, as recommended by the Project geotechnical engineer.

3.5 LEVELING PAD PREPARATION

- A. Place base materials to the depths and widths shown on the Drawings, upon undisturbed soils, or foundation soils prepared in accordance with Paragraph 3.04.
 - 1. Extend the leveling pad laterally at least 6 inches in front and behind the lowermost SRW unit.
 - 2. Provide aggregate base compacted to 6 inches thick (minimum) or as shown on the drawings.
 - 3. The Contractor may at their option, provide a concrete leveling pad as specified in Subparagraph 2.01.C.2, in lieu of the aggregate base.
 - 4. Where a reinforced footing is required by local code official, place footing below frost depth.
- B. Compact aggregate base material to provide a level, hard surface on which to place the first course of SRW units.
- C. Prepare base materials to ensure complete contact with SRW units. Gaps are not allowed.

3.6 ERECTION

- A. General: Erect SRW units in accordance with manufacturer's instructions and recommendations, and as specified herein.
- B. Place first course of concrete wall units on the prepared base material. Check units for level and alignment. Maintain the same elevation at the top of each unit within each section of the base course.
- C. Ensure that foundation units are in full contact with the leveling pad.
- D. Place concrete wall units side-by-side for full length of wall alignment. Alignment may be done by using a string line measured from the back of the block. Gaps are not allowed between the foundation concrete wall units.
- E. Place drainage aggregate between and directly behind the SRW. Fill any voids in SRW units with drainage aggregate. Provide a drainage zone behind the SRW units a minimum of 12 inches wide to within 8 inches of the final grade. Cap the backfill and drainage aggregate zone with separation fabric and then 8 inches of low permeability soil.
- F. Install drainage pipe at the lowest elevation possible to maintain gravity flow of water to outside of the reinforced zone. Slope the main collection drainage pipe 2 percent (minimum) to provide gravity flow to the daylighted areas. Daylight the main collection drainage pipe through the face of the wall, and/or to an appropriate location away from the wall system at each low point or at 50 foot (maximum) intervals along the wall. Alternately, the drainage pipe can be connected to a storm sewer system at 50 foot (maximum) intervals.

- G. Remove excess fill from top of SRW units and install next course. Ensure drainage aggregate and backfill are compacted before installation of next course.
- H. Check each course for level and alignment. Adjust SRW units as necessary to maintain level and alignment prior to proceeding with each additional course.
- I. Install each succeeding course. Backfill as each course is completed. Pull the SRW units forward until the locating surface of the SRW unit contacts the locating surface of the SRW units in the preceding course. Interlock wall segments that meet at corners by overlapping successive courses. Attach SRW units at exterior corners with adhesive specified.
- J. Install geosynthetic reinforcement in accordance with geosynthetic manufacturer's recommendations and the shop drawings.
 - 1. Orient geosynthetic reinforcement with the highest strength axis perpendicular to the wall face.
 - 2. Prior to geosynthetic reinforcement placement, place the backfill and compact to the elevation of the top of the wall units at the elevation of the geosynthetic reinforcement.
 - 3. Place geosynthetic reinforcement at the elevations and to the lengths shown on the Drawings.
 - 4. Lay geosynthetic reinforcement horizontally on top of the SRW units and the compacted backfill soils. Place the geosynthetic reinforcement within one inch of the face of the SRW units. Place the next course of SRW units on top of the geosynthetic reinforcement.
 - 5. The geosynthetic reinforcement shall be in tension and free from wrinkles prior to placement of the backfill soils. Pull geosynthetic reinforcement hand-taut and secure in place with staples, stakes, or by hand-tensioning until the geosynthetic reinforcement is covered by 6 inches of loose fill.
 - 6. The geosynthetic reinforcements shall be continuous throughout their embedment lengths. Splices in the geosynthetic reinforcement strength direction are not allowed.
 - 7. Do not operate tracked construction equipment directly on the geosynthetic reinforcement. At least 6 inches of compacted backfill soil is required prior to operation of tracked vehicles over the geosynthetic reinforcement. Keep turning of tracked construction equipment to a minimum.
 - 8. Rubber-tired equipment may pass over the geosynthetic reinforcement at speeds of less than 10 miles per hour. Turning of rubber-tired equipment is not allowed on the geosynthetic reinforcement.

3.7 BACKFILL PLACEMENT

- A. Place reinforced fill, spread and compact in a manner that will minimize slack in the reinforcement.
- B. Place fill within the reinforced zone and compact in lifts not exceeding 6 inches (loose thickness) where hand-operated compaction equipment is used, and not exceeding 12 inches (loose thickness) where heavy, self-propelled compaction equipment is used.
 - 1. Only lightweight hand-operated compaction equipment is allowed within 3 feet of the back of the retaining wall units. If the specified compaction cannot be achieved within 3 feet of the back of the retaining wall units, replace the reinforced soil in this zone with drainage aggregate material.
- C. Compaction testing shall be done in accordance with ASTM D1556 or ASTM D2922.

- D. Minimum Compaction Requirements for Fill Placed in the Reinforced and Retained Zone.
1. The minimum compaction requirement shall be determined by the project geotechnical engineer testing the compaction. At no time shall the soil compaction requirements be less than 95 percent of the soil's standard Proctor maximum dry density (ASTM D698) for the entire wall height.
 2. Utility Trench Backfill: Compact utility trench backfill in or below the reinforced soil zone to 98 percent of the soil's standard Proctor maximum dry density (ASTM D698), as recommended by the Project geotechnical engineer. If the height from the utility to finish grade is higher than 30 feet, increase compaction to 100 percent of the standard Proctor density [modified Proctor density].
 - a. Utilities must be properly designed (by others) to withstand all forces from the retaining wall units, reinforced soil mass, and surcharge loads, if any.
 3. Moisture Content: Within 2 percentage points of the optimum moisture content for all wall heights.
 4. These specifications may be changed based on recommendations by the Project geotechnical engineer.
 - a. If changes are required, the Contract Sum will be adjusted by written Change Order.
- E. At the end of each day's operation, slope the last level of compacted backfill away from the interior (concealed) face of the wall to direct surface water runoff away from the wall face.
1. The General Contractor is responsible for ensuring that the finished site drainage is directed away from the retaining wall system.
 2. In addition, the General Contractor is responsible for ensuring that surface water runoff from adjacent construction areas is not allowed to enter the retaining wall area of the construction site.
- F. Refer to Article 3.10 for compaction testing.

3.8 CAP UNIT INSTALLATION

- A. Apply adhesive to the top surface of the SRW unit below and place the cap unit into desired position.
- B. Cut cap SRW units as necessary to obtain the proper fit.
- C. Backfill and compact to top of SRW unit.

3.9 SITE CONSTRUCTION TOLERANCES

- A. Site Construction Tolerance
1. Vertical Alignment: Plus or minus 1-1/2 inches over any 10-foot distance, with a maximum differential of 3 inches over the length of the wall.
 2. Horizontal Location Control from Grading Plan
 - a. Straight Lines: Plus or minus 1-1/2 inches over any 10-foot distance.
 - b. Corner and Radius Locations: Plus or minus 12 inches.
 - c. Curves and Serpentine Radii: Plus or minus 2 feet.
 3. Immediate Post Construction Wall Batter: Within 2 degrees of the design batter of the concrete retaining wall units.
 4. Bulging: Plus or minus 1-1/4 inches over any 10-foot distance.

3.10 FIELD QUALITY CONTROL

- A. Installer is responsible for quality control of installation of system components.
- B. The Owner or General Contractor, at their expense, will retain a qualified professional to perform quality assurance checks of the installer's work.
- C. Correct work which does not meet these specifications or the requirements shown on the Drawings at the installer's expense.
- D. Perform compaction testing of the reinforced backfill placed and compacted in the reinforced backfill zone.
 - 1. Testing Frequency
 - a. One test for every 2 feet (vertical) of fill placed and compacted, for every 50 lineal feet of retaining wall.
 - b. Vary compaction test locations to cover the entire area of the reinforced soil zone, including the area compacted by the hand-operated compaction equipment.

3.11 ADJUSTING AND CLEANING

- A. Replace damaged SRW units with new units as the work progresses.
- B. Remove debris caused by wall construction and leave adjacent paved areas broom clean.

END OF SECTION 32 32 23

SECTION 32 80 00 – LANDSCAPE IRRIGATION

PART 1 - GENERAL

1.1 RELATED SPECIFICATION SECTIONS

- A. Landscape Work – Section 32 90 00

1.2 SUMMARY

- A. The prospective bidder must be licensed to practice in the State and City in which the Project is located. Bidders may be required to submit proof of licensing and other qualifications prior to the award of the bid. If requested, the prospective Irrigation Contractor shall provide a record of previous similar experience and a list of at least (3) projects of similar size and scope completed within the past (5) years. The prospective bidder must have knowledge and experience installing Two Wire type irrigation systems.
- B. The Irrigation Contractor shall furnish all materials, tools, equipment, and labor to install a complete and operable automatically controlled Landscape Irrigation System as indicated on the drawings, as specified and as necessary to complete the contract, including, but not limited to, these major items:
 - 1. Submittal of required material data.
 - 2. Pre-installation Flow and Pressure tests and the submittal of a Report of the findings prior to beginning the actual installation work. The Irrigation Contractor shall submit this report in a timely fashion and allow ample time for resolution if the reported flow and pressure are below the system design parameters. Failure of the Irrigation Contractor to follow and adhere to the specified testing and reporting process will not relieve him of his responsibility to provide a functional system as per the spirit and intent of the plans and contract documents. Any additional costs arising from said failure to comply with the specifications will be the sole responsibility of the Irrigation Contractor.
 - 3. All Irrigation System sleeves and/ or cased bores shall be furnished and installed by the General Contractor.
 - 4. Utility Locates.
 - 5. Coordination of the Controller power supply and system water supply Point Of Connection (POC) with the General Contractor and other trades.
 - 6. Installation of the Irrigation System and all related appurtenances.
 - 7. Irrigation System sleeving and /or boring as noted on the drawings or as may be required to complete the installation. This includes scheduling coordination with other trades and minor field adjustment that may be required due to actual site conditions.
 - 8. Excavation and backfill of pipe trenches.
 - 9. Record drawings, Close Out Documents and guarantees as specified.
 - 10. All applicable Permits and licenses.
 - 11. Pre and Post installation Owner inspection and testing of layout, supplies and systems.
 - 12. Clean-up.
- C. The Irrigation System shall be bid as per the following:
 - 1. The Owner Furnishes and Installs the following (no bids are required for the following scope):
 - Includes the new Weathermatic two wire controller, wireless rain sensor, two wire path, master valve, flow sensor, manual and turf zone solenoid control valves, decoders, PVC main line pipe, PVC lateral line pipe, fittings, quick couplers, Rain Bird heads, drip zone solenoid control valves, drip tubing and all other necessary system components required to install the new irrigation system as shown on the drawings.

2. The General Contractor Furnishes and Installs the following:
 - All Irrigation Sleeves and Cased Bores
 - The 1" irrigation deduct water meter, 1" RPZ backflow Preventer, 1 ½" connecting service pipe and stub-out to green space area.
 - The 1" wire conduit from the irrigation controller location inside the mechanical room to the green space area.
 - 120vac continuous power to the irrigation controller location.

1.3 DEFINITIONS

- A. Circuit Piping: Lateral pipe downstream from solenoid control valves to sprinklers and specialties. Pipe is under pressure during scheduled flow.
- B. Drain Piping: Downstream from main line manual drain valves. Pipe is not under pressure.
- C. Main Line Piping: Downstream from POC to solenoid control valves and specialties. Pipe is under pressure when the solenoid master control valve is operational.
- D. Matched Precipitation (Compatible Heads): Heads delivering an equal amount of water over and equivalent surface area.
- E. Diameter of Coverage: Diameter of the surface area receiving water (pertains to full or part circle).
- F. Fill-In Heads: heads not located on a basic symmetrical pattern and/ or which may not have the same coverage or application rate as the heads in the pattern.
- G. Last Head: Head located on a zone usually the farthest from the zone valve and having the least amount of pressure for operation.
- H. Pop-Up Head: Spray or rotary head installed flush with grade containing a nozzle that rises above grade when operating.
- I. Emitter Tube: special tubing for low volume emission to individual plants or beds.
- J. Header: Water line heading off from a zone valve; subject to pressure only when zone is operating.
- K. Lateral: Pipe downstream from a solenoid control valve to a head or specialty.
- L. Solenoid Control Valve: Low voltage solenoid valve used to activate/ terminate flow to a zone.
- M. Zone: Section of heads or other distribution devices controlled by one solenoid control valve.
- N. Industry Abbreviations for plastic materials:
 - ABS: Acrylonitrile-butadiene-styrene plastic.
 - FRP: Fiberglass-reinforced plastic.
 - PA: Polyamide (nylon) plastic.
 - PE: Polyethylene plastic.
 - PP: Polypropylene plastic.
 - PTFE: Polytetrafluoroethylene plastic.
 - PVC: Polyvinyl chloride plastic.
 - TFE: Tetrafluoroethylene plastic

1.4 SUBMITTALS

General: As soon as practical after notice to proceed and before procurement of any products, the Irrigation Contractor shall submit, along a complete list of products to be incorporated in the work. List shall include catalog cut sheets, diagrams, and such other descriptive data as may be required by the Landscape Architect and/ or Irrigation Design Professional. Approval of products under this provision shall not be construed as authorizing any deviations from the specification unless attention has been directed in writing to the specific deviation. No consideration will be given to partial lists submitted from time to time. Approval of products will be based on manufacturer's published ratings. Products submitted that are not in accordance with the specification requirements will be rejected and resubmitted. Submitted Cut Sheet pages with multiple models, products and options shall be noted to clearly indicate the actual item intended for submittal and installation. Submitted Cut Sheet pages without such delineation will be rejected and resubmitted.

- A. Product Data: Include pressure ratings, rated capacities, and recommended settings of selected models for the following as applicable to the project:
 - 1. General-duty valves
 - 2. Specialty valves
 - 3. Flush and air relief valve configuration for drip irrigation if applicable
 - 4. Control-valve boxes
 - 5. Irrigation heads and drip components
 - 6. Irrigation specialties
 - 7. Controller, and accessories - include wiring diagrams
 - 8. Control wire and cable - include wire splice kits and conduit as applicable

- B. Changes: Once the Contractor's submittal has been approved by the Landscape Architect and/ or Irrigation Design Professional, if there are any departures from the approved submittal deemed necessary by the Contractor, details of such departures and reasons therefore shall be submitted in writing to the Landscape Architect and/ or Irrigation Design Professional for review and approval prior to implementation.

- C. Quality Assurance Submittals:
 - 1. Qualification Data: Installer shall have 5 years of experience in irrigation installation on projects of similar scope and scale.
 - 2. Coordination Drawings – as may be required to effectively communicate questions and field conditions: Show piping and major system components. Indicate interface and spatial relationship between piping, system components, adjacent utilities, and proximate structures.
 - 3. Field quality-control test reports shall include written documentation of pressure tests and findings.

- D. Closeout Submittals:
 - 1. Operation and Maintenance Data: For irrigation systems: to include emergency shut off procedures in case of a pipe break or leak, daily and seasonal operation of all controls and components, winterization and spring start-up procedures, maintenance, and manufacturers operation manuals. In addition to items that may be specified in the General Conditions Specification Section.
 - 2. As-Built Drawings: Subsequent to completing construction and prior to receiving final approval by the Owner, Landscape Architect, and Irrigation Design Professional, provide an As-Built drawing of the irrigation system showing the installed locations and types of all irrigation heads, valve boxes, lateral and main piping with sizes, sleeves with sizes, quick couplers, valves, controller, and specialties. All As-Built zone numbering shall accurately correspond to those on controller. All calculations per zone shall be included if changed from the original installation plan. Recommended run times by season and condition shall be included. The As-Built drawings shall be completed in Auto-CAD

(v.2018 minimum, do NOT use the Academic Version), burned to CD/DVD and submitted with the close out documents in the quantities determined by the General Conditions. Additionally, the Irrigation Contractor shall also furnish the completed As-Built drawings in Auto-CAD .dwg file format directly to the Irrigation Design Professional by email. Upon request, the Irrigation Design Professional will supply CAD files of the Irrigation System for Irrigation Contractor to use in preparation of the As-Built drawings. The Irrigation Contractor shall complete and submit the As Built Drawings within 10 working days after final installation and prior to requesting final inspection and acceptance.

1.5 QUALITY ASSURANCE

- A. Contractor's Quality Assurance Responsibilities: Contractor is solely responsible for quality control of the Work.
- B. The publications and standards listed below form a part of this specification to the extent referenced. The publications and standards are referred to in the text by the basic designation only.
- C. American Society for Testing and Materials (ASTM)
 - 1. ASTM D 3350-03 – Standard Specifications for Pipe Resin Materials
 - 2. ASTM D 2737 – Standard Specifications for Pipe Manufacturing
 - 3. ASTM F 714 – Standard Specifications for Pipe Manufacturing
 - 4. AWWA C 901 – Standard Specifications for Pipe Pressure Classifications
 - 5. AWWA C 906 – Standard Specifications for Pipe Pressure Classifications
 - 6. NSF 61 – Standard Specifications for Pipe Agency Listing of Pipes Suitable as a Pressure Conduit
 - 7. ASTM D 3261 – Standard Specifications for Manufacturing of Butt Fusion Fittings
 - 8. ASTM D 1055 – Standard Specifications for Manufacturing of Electro-fusion Fittings
 - 9. ASTM F 2164 – Field Leak Testing of Polyethylene Pressure Piping Systems Using Hydrostatic Pressure
 - 10. ASTM B 62-85 – Standard Specifications for Composition Bronze or Ounce Metal Castings
 - 11. ASTM D 1784-81 – Standard Specifications for Rigid (PVC) Compounds and Chlorinated Polyvinyl Chloride (CPVC) Compounds
 - 12. ASTM D 1785-86 – Standard Specifications for (PVC) Plastic Pipe, Schedules 40 and 80
 - 13. ASTM D 2241-84 – Standard Specifications for (PVC) Pressure-Rated Pipe (SDR Series)
 - 14. ASTM D 2564 – Standard Specifications for Solvent Cements for (PVC) Plastic Pipe and Fittings
 - 15. ASTM F 477 – Specification for Electrometric Seals (Gaskets) for Joining Plastic Pipe
- D. Standards: Comply with all applicable provisions of the latest edition of the following codes:
 - 1. UPC Uniform Plumbing Code
 - 2. BOCA Building Officials and Codes Administrators
 - 3. UBC Uniform Building Code
 - 4. NEC National Electric Code
 - 5. Institute of Electrical and Electronics Engineers – IEEE 1100-1999 Recommended Practice for Powering and Grounding Electronic Equipment
 - 6. Plastics Pipe Institute (PPI) – Polyethylene Joining Procedures
 - 7. Plastics Pipe Institute (PPI) – recommendations for hydrostatic design stresses for PVC Pipe
 - 8. Local codes and jurisdiction requirements for the City of Kansas City, Missouri
- E. Permits, Fees and Licenses: Contractor is responsible to obtain all required permits and pay all associated fees unless otherwise noted.

- F. Provide labeled equipment certifying approval, as hereinafter specified, by the following organizations.
 - 1. NSF National Sanitation Foundation
 - 2. UL Underwriters Laboratories

1.6 DELIVERY, STORAGE AND HANDLING

- A. During loading, transportation and unloading, every precaution shall be taken to prevent injury to the pipe. No pipe shall be dropped from cars or trucks or allowed to roll down slides without proper retaining ropes. During transportation, each pipe shall rest on suitable pads, strips, skids or blocks securely wedged or tied in place. Any pipe damaged shall be replaced.
- B. Pipe and Large Fitting Handling: A nylon fabric choker sling capable of safely handling the weight of the pipe or fitting shall be used to lift, place, and move pipe and fittings.
- C. Store PVC pipe in a neat and orderly manner fully supported and protected from sunlight.
- D. All equipment shall be delivered, unloaded, and handled so as to protect from damage at all times.

1.7 PROJECT/ SITE CONDITIONS

- A. Trench excavation and backfilling shall not be performed during excessively wet conditions.
- B. PVC shall not be cemented during excessively wet conditions.
- C. All locations for equipment, sleeves and pipe shall be flagged by the Irrigation Contractor and approved by the Owner prior to installation.

1.8 SEQUENCE AND SCHEDULING

- A. The Contractor shall be responsible for coordinating, sequencing, and scheduling all work related to the irrigation system.

1.9 INSPECTIONS

- A. The Owner, Owner's Agent, Landscape Architect and/or Irrigation Design Professional shall inspect all work. The Irrigation Contractor shall flag and obtain approval for all sleeving, system pipe, heads, valves, and other ancillary components prior to actual installation. If the work is not being performed in a workmanlike manner as specified, not within construction standards, or not operating under OSHA or Owner's safety policies, the Owner, Owner's Agent, Landscape Architect and/or Irrigation Design Professional shall recommend halting construction. Construction shall be halted until the portion of the specification or standard is corrected. There will be a written notice of the violation, a copy of which shall be filed with the Contractor's license application for future review. If the deficiencies are not corrected, the Irrigation Contractor's surety shall be required to correct the work.

1.10 WARRANTY

- A. Conform to all applicable technical specifications.

- B. The Irrigation Contractor shall provide a written warranty covering the entire system against defects in installation, workmanship, and equipment for a period of one year from date of Final Acceptance.

1.11 MANUFACTURER'S WARRANTY

- A. The Irrigation Contractor shall provide the Owner with a written warranty transfer that shall confer all applicable product warranties and replacement benefits to the Owner upon final acceptance.
- B. Provide this warranty transfer for each manufacturer whose products have been installed on the project.

1.12 MAINTENANCE SERVICE

- A. Initial Maintenance Service: Beginning at Substantial Completion, provide 12 months and maintenance service by skilled employees of the Irrigation Contractor. Does not include Seasonal Controller Programming and Scheduling which will be handled by the Owner or his representatives after Project turnover. The 1-year maintenance period includes: additional backfill and compaction due to settling trenches, re-tamping and filling around heads, straightening, raising, and lowering of heads, repair or replacement of worn or defective components, lubrication, cleaning, and adjusting as required for proper irrigation system operation. Provide parts and supplies as used in the manufacture and installation of original equipment. The Irrigation Contractor shall drain, "blow out" and winterize the irrigation system utilizing compressed air (not to exceed 80 cfm @ 100 psi) through the quick coupler near the POC, in the fall of the first year and re-start system in the following spring. Perform maintenance during normal working hours and respond within one day or less from the time-of-service requests.
- B. The Irrigation Contractor shall coordinate with other Maintenance Service providers as may be necessary.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Manufacturer: Subject to compliance with requirements, provide products of the following:
 - 1. Weathermatic/ Rain Bird as per the irrigation plans and details.
 - 2. No substitutions shall be accepted except as may be due to manufacturer availability.
- B. Install only new materials of brands specified herein or as acceptable to the Landscape Architect and/ or Irrigation Design Professional.

2.2 PIPE MATERIALS

- A. PVC Pipe:
 - 1. Mainline 3" or smaller: Schedule 21 Class 200, Type 1120-1220 polyvinyl chloride (PVC); ASTM D 1784 and D 1785; uniformly white in color.
 - 2. Laterals: Same as mainline. 1" diameter minimum size.
 - 3. Copper Pipe (if used): Seamless Copper Pipe; ASTM B88, Type K.

4. Copper Unions: ASME B16. 18, cast copper alloy body, hexagonal stock, with ball-and-socket joint, metal-to-metal seating surfaces, and solder-joint, threaded or solder-joint, and threaded ends.
 5. Threaded Ends: Threads conforming to ASME B1.20.1.
- B. Sleeves: **NOTE: All sleeves and cased bores shall be furnished and install by the General Contractor.** All sleeves shall be new sections of PVC Schedule 40 BE pipe. Install sleeves as necessary and at the depths required for laterals (12 – 18” depth) and mainlines (18 – 24” depth).
1. Sleeve depths may be greater under major drive entries. Install sleeves under major drive entries at a depth of 30” below final pavement grade.
 2. In the event that the hard surface layout precludes the installation of relatively straight PVC sleeve runs, it is acceptable to use solid, un-jointed sections of HDPE solid pipe, 3408 DR9 (200psi rated); ASTM D 3035, to accomplish a required bend or curve in the pipe sleeve.
 3. Sleeves shall be twice the size of the passing pipe or as noted on the plans to allow for bell ends and control wire fitment.
 4. Sleeves shall extend a minimum of 18” into the green space area beyond the edge of the hard surface crossing.
 5. Install all sleeves to 18” beyond back of curb, walks or pavement. Flag sleeve locations and obtain Owner approval prior to actual installation.
 6. Securely cap or seal all sleeve end with duct tape to prevent sediment from encasing and fouling the sleeves.
 7. Physically scribe or notch the back of curb, walks or pavement edge at all sleeve end locations so that they may easily be located.
- C. Swing Joints:
1. Prefabricated swing joints, Rain Bird Model SA-125050 for spray heads and TSJ-12075 for turf rotor heads or an approved equal.
 2. The installed swing joint size shall be the same as the head or device inlet size.
- D. Fittings
1. Flanged and Mechanical Joint Adapters – Flanged and Mechanical Joint Adapters shall be PE 3408 HDPE, Cell Classification of 345464C as determined by ASTM D3350-02. Flanged and Mechanical Joint Adapters shall have a manufacturing standard of ASTM D3261. Fittings shall have a pressure rating equal to the pipe unless otherwise specified on the plans.
 2. Metallic: Cast bronze with standard iron pipe thread; 125 lb. class rating in conformance with ANSI B16.15.
 1. Dielectric Fittings: Assembly or fitting with insulating material isolating joined dissimilar metals to prevent galvanic action and stop corrosion. These devices are a combination of copper alloy and ferrous metal; threaded- and solder- end types, matching piping system materials.
 2. Dielectric Unions: Factory-fabricated, union assembly, designed for 250 psig minimum working pressure at 180 degrees F (82 degrees Celsius). Include insulating material isolating dissimilar metals and ends with inside threads according to ASME B 1.20.1.
 3. Dielectric Flanges: Factory-fabricated, companion-flange assembly for 150 psig or 300 psig minimum pressure to suit system pressures.
 4. Copper-PVC Transition Fittings: Manufactured assembly or fitting, with pressure rating at least equal to that or system and with ends compatible to piping where fitting is to be installed.
- E. Copper: ANSI B16.22 wrought copper or cast brass, recessed solder joint type fittings.
- F. PVC:
1. Mainline three-inch (3”) or smaller: Same as lateral line fittings.
 2. Lateral lines: ASTM D 2467, Schedule 40, socket-type, Type 1 Grade 1 polyvinyl chloride (PVC) with solvent weld or threaded connections in conformance with ASTM D 1784 and D 2466; uniformly white in color.

- G. Nipples:
1. Metallic: Schedule 40 red brass (35% copper, 15% zinc) pipe; threaded both ends. Pipe shall be in accordance with ASTM B43.
 2. Plastic: Factory-threaded Schedule 80, Type 1, Grade 1 polyvinyl chloride (PVC) pipe; threaded both ends. Pipe shall be in conformance with ASTM D 1784 and D 1785. Color: gray.

2.3 JOINING METHODS AND MATERIALS

- A. PVC Pipe and Fittings:
1. Solvent Cement: ASTM F 656 primer and ASTM D 2564 solvent cement in color other than orange, compatible with PVC pipe and of proper consistency.
 2. Cement: IPS Corporation Weld-on #705 for Class 200 P.V. C. IPS Corporation Weld-on #795 for flexible P.V. C. connections.
 3. Primer: IPS Corporation Weld-on #P-70.
 4. Teflon Tape
 5. **Do Not use Pipe Dope**
- B. Copper Pipe and Fittings
1. Solder: ASTM B 32, Alloys Sn95 and E.
- C. Miscellaneous Pipe and Fittings
1. Gaskets and Fasteners for Metal and Metal-to-Plastic Flanged Joints: ASME B16.21, nonmetallic, asbestos-free, flat, 1/8-inch thickness gaskets and ASME B18.2.1, carbon steel bolts, nuts, and washers.
 2. Gaskets for Plastic Flanged Joints: Materials recommended by plastic pipe and fittings manufacturer.

2.4 VALVES

- A. Manual Isolation Valves: Brass Ball Valves, 3 inches (75mm) and Smaller: WW-V-35C, Type 2, solid body, and screw bonnet of ASTM B 62 cast brass, with threaded or solder joint ends. Include polytetrafluoroethylene (PTFE)-impregnated packing. Model 200 Series as manufactured by Apollo or approved equal.
- B. Manual Drain Valves: All manual drain valves shall be 3/4" (19 mm) Mueller Oriseal or approved equal and installed at low points in the mainline to accommodate a minimum mainline slope of 1%. Manual Drain Valves are to be field located, installed on mainlines only with a cross handle and a 2 1/2" standpipe sleeve to allow for above grade manual key operation.
- C. Electric Solenoid Remote Control Valves:
1. Master Control Valve: Weathermatic 8200CR Series Brass Solenoid Control Valve, no substitutions accepted.
 2. Turf Zone Remote Control Valves: Weathermatic SB Series Solenoid Control Valves, no substitutions accepted.
 3. Drip Zone Control Valves: Rain Bird XCZ-PRB-COM Series Drip Valve Assy. Kits as per the plans and drawing schedules, no substitutions accepted.
- D. Quick Coupler Valves: All quick coupler valves shall be Rain Bird 44LRC or an approved equal.

- E. Valve Boxes: Valve boxes shall be of a variety as produced by Armor Access Boxes, Carson, or approved equal.
1. Manual Isolation and Manual Drain Valve boxes: All valve boxes for manual isolation and manual drain valves shall be round boxes (6").
 2. Remote Control Solenoid Valve boxes: All valve boxes for remote control solenoid valves shall be standard rectangular boxes (12") with vandal-resistant, locking lids.
 3. Control Zone Kit Valve Boxes (for drip irrigation): All valve boxes for drip control zone kit assemblies shall be "Jumbo" size boxes with vandal-resistant, locking lids to allow for valve and filter servicing.
 4. Manual Drip Flush Valve boxes (for drip irrigation): All valve boxes for manual drip flush valves shall be 6" round boxes with vandal-resistant, locking lids.
 5. Quick Coupler Valve boxes: All valve boxes for quick coupler valves shall be 10" round boxes with vandal-resistant, locking lids.

2.5 SPRINKLER HEADS AND DRIP IRRIGATION EMISSION DEVICES

- A. All heads shall be as specified or an approved equal. If necessary, the Irrigation Contractor shall adjust patterns shown on plans to provide adequate coverage.
1. Turf Areas: Rain Bird 1806-SAM-PRS shown on the drawings, schedules, and installation details.
 2. Drip Irrigation: Rain Bird XFD-06-12 (12" Row Spacing) in-line emitter drip tube at as shown on the drawings, schedules and installation details.

2.6 WEATHERMATIC TWO WIRE AUTOMATIC CONTROL SYSTEM

- A. The automatic controller shall be a commercial type controller manufactured expressly for control of automatic circuit valves of landscape irrigation system using a 14 gauge 2-Wire Path. The controller shall have factory installed lightning and surge arresters for both input/output protections. The Irrigation Contractor shall coordinate the required 120vac non-timer/ non-photocell power to the irrigation controller with the General and Electrical Contractors
- B. UL Listed Controller: Weathermatic SL9648TW, wall mount with lockable plastic enclosure, automatic irrigation controller, no substitutions accepted. Install the controller where indicated on the plans.
1. Station Control: The controller shall be capable of controlling of up to 60 stations. Programs: The controller shall have four (4) separate irrigation programs (A, B, C, D) which can have different start times, watering days, day cycles, and station timing. Each program shall have up to eight start times per day.
 2. Calendar: The controller shall have a 365-day calendar with day-of-the-month off feature. Programs will run on an ODD / EVEN day cycle, day-of-the-week ON / OFF cycle.
 3. Memory: The controller shall have an internal non-volatile memory which will retain the irrigation program and the programmed date and time in the event of a power outage.

2.7 LOW VOLTAGE FIELD CONTROL WIRE

- B. Field Control Wire: Weathermatic SLWIRE 14-2 Decoder Cable, single strand solid copper, UF insulated, blue jacket - no substitutions accepted.

2.8 WIRELESS RAIN / FREEZE SENSOR

- A. Weathermatic RFS5 wireless rain/ freeze sensor, no substitutions accepted. Install as per manufacturers recommended instruction.
- Rain conditions: at 1/8 – 1/4” received rain fall (adjustable) - deactivates system within 2 – 5 minutes.
 - Freezing conditions: at 33 - 41 degrees Fahrenheit (adjustable) – deactivates system.

The sensor location shown on the plan is diagrammatic. Final sensor location shall be field determined. Accurately note the final transmitter location on the as built drawing. Final location shall be at an orientation so as to best maximize the devices exposure to weather conditions. Final location must not be under any eaves or overhangs. Coordinate the final placement and obtain approval with the Owner prior to actual installation.

2.9 GROUNDING

- A. It is the responsibility of the Irrigation Contractor to provide proper grounding per manufacturer’s recommendation for all electrical equipment installed in relation to the irrigation control system. The grounding shall include but not be limited to the items described in the following paragraphs.

Components: The Contractor shall use UL listed grounding electrodes or those that meet the minimum requirements of the National Electrical Code (NEC) at each controller location. At the very minimum, the Contractor shall connect a solid bare copper wire to the building for grounding systems, as defined herewith.

- B. Connections: All ground circuit connections shall be made using an exothermic welding process by utilizing products such as the Cadweld “One-Shot” kits. Solder shall not be allowed to make connections. The wires are to be installed in as straight a line as possible and if is necessary to make a turn or a bend it shall be done in a sweeping curve with a minimum radius of 8” and a minimum included angle of 90 degrees. Mechanical clamps shall be permitted temporarily during the resistance test process but shall be replaced with Cadweld “One-Shot” kits immediately thereafter.
- C. Bonding: All supplementary grounds for each controller will be bonded to the service entrance ground, per the requirements of the NEC and IEEE standards. The shield wire network as described above shall be used to bond each supplementary ground to the service entrance ground.
- D. Bare Copper Wire Connections: When joining bare copper wires, it shall be done using an ERICO PG11L exothermic welding kit or approved equal. Wire connectors, terminal ends, lugs, or other types of connectors are not acceptable alternatives.

2.10 SUPPORTING DEVICES

- A. Provide all necessary uni-strut, inserts, fasteners, clamp rods, hangers, saddles, supports, anchor bolts, nuts, washers, and steel plates and shapes as required to properly support all piping and equipment included under this section.

2.11 MISCELLANEOUS COMPONENTS, EQUIPMENT AND TOOLS

- A. Communication Wire Splices:
 - 1. All decoder wire to valve solenoid wire or sensor wire connections shall be absolutely watertight with no leakage to ground or shorting from one conductor to another. Install Epoxy-type wire connector Weathermatic SLCONN wire splice kits. Follow the manufacturer's instructions on the package.
 - 2. All 2-Wire paths to Decoder Connections shall be absolutely watertight with no leakage to ground or shorting from one conductor to another. Install Weathermatic SLCONN wire splices at all 2-Wire to Decoder Connections.
- B. Pipe Detection Tape: "Sentry Line" three (3) inch wide, detectable, "Caution Water Line Buried Below" tape as available from Terra Tape Inc. Houston Texas, (800) 231-0674 or acceptable equal. Install above the main line and two wire paths only.
- C. Valve Tags: Provide an identification tag on flow control handle shaft of each control valve. Tag material shall be made of aluminum, plastic or other durable material, with valve station and controller number identified in 1/8" minimum letters. Provide yellow "Christy" tags or similar approved equal.
- D. Drainage Backfill: Cleaned gravel or crushed stone, graded from three (3) inches maximum to 3/4 inch minimum
- E. Pressure Gauges: ASME B40. One, 4-1/2" (115 mm) diameter dial, with dial range of two (2) times system operating pressure and bottom outlet. Furnish with an adapter and quick coupler key so that the gauge can be used on a quick coupler valve.

PART 3 - EXECUTION

3.1 GENERAL

- A. Verification of Conditions: Examine the areas to receive the Work and the conditions under which the Work would be performed. Remedy conditions detrimental to the proper and timely completion of the Work. Do not proceed until unsatisfactory conditions have been corrected.
- B. The Irrigation Contractor shall install all irrigation system components in accordance with the Contractor's approved submittals, the Plans, and these Specifications. The workmanship of the entire job must in every way be first class and only experienced and competent persons shall work on the project.
- C. Supervision: The Irrigation Contractor shall supervise the work constantly while his work is underway and shall keep the same foremen and workmen of the job from commencement to completion.
- D. Schedule of Work: The Irrigation Contractor shall be responsible for the installation of the piping and equipment in a manner that will affect the earliest completion of the work in conformance with the construction progress schedules of other Contractors and Trades, and these Specifications.
- E. Installation Observation and Inspection: In addition to normal progress inspection, the Irrigation Contractor shall give at least 72 hours' notice to the Owner, Landscape Architect, and Irrigation Design Professional for observation of the work as follows:
 - 1. Layout of the system
 - 2. Observation of trenches, backfilling and equipment installation
 - 3. Pressure tests and flushing operations

4. Coverage adjustment
5. Demonstration of final automatic operation and Final Walkthrough

3.2 PROTECTION

- A. The Irrigation Contractor shall be responsible for the storage of materials and any theft or damage to the work covered by these Specifications before the final acceptance of the work.
- B. Pipe and fittings shall be packaged in a manner suitable for shipment by a commercial carrier. Upon receipt at job site, a receiving inspection shall be prepared. The quantity shall be verified, and any shipping damage shall be reported to the supplier within seven (7) days.
- C. Protect work and materials from damage during construction. Storage of polyvinyl chloride (PVC) pipe and fittings shall be protected from direct sunlight. Beds on which materials are stored must be the full length of the pipe to avoid damage. Any pipe that has been damaged or dented shall not be used in the work.
- D. Any existing structures, equipment, utilities, pavement, landscaping, etc., damaged by Irrigation Contractor during the course of the work, including any damage caused by leakage or settling of piping systems being or having been installed by them, shall be restored at Irrigation Contractor's expense and to the Owner's satisfaction.
- E. Securely cover openings into the system and cover apparatus, equipment, and appliances, both before and after being set in place to prevent obstruction in the pipes and the breakage, misuse or disfigurement of the apparatus, equipment or appliances.

3.3 LAYOUT AND VERIFICATION

- A. The Irrigation Contractor shall flag or stake the locations of all pipe circuits, quick coupling valves, and irrigation heads in accordance with the Project drawings. The Irrigation Contractor shall check and verify dimensions of layout and report any variations to the Owner, Landscape Architect, and Irrigation Design Professional. Layout the work as accurately as possible to the drawings.
- B. Minor changes in locations to the above from locations shown shall be made as necessary to avoid existing or proposed planting, piping, utilities, structures, etc., at the Irrigation Contractor's expense or when directed by the Owner's Representative, providing such change is ordered before such items or work directly connected to same are installed, and providing no significant additional materials and/ or labor are required.
- C. The Irrigation Contractor will be held responsible for the relocating of any items without first obtaining the Owner's Representative approval. The Irrigation Contractor shall remove and relocate such items, at his expense, if so, directed by Owner or Owner's Representative.
- D. Before stating work on irrigation system, carefully check all grades to determine that work may safely proceed, keeping within the specified material depths.
- E. No fittings shall be installed on pipe underneath pavement or walls. If such a need should occur, the Contractor shall bring it to the attention of Landscape Architect and Irrigation Design Professional and allow ample time for response.

- F. Exact drip line and sprinkler head placement is based on and shall be coordinated with actual planting layout and shall be verified by Owner, Landscape Architect, and Irrigation Design Professional.

3.4 TRENCHING, BORING AND ENCASEMENT

- A. Excavation: Trenches shall be excavated in accordance with the plans and specifications. OSHA standards or Owner safety policies regarding safety shall be followed regarding trench safety. If groundwater is encountered, it shall be removed by the Contractor. Shoring of the trench, where required, is the responsibility of the Contractor.

Make trenches for main and laterals straight and true with the bottoms graded on uniform slopes to low points. Excavate trenches wide enough to allow a minimum of four inches (4") (100 mm) between parallel pipelines, eight inches (8") (200 mm) from lines of other trades. Do not install lines parallel and directly over one another. Maintain two inches (2") (50 mm) vertical clearance between irrigation lines; minimum transverse angle is 45 degrees. There shall be a maximum of two lines per trench. No irrigation lines shall extend above subgrade.

- B. Trench Depths:
1. Main Line
 - a. 18 – 24" below final grade in green space areas
 - b. 30" below top of hard surface under hard surface areas within sleeves
 2. Laterals
 - a. 12 – 18" below final grade in green space areas
 - b. 30" below top of hard surface under hard surface areas within sleeves

3.5 PIPE ASSEMBLY

- A. General:
1. Provide flanges or unions as indicated and as necessary to allow removal and reinstallation of any item of equipment or accessory without cutting, welding, or soldering.
 2. Provide discharge piping of proper size for all air vent, solenoid, and relief valves. Extend to nearest drain.
 3. Provide ½" manual drain gate valves with hose connection at all low points in the system and immediately upstream of check valves as necessary to allow the system to be completely drained. Accurately locate manual drain valves on the As-Built drawings.
 4. Cut pipe to measurements established at the site. Work into place without springing or forcing.
 5. Protect all openings in piping during construction to prevent entrance of foreign matter.
 6. Cut pipe and tubing ends square. Remove rough edges and burrs so that a smooth and unobstructed flow will be obtained.
 7. Close or short nipples shall only be used where shown on the irrigation drawing, or absolutely necessary to satisfy dimensional constraints.
 8. Make changes in pipe size using reducing fittings.
 9. Wherever two or more pipes are installed parallel, allow sufficient space for required welding, soldering, painting, and/or the application of insulation.
- B. Installation of all pipes and fittings shall be in strict accordance with the manufacturer's written specifications. Deviations from these specifications shall be permitted only with the written approval of Owner's Representative.
- C. PVC pipe and fittings:
1. Plastic pipe and fittings shall be solvent welded using solvents and methods as recommended by manufacturer of the pipe, except where screwed connections are required. Pipe and fittings

- shall be thoroughly cleaned of dirt, dust, and moisture before applying solvent with a non-synthetic bristle brush.
2. Install PVC pipe in dry weather when temperature is above 40 degrees Fahrenheit in strict accordance with manufacturer's instructions.
 3. Pipe may be assembled and welded on the surface. Snake pipe from side to side of trench bottom to allow for expansion and contraction.
- D. Connections between plastic pipe and metal valves shall be made using plastic male adapters and applying the recommended threaded joint compound. Do not use pipe dope.
- E. All metal screwed joints shall be tightened with tongs or wrenches and employ the specified joint compound. Caulking of any kind will not be permitted. All lines to be installed under hard surfaces shall be installed in a PVC Schedule 40 sleeve. Depth of sleeves to be determined by the final top elevation of the hard surface above sleeve. All sleeves shall be placed at a minimum 30" depth below the final top elevation of the hard surface above the sleeve crossing. All sleeves are to be placed prior to the installation of any hard surface. Each end of all sleeve locations shall be marked with a brass marker placed below grade back of curb or walk. All sleeve locations shall be approved by the Owner prior to actual installation.
- F. Core drilling for irrigation piping penetrations, if required, shall be accomplished in a manner approved by the Landscape Architect and Irrigation Design Professional. Provide metal sleeves for all irrigation lines wherever passing through a concrete wall or floor. Provide a water stop or membrane clamp for every pipe or sleeve penetrating an exterior concrete wall or floor; whichever is appropriate to the waterproofing method.
- G. Install drip emitter line, if required, and related equipment under the mulch and as per manufacturer's recommendations and written instructions. Do not install emitter line in direct sunlight. Do not bury the drip tube in the soil. Maintain consistent spacing of drip line within planter beds to provide even distribution throughout the area.
- H. Pipe Detection Tape: Install over main line only.

3.6 AUTOMATIC CONTROLLER

- A. The automatic controller shall be provided with direct surge protection. The Irrigation Contractor shall verify power location and type, as well as power connection requirements to the Controller Location indicated on the Plan. The Irrigation Contractor shall connect the power to the controller. The location of the controller shall be as shown and noted on the drawings and as directed by the Owner's Representative.
1. The controller shall be properly grounded as per manufacturer's recommendations and as noted elsewhere in these specifications.

3.7 ELECTRICAL CONTROL WIRES

- A. Electrical control wires shall be installed in the same trench as the main line wherever possible. Wires shall be laid alongside the pipe by "snaking" into the trench to allow as much slack as possible for contraction and expansion of the wire. All wire connections at remote control valves and at all wire splices will be left with two feet of wire so that the splice or the valve manifold can be brought to the surface for repairs without disconnecting the wires.
- B. Wire splices shall be absolutely waterproof so that there is no chance for leakage of water and corrosion build-up on the connection. All wiring shall be accomplished with as few splices as possible.

- C. Install all wire splices in a minimum 10" round valve box and accurately note their locations on the As-Built drawings.

3.8 FIELD QUALITY CONTROL

- A. The Irrigation Contractor shall notify the Owner, Landscape Architect, and Irrigation Design Professional for the following reviews, with three (3) working days minimum notice:
 - 1. Flagged installation locations for all sleeves, pipe, and related equipment
 - 2. Pressure testing pipe
 - 3. Observation of trenches, backfilling and equipment installation
 - 4. Pressure tests and flushing operations
 - 5. Coverage adjustment
 - 6. Demonstration of final automatic operation and Final Walkthrough
- B. Provide equipment and / or personnel required to conduct tests.
- C. Provide up-to-date Progress Drawings at each review.
- D. If Landscape Architect or Irrigation Design Professional is called out for review prior to the intended review item being ready for inspection, the Irrigation Contractor will be back charged for the cost of rescheduling the review including all associated travel, fees, and expenses.

3.9 CLOSING OF PIPE AND FLUSHING OF LINES

- A. Closing: Openings in laterals and main shall be capped or plugged, leaving caps and plugs in place until removal is necessary for completion of installation. Contractor shall take other precautions as necessary to prevent dirt and debris from entering pipe or equipment.
- B. Flushing: Lines shall be thoroughly flushed out before installing quick coupling valves, sprinklers, or emitters. After flushing, main line pipe may be partially backfilled, butt joints, fittings and connections shall remain free and visible.
- C. Test in accordance with paragraph on Hydrostatic Test. Upon completion of the testing the Contractor shall complete assembly and adjust sprinkler heads for proper distribution.

3.10 PURGING

Immediately prior to hydrostatic testing, all irrigation lines shall be thoroughly purged of all entrapped air. Introduce water into lines to be tested at full operating head. Observe water flow at end of discharge point until determination is made that all air and residual debris has been expelled from the line.

3.11 HYDROSTATIC TESTING

- A. While the necessary piping system components are exposed, all mainline piping is to be subjected to a hydrostatic test. The Owner, Landscape Architect and/or the Irrigation Design Professional should be on premises for this testing.

- B. The Irrigation Contractor is responsible to keep logs and written documentation of all testing activities. The Irrigation Contractor shall summarize and distribute this documentation as a part of the close out submittal package.
- C. Do not install remote control valves, quick couplers, or any other valve assembly until Landscape Architect and/or Irrigation Design Professional accepts testing of pressure main lines.
- D. Testing shall occur with pipe joints exposed. Small amounts of backfill between fittings shall be allowed to prevent pipe displacements and floating. All fittings shall be visible prior to testing.
- E. Pressure gauges shall be read in PSI. Calibration shall be such that accurate determination of potential pressure loss can be ascertained. The Irrigation Contractor shall furnish all required testing gauges.
- F. For PVC pipe:
 - 1. Test pressure supply lines under hydrostatic pressure of 125 psi minimum. Pipe shall hold pressure for a period of one (1) hour with no more than five (5) psi lost in order to pass test.
 - 2. Re-test as required until the system meets the requirements. During the tests, regardless of the amount of leakage, all detectable leaks are to be stopped and all defects corrected. Note such activities and locations in the written log documentation as mentioned in Item B of this section.

3.12 BACKFILLING AND COMPACTING

- A. Backfilling of PVC pipe:
 - 1. Rock free backfill material for mainline pipe is to be tamped in four-inch (4") (100 mm) layers under the pipe and uniformly on both sides of the full width of the trench or as shown, and the full length of the pipe. Materials are to be sufficiently damp to permit thorough compaction under and on each side of pipe, to provide support free voids. PVC pipe shall not rest on concrete, rock wood blocks, or similar items. In heavy rock type soils, suitable import backfill material may be required.
- B. All pipe is to be immediately backfilled with preliminary backfill sufficient to prevent arching or slipping under pressure.
- C. Other than for preliminary backfill over pipe, do not allow or cause any of the work to be covered before it has been inspected, tested, and approved by the Owner, Landscape Architect and/or Irrigation Design Professional.
- D. Upon approval, proceed to place remaining (final) backfill. Final backfill material shall be clear of all debris (i.e., roots, limbs, large rocks, boulders, clumps, or frozen clods) larger than two-inch (2") (50 mm) in diameter, or any object that could damage the pipe. Finish grade of all trenches must conform to adjacent grades without dips, sunken areas, humps, or other irregularities. Dispose of any excess debris.
- E. Restore all surfaces, existing underground installations, damaged or cut as a result of the excavations to their original condition.

3.13 ADJUSTING THE SYSTEM

- A. Adjust alignment and coverage of all heads. If it is determined that adjustments in the irrigation equipment will provide proper and more adequate coverage, make all necessary changes, or make

arrangements with the manufacturer to have adjustments made, prior to any planting. These changes or adjustments shall be made without additional cost and noted on the As-Built Drawings.

- B. If any heads require different nozzles other than those specifically noted per each head on the plan, note the new nozzle size/ type and include the revised calculations on the As-Built drawings.
- C. If any heads are added or subtracted from the current plan, due to actual site layout conditions, accurately note such heads and include revised zone calculations on the As-Built drawings.
- D. Adjust and balance system to eliminate over spray and fogging and as directed by Landscape Architect and/or Irrigation Design Professional.

3.14 TURN-OVER MATERIALS

- A. Final Record As-Built Drawings:
 - 1. A minimum of two physical sets of these shall be produced, one half sized plastic laminated paper set for placement in close proximity to irrigation controller cabinet location and one full size paper set for storage at another location desired by the Owner's Representative.
 - 2. Both sets shall have the irrigation valve zone lateral lines color-coded so as to readily distinguish between adjacent zones.
 - 3. The valve size, station number and gallons per minute shall be legible at each valve and shall match how the controller is wired. Additionally, each valve shall be annotated to describe which type of irrigation it is, i.e.: spray, rotor, bubbler, etc.
 - 4. Color-coded copies shall then be professionally laminated in 5 mil clear plastic.
 - 5. The As-Built drawings shall be performed in Auto-CAD as per paragraph 1.4, subsection E, paragraph 2 of this specification section.
 - 6. Include PDF files of all As Built Drawings. Distribute these electronic files to the Owner, Landscape Architect, and Irrigation Design Professional
- B. Operational and Maintenance Data: Submit four copies of manufacturer's data, maintenance schedule and operational schedule in separate three ring binders, labeled and indexed. Include the Booster Pump O&M Manual and step by step written winterization procedures to include Booster Pump drain-down and blow-out.
- C. Equipment: Provide the following to the Owner's Representative:
 - 1. One (1) Quick Coupler key equipped with swivel 90 (standard thread hose bib) per every (4) Quick Couplers installed on the project.
 - 2. Two (2) valve stem keys (48")
 - 3. Four (4) spare heads of each type installed on the Project
 - 4. Three (3) spare nozzles of each type installed on the Project
 - 5. A total of One (1) remote control solenoid valves/ kits of each type and size installed on the Project
 - 6. A total of One (1) valve decoder of each type installed on the Project
 - 7. A total of 100 lineal feet of drip line of each type installed on the Project
 - 8. A total of 10 spare drip line fittings of each type installed on the Project
- D. Provide Owner's Representative with all Record Drawing submittals, turnover materials, salvaged items, and warranty requirements prior to requesting Final Walkthrough and Review.

END OF SECTION

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SECTION 32 93 02- TOPSOIL

PART 1 - GENERAL

1.1 RELATED DOCUMENTS

- A. The General Contract Conditions, Drawings and Division - 1 Specification sections apply to Work of this section.

1.2 SUMMARY

- A. Work Includes: Furnishing, stockpiling and placing topsoil on a previously prepared subgrade.
- B. Related Work:
 - 1. Turf Seeding and Sodding: Section 32 92 00

1.3 QUALITY ASSURANCE:

- A. Submit soil analysis report for imported topsoil from approved soil testing laboratory. Report shall cover soil textural classification (percentages of sand, silt, and clay), pH, % organic matter, and soluble salts (electric conductivity in millimos/centimeter), and shall include additive recommendations. Testing will be at the expense of the Contractor.

1.4 DELIVERY, STORAGE AND HANDLING:

- A. Do not deliver or place topsoil in frozen, wet, or muddy condition.

1.5 SUBMITTALS

- A. Local/Regional Materials: Indicate location of manufacturer facility including name, address and distance between manufacturing facility and the product site. Provide manufacturer's documentation including location where the base materials were extracted, mined, quarried, harvested, etc. and the distance between this location and the project site. Include material costs, excluding cost of installation.

PART 2 - PRODUCTS

2.1 IMPORTED TOPSOIL:

- A. All topsoil shall be a loam or sandy loam. At least 10 days prior to topsoil delivery, notify Project manager of the source(s) from which topsoil is to be furnished. Topsoil shall be furnished by the Contractor and shall be a natural, friable soil representative of productive soils in the vicinity. It shall be obtained from the top 12" of well drained areas.

- B. Fertile, friable, loamy soil, reasonably free from subsoil, refuse, roots, heavy or stiff clay, stones larger than 1 inch, coarse sand, noxious seeds, sticks, brush, litter, and other deleterious substances; suitable for the germination of seeds and the support of vegetative growth. The pH value shall be between 7.0 and 8.0.
- C. Imported Topsoil Mix at Turf Areas: Sand, 35%; compost, 10%; peat, 10%; topsoil, 45% by volume
- D. Additives: Refer to Turf Seeding and Sodding: Section 32 92 00
- E. % Organic Content: 2.9% minimum.
- F. Soluble Salts: Electric conductivity shall be less than 3.3 mmhos/cm for dryland areas and less than 5.1 mmhos/cm for irrigated lands.

2.2 LOCAL/REGIONAL MATERIALS

- A. Preference shall be given to materials that are manufactured, harvested, extracted, mined, quarried, etc. within a 500 mile radius of the project site.

PART 3 - EXECUTION

3.1 PLACING TOPSOIL:

- A. Place Topsoil per "Turf Seeding and Sodding" Section 32 92 00

END OF SECTION

SECTION 33 11 00 – WATER UTILITY DISTRIBUTION PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section includes:
 - 1. Site potable water lines
 - 2. Site fire protection water lines
 - 3. Related accessories.
- B. Related Sections:
 - 1. Section 312000 – Earth Moving.

1.2 SYSTEM DESCRIPTION

- A. Buildings located on the MU campus will typically have potable water service from MU's distribution system. Internal fire protection will also be served by the MU distribution system. Usually one service line into a building will provide both needs. If a separate service line is required for fire protection, installation of a post indicator valve will be required.
- B. Flow tests, when required, can be obtained from the system owner.
- C. A permanent line shall be installed to facilitate flushing of the water service line. The line shall be a minimum of 2" diameter and shall flow the water to a location outside of the building. The line shall be connected after the 1st valve inside of the building.
- D. All water connections (fire and potable) shall include the installation of testable backflow prevention assemblies as required and approved by the Missouri Department of Natural Resources and MU Construction Standards.
- E. All potable water service shall have a water meter.
- F. All sizing and locations for mains, services and other auxiliary equipment shall be coordinated with system owner.
- G. All service line entrances to buildings shall be designed to be maintainable. If a building is being built on a slab, a pit allowing access to the water line must be installed. Water service lines under buildings are not acceptable.
- H. Water service-line connections to water mains shall include a three-valve (main-tap-main) cluster which will allow for maximum valving flexibility.
- I. Nutating disc meters are to be installed on applications requiring water flows equal to, or less than one-hundred (100) gallons per minute. Turbine meters are to be installed on applications requiring water flows more than one-hundred (100) gallons per minute. Compound meter are to be installed on applications that will see large peak flows over typical normal flows.

1.3 SCHEDULING

- A. Site utility tie-ins shall be coordinated with the Owner's Representative. Contactor shall notify Owner's Representative two (2) weeks in advance of desired tie-in time. Owner's Representative will give Contractor 72 hours advance notice of actual time for tie-ins.
- B. Tie-ins to utility systems shall be made on weekends or nights, and work shall be done around-the-clock until the tie-in is completed. Line outages are to be kept to a minimum.

1.4 SUBMITTALS

- A. Product Data: Manufacturer's specification and technical data on the following.
 - 1. Piping and Restraints.
 - 2. Water Meters.
 - 3. Valves.
 - 4. Fire Hydrants.
- B. Quality Control Submittals:
 - 1. Field Quality Control submittals are specified under PART 3.
- C. Contract Closeout Submittals.
 - 1. Project Record Documents.
 - a. Contractor to provide X, Y and Z as-built coordinates, prepared by Registered Land Surveyor, at 25-foot intervals of installed water line, as well as all valves, fittings, and appurtenances prior to backfill of the water line.

1.5 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
- B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following.
 - 1. Not less than 3 years experience with systems.
 - 2. Successfully completed not less than 5 comparable scale projects using this system.
- C. Regulatory Requirements:
 - 1. Comply with the Missouri Department of Natural Resources requirements for fire and potable water.
 - 2. Comply with requirements of the University of Missouri construction standards.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.
- B. Storage and Protection: Comply with manufacturer's recommendations.
 - 1. Store valves indoors.

2. Protect pipes from moisture and dirt.

PART 2 - PRODUCTS

2.1 Materials, Pipe and Pipe Fittings

- A. All underground water piping shall be PVC.
 1. EXCEPTION 1: Domestic water service lines 2" or less shall be Type K copper or high density polyethylene (HDPE) piping.
 2. EXCEPTION 2: Lines passing directly over or under steam tunnels or direct buried steam/condensate lines must be ductile iron or Type K copper (2" or less) with 4" R-5 extruded polystyrene insulation board between the pipe and steam lines.
- B. PVC Pipe (Open Trench Construction)
 1. 4 Inches to 12 Inches: AWWA C900; Pressure Class 235 (DR 18); Cast Iron O.D. equivalent; with bell end and elastomeric gasket.
 2. 14 Inches to 48 Inches: AWWA C905; Pressure Rating 165 (DR 25); Cast Iron O.D. equivalent; with bell end and elastomeric gasket.
 3. Gaskets: ASTM F 477, elastomeric seal.
- C. Ductile-Iron Pipe
 1. 4 Inches to 12 Inches: AWWA C151; Mechanical Joint Pipe; Minimum Thickness Class 52 or Pressure Class 350; with integrally cast flanged bell, cast iron gland, and rubber gasket.
 2. Lining: Standard cement lining with asphalt coating.
 3. Encasement: AWWA C105, polyethylene film.
- D. High-Density Polyethylene (HDPE) Pipe and Fittings
 1. 2 Inches and Less: SDR9 CTS Premium Grade Pipe, AWWA C901, ASTM D3035, NSF 14 and 61, 200 psi pressure rating. Pipe to be CenCore HDPE as manufactured by Centennial Plastics or approved equal.
 2. Fittings and Joints: All molded fittings and fabricated fittings shall be fully pressure rated to match the pipe pressure rating. All fittings shall be molded or fabricated by the pipe manufacturer. Connections must be made by either the use of brass/stainless steel compression couplings with insert rings or by creating a fusion butt weld all in strict accordance with manufacturer's recommendations. All brass fittings shall be lead free.
- E. Pipe Fittings
 1. 4 Inches to 24 Inches: AWWA C153; 350-psi pressure rating.
 2. Lining: Standard cement lining with asphalt coating.
 3. All pipe fittings shall be cast-iron construction, installed wrapped with AWWA C105 polyethylene film.
- F. Restraints
 1. Mechanical joint: AWWA C111. Provide retainer type packing glands with rubber gasket, for use with PVC pipe and conforming to Uni-B-13-92. Pipe sizes 4" to 12" must also be FM approved. Mechanical joint restraints shall be Megalug 2000 PV, as manufactured by EBAA Iron Inc., Eastland TX, or approved equal.
 2. Joint Retainers: Provide ductile iron split serrated ring harnesses and rod type joint retainers for PVC bell and spigot joints. Clamps shall be designed for use with PVC pipe and shall meet Uni-B-13-92 Standards and be FM approved on sizes 4" to 12". Restraint harnesses shall be Series 1500 for pipe 4 inches to 12 inches, and Series 2800 for pipe

- 14 inches and larger, all as manufactured by EBAA Iron Inc., Eastland TX or approved equal.
3. Rods, nuts and washers: $\frac{3}{4}$ " SS304 all thread rods, nuts and washers.
 4. All pipe restraints and ductile iron fittings shall be installed wrapped with AWWA C105 polyethylene film.
 5. Link Assembly: Seal annular space for piping passing through walls with interlocking synthetic rubber link assembly, Link-Seal® as manufactured by PSI-Thunderline Corporation, Houston TX, or approved equal.
- G. Trace Wire
1. Tracer wire shall be #14 AWG Solid, steel core soft drawn high strength tracer wire, 250# average tensile break load, 30 mil high molecular weight-high density blue polyethylene jacket complying with ASTM-D-1248, 30 volt rating. No THHN insulated wire shall be allowed. Tracer wire shall be Copperhead Industries HS-CCS or approved equal.
 2. Tracer wire shall have moisture resistant splices for direct bury applications. Splices shall be Copperhead Industries Snakebite or 3M DBR or approved equal.
 3. Tracer wire test stations shall be designed to be easily detected by magnetic and electronic locators. A magnet shall be securely attached at the top of the upper tube of the box for locating purposes. Lid shall be blue and have a brass terminal for attaching locating equipment and a brass 5 sided nut for removing cap. Tracer wire test station shall be Copperhead Industries Snake Pit or approved equal.

2.2 WATER UTILITIES METERING

- A. The University of Missouri Columbia campus has standardized on bronze disc and turbine utility meters as manufactured by BadgerMeter, Milwaukee, WI. Substitutes will not be accepted.
- B. Compound Meter
1. Construction shall comply with ANSI and AWWA C702 standards as required for domestic water compound metering applications.
 2. Meter housing shall be lead free cast bronze construction. Nose cone, straightening vanes, rotor, rotor and valve casing, measuring chamber and disc and high flow valve shall be thermoplastic construction. Register lid and shroud shall be thermoplastic and bronze and trim shall be stainless steel.
 3. Register shall be a straight-reading odometer-type totalization display (gallons), 360 degree test circle with dual center sweep hands. Register shall be installed using TORX tamper resistant seal screws. A tamper resistant calibration plug seal shall also be provided to protect from unauthorized personnel.
 4. Meters shall be Recordall Compound Series.
- C. Plate Strainers
1. Plate strainers shall exceed AWWA standards. Double-flanged housing and cover shall be constructed of cast bronze. Strainer screen and housing bolts shall be stainless steel. Housing cover seal and flange gaskets shall be neoprene rubber. Screen shall have $\frac{3}{16}$ " perforations with a minimum straining area that is double the meter inlet size. Flange connections shall be elliptical (2" meters) or round. Plate strainers shall be as manufactured by BadgerMeter or approved equal. Strainer not required for Electromagnetic meter

2.3 Valves and Valves Boxes materials

- A. Non-rising Stem Gate Valves: ANSI/AWWA C509, resilient seated, bronze stem, cast-iron or ductile-iron body and bonnet, epoxy coated disc, stem nut, 250 psig working pressure, mechanical joint ends. Valves shall be Model A-2360 as manufactured by Mueller Company, Decatur IL, or approved equal. Valves shall turn clockwise to close.
- B. Ball Valves: Threaded lead free bronze, 125 lb., 2-piece design, full port. Valves shall be Model T-FP-600A-LF-LL as manufactured by NIBCO, Elkhart IL, or approved equal.
- C. Valve Boxes: Valve box shall be 6" PVC C900 pipe with cast iron cover No. 2195 as manufactured by Clay and Bailey Manufacturing Company, Kansas City MO, or approved equal. Lid shall be marked "WATER". Provide below grade concrete collar in planted and asphalt areas.

2.4 fire hydrant materials

- A. University fire hydrants shall be Super Centurion Fire Hydrants, Model 250, Number A-423, as manufactured by Mueller Water Products, Decatur IL. No substitutions will be allowed.
- B. Fire hydrants shall be painted in the following manner using Sign Painters' 1 Shot Lettering Enamel or approved equal:
 - C. University water:
 - 1. Barrel - Metallic Gold
 - 2. Caps - Black
 - 3. Bonnet - Blue.
 - D. City water, University maintained system:
 - 1. Barrel - Metallic Gold
 - 2. Caps - Blue.
 - 3. Bonnet - Blue.
- E. Final hydrant bonnet color based on measured flow will be painted by MU.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
 - 1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 pipe installation

- A. Preparation of Trench
 - 1. Final bury depth shall have a minimum of 42" cover to the top of the pipe.
 - 2. Trench bottom shall be graded to provide a smooth, firm, stable, and rock-free foundation throughout the length of the piping.

3. All rock greater than one inch in diameter found in the trench shall be removed for a depth of six inches below the bottom of the pipe and replaced by suitable bedding material.
4. Unstable, soft, and unsuitable materials shall be removed at the surface upon which pipes are to be laid and backfill with crushed stone as indicated on the drawings.
5. Layers of crushed stone shall be installed in the bottom of trench as indicated on the drawings. Shape stone layer to fit bottom of piping. Dig bell holes at each pipe joint to relieve the bells of all loads and to ensure continuous bearing of the pipe barrel on the foundation.

B. Pipe Separation

1. Finished pipe installation shall have minimum 12" separation to all other utilities.
2. Maintain at least a ten foot (10') horizontal separation of water mains from any existing or proposed sanitary sewer. The distance must be measured edge to edge. Installation of the water main closer to a sanitary sewer is acceptable where the water main is laid in a separate trench or on an undisturbed earth shelf located on one (1) side of the sanitary sewer at an elevation so the bottom of the water main is at least eighteen inches (18") above the top of the sanitary sewer.
3. Provide a minimum vertical distance of eighteen inches (18") between the outside of the water main and the outside of the sanitary sewer where water mains cross the sanitary sewer mains. This shall be the case where the water main is either above or below the sanitary sewer. At crossings, one (1) full length of water pipe must be located so both joints will be as far from the sanitary sewer line as possible. Special structural support for the water and sanitary sewer pipes may be required.
4. Provide at least a ten-foot (10') horizontal separation between water mains and sanitary sewer force mains. There shall be an eighteen-inch (18") vertical separation at crossings
5. Locate water mains so that they do not pass through or come in contact with any sanitary sewer manhole
6. Consult the system owner where above conditions cannot be met.

C. Installation of Pipe and Pipe Fittings

1. Piping 2" and less:
 - a. All domestic water service piping from the water main to the building with a nominal diameter of two inches and less shall be Type K copper or HDPE piping.
 - b. In all installations, Type K copper shall be used where the water line enters the building. If the water meter is located in a meter pit, the piping within the meter pit, and stubbed out on either side shall also be Type K copper.
 - c. All buried copper piping shall be wrapped.
 - d. For pulled pipe installations, tracer wire shall be pulled with pipe, without splices. Upon completion of installation, a continuity test on the wire shall be performed and all breaks shall be repaired.
 - e. For trenched pipe installation, tracer wire shall be taped to the pipe at the three o'clock position every 5 feet. Upon completion of installation, a continuity test on the wire shall be performed and all breaks shall be repaired.
2. PVC (Polyvinyl Chloride) Pipe: Install in accordance with AWWA C605.
3. All joints shall be restrained with joint retainers. All fittings shall be restrained with retainer type packing glands.
1. Install stainless steel rods between fittings on all offsets and between fittings, valves, and blind flanges, in addition to the Megalugs. On isolated fittings, valves, etc., attach restraint rings to PVC pipe and install stainless steel rods between fitting and restraint rings. Rods shall be positioned through the bolt holes in fitting and Megalug. Each rod will require four nuts and washers. Duct lugs are acceptable. The number of stainless steel rods required per fitting flange shall be as follows:

Pipe Diameter	No. of Rods
---------------	-------------

10" and Less	2
12"	3
14"	4
16"	5
18"	6

2. All ductile iron pipe, fittings, valves, bell end restraints, etc. shall be wrapped with a polyethylene cover conforming to AWWA C105, and installed per AWWA C600.
3. All dead end mains shall have a dry barrel fire hydrant at the end to facilitate flushing of the main.
4. Pipe shall be installed in clean condition, and shall never be laid in trenches with standing water. The trench shall be dewatered during installation of the water line. Open pipe ends shall be protected with a hard cap or inflatable plug at the end of the work day. NO PLYWOOD OR DUCTTAPE COVERINGS WILL BE ALLOWED.

D. Backfill

1. Under Pipe: All backfill under the barrel of the pipe shall be free from debris, organic matter, and stones larger than one inch, and shall be tamped into place. Sand or crushed stone aggregate (95% passing a 1/2" screen but not more than 10% passing a #200 sieve) are acceptable substitutes for soil.
2. Adjacent To and Top of Pipe: The first one foot of backfill over the top of pipe shall be "3/4 inch minus waste rock with fines" uncleaned crushed stone aggregate or suitable soil. Backfill shall be free of debris, brush, roots and stones or rubble more than one inch.
3. Rough final grading of subgrade and the placement of final topsoil shall be detailed on the drawings.
4. All sidewalks, paving, etc. which are removed or damaged during construction shall be replaced and shall match existing.

E. Identification

1. Install continuous plastic underground warning tape during back-filling of trench for underground water piping. Tape shall be located twenty-four (24) inches above pipe, directly over each water line.
2. Tape trace wire to the top of each water line with duct tape every five (5) feet. Wire splices shall be minimized. Terminate trace wires inside building and inside valve boxes. Drill 1/4" hole in PVC valve box one inch below cast iron cover. Route wire up outside of valve box, through 1/4" hole and knot. A tracer wire test station shall be installed at all fire hydrants and at all runs of piping without valves every 400 feet. Upon completion of installation and final grading, a continuity test on the wire shall be performed and all breaks shall be repaired.

3.3 WATER UTILITIES METERING INSTALLATION

- A. Installation of water meter, valving, bypass loop and water sampler/test outlet shall be in strict accordance with manufacturer's printed instructions and recommendations, applicable ANSI and AWWA requirements, and as detailed on "Bronze Disc Water Meter Installation Detail" and "Bronze Turbo Water Meter Installation Detail."
- B. The preferred location for water revenue meter installation is within a building mechanical room. In some cases, water meter may need to be installed in an exterior below-grade meter pit. These pit installations shall be installed in strict accordance with manufacturer's printed instructions and University of Missouri-Columbia "Meter Box Pit Detail" drawing.

- C. Water meters shall be installed with a three-valve bypass design using ball valves (2" or less) or OS&Y rising stem gate valves (larger than 2"). The bypass valve shall be full-flow and capable of being locked. All other valves associated with the meter installation shall be ball valves. Water meters shall be installed in a straight run with no obstructions a minimum of ten diameters upstream and five diameters downstream.
- D. Water meter shall be installed after the backflow prevention device but prior to any booster pumps or pressure reducing valves.
- E. Water meter shall be installed no greater than 4' from the floor. Variations from this requirement need prior approval from system owner. If this requirement is impossible or the meter is located in an inaccessible location, the meter shall be equipped with a remote read, and the register shall be mounted no greater than 4' from the floor.

3.4 water utilities COMMISSIONING

- A. Water service will not be turned on until the water meter is fully installed and operating satisfactorily, the downstream water piping is successfully leak tested and secure (including freeze protection), and the necessary backflow preventer device is installed and successfully tested with the delivery of the test report to Campus Facilities - Energy Management Steam and Water Distribution Engineering.
- B. Only Energy Management Steam and Water Distribution personnel will be authorized to turn water service on or off.

3.5 Valves and Valves Boxes Installation

- A. Valve Storage: Use the following precautions for valves during storage:
 - 1. Do not remove end protectors unless necessary for inspection; then reinstall for storage.
 - 2. Protect valves from weather - valves shall be stored indoors. Maintain valve temperature higher than the ambient dew point temperature. If outdoor storage is necessary, support valves off the ground or pavement in watertight enclosures.
- B. Handling: Use a sling to handle valves whose size requires handling by crane or lift. Valves shall be rigged to avoid damage to exposed valve parts. Do not use hand wheels or stems as lifting or rigging points.
- C. Domestic Water Service: AWWA-Type Gate Valves: Comply with AWWA C600. Install buried valves with stem pointing up and with valve box.
- D. Valve boxes shall be installed vertically with top of box even with final grade.

3.6 valves and valves boxes Testing

- A. All valves shall be pressure tested in accordance with standards set forth in the Water Piping Construction Standard.
- B. All valves shall be disinfected in accordance with standards set forth in the Water Piping Construction Standard.

3.7 valves and valves boxes COMMISSIONING

- A. All valves under pressure in the MU water distribution mains will be operated only by Campus Facilities - Steam & Water Distribution personnel, except in cases of extreme emergency. All valves installed as part of new construction shall remain fully closed during construction.

3.8 fire hydrant Installation

- A. The location of new fire hydrants shall be determined by a collaboration of system owner, City of Columbia Fire Department and the design engineers.
- B. Installation of fire hydrants maintained by the University shall be installed per "Fire Hydrant Detail" and in strict accordance with manufacturer's written instructions.
- C. Installation of fire hydrants maintained by the City of Columbia shall be in strict accordance with Columbia Water and Light Specifications as last revised.
- D. The pumper nozzle shall be installed pointing to the street and/or away from the building.

3.9 FIRE HYDRANT Testing

- A. Newly installed fire hydrants shall be cleaned and pressure tested in accordance with standards set forth in this section, and will be flow tested by system owner.

3.10 FIRE HYDRANT COMMISSIONING

- A. Water will be turned on to the hydrant by Campus Facilities - Energy Management Utility Distribution personnel.
- B. Hydrant will be flow tested by owner.

3.11 Disinfection and Testing OF WATER UTILITY DISTRIBUTION

- A. MU will perform pressure testing and disinfection of new water lines. Contractor shall prepare water line for successful pressure testing and disinfection.
- B. All domestic potable water systems will be pressure tested in accordance with AWWA M23.
- C. All domestic potable water systems will be disinfected and tested for bacteriological contamination before the system is put into operation, as required by the Department of Natural Resources and in accordance with AWWA C651.
- D. Contractor shall ensure internal surfaces of water line shall be clean and free of foreign matter.
- E. Water line shall be completely separated from MU water system for pressure tests and disinfection purposes.

- F. Contractor shall install number and size of taps based off of water line size in table below:

Pipe Diameter (in)	2" Taps Needed
4"	1
6"	1
8"	1
10"	2
12"	2

- G. Contractor shall install water line entrance and exit piping which enters and exits above ground as shown in "Taps for Flushing and Disinfection of Water Line" per University of Missouri Construction Standards. The purpose of this piping is to provide a means for flushing, pressure testing, and disinfecting the new water line.
- H. Contractor shall contact Energy Management 72 hours prior to requesting flushing and disinfection of new water line.
- I. Campus Facilities - Energy Management Steam and Water personnel will draw water samples for bacteriological testing and send sample off for testing.
- J. Allow twenty-four (24) hours for disinfection of water line and an additional forty-eight (48) hours for return of testing before making tie-ins to existing system.
- K. Commissioning
1. System shall be placed in operation only after testing shows the absence of bacteriological contamination and approved by system owner.
- L. Only Campus Facilities - Energy Management Steam and Water personnel will be allowed to operate valves on new water systems.

END OF SECTION

SECTION 33 31 00 - SANITARY UTILITY SEWERAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sanitary sewage piping.
 - 2. Manholes.
 - 3. Connection of building sanitary drainage system to municipal sewers.
 - 4. Related accessories.
- B. Related Sections:
 - 1. Section 312000 – Earth Moving.

1.2 SUBMITTALS

- A. Product Data: Manufacturer's specifications and technical data on the following:
 - 1. Piping.
 - 2. Fittings.
 - 3. Cleanouts.
- B. Shop Drawings: Indicate dimensions, description of materials, general construction, specific modifications, component connections, anchorage methods, and installation procedures, plus the following specific requirements.
 - 1. Include manholes, frames, and covers.
- C. Contract Closeout Submittals:
 - 1. Project Record Documents.
 - a. Contractor to provide as-built survey, prepared by Registered Land Surveyor, that indicates the exact location, top elevations, flow lines and pipe sizes of all structures.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
- B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
 - 1. Not less than 3 years experience with systems.
 - 2. Successfully completed not less than 5 comparable scale projects using this system.
- C. Regulatory Requirements:
 - 1. Comply with requirements of American Public Works Association.
 - 2. Comply with requirements of City.

- D. Certificates: Certification from precast manufacturer that Con^{mic}Shield® with CONTINT was used in the fabrication of sewer manhole.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.
- B. Precast concrete sections shall not be delivered to the job until the concrete control cylinders have attained a strength of at least 80 percent of the specified minimum.
- C. Precast concrete sections shall be handled carefully and shall not be bumped or dropped. Hooks shall not be permitted to come in contact with joint sections.
- D. Precast concrete sections shall be inspected when delivered. All cracked or otherwise visibly defective units will be rejected. City reserves the right to inspect the production of the units at the manufacturing plant.
- E. Storage and Protection: Comply with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Polyvinyl Chloride (PVC) Pipe and Fittings: ASTM D3034, SDR 21.
 - 1. Joints: Pipe and fittings shall have elastomeric gasket joints providing a watertight seal when tested in accordance with ASTM D3212. Gaskets shall conform to ASTM F477. Solvent welded joints shall not be permitted.
- B. Concrete:
 - 1. Portland Cement Design Mix: 4000 psi (27.6 MPa) minimum, with 0.45 maximum water/cementitious materials ratio.
 - a. Reinforcing Fabric: ASTM A 1064/A 1064M, steel, welded wire fabric, plain.
 - b. Reinforcing Bars: ASTM A 615/A 615M, Grade 60 (420-MPa) deformed steel.
 - 2. Con^{mic}Shield® with CONTINT shall be added to all precast and cast-in-place manholes in accordance with the manufacturer's recommendations.
 - a. Cast-in-place concrete invert fill and collars inside the manhole shall contain Con^{mic}Shield® with CONTINT per manufacturer's recommendation.

2.2 COMPONENTS

- A. Manholes: ASTM C478, precast reinforced concrete.
 - 1. Base section:
 - a. Floor slab: 8 inch thick, unless otherwise indicated on drawings.
 - b. Walls: 6 inch thick, unless otherwise indicated on drawings.
 - c. Base riser section: 6 inch thick, unless otherwise indicated on drawings.
 - 2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.

3. Top section: Concentric cone, eccentric cone, or flat slab type, as indicated on Drawings.
 - a. Top of cone to match grad rings.
4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
5. Gasket: O-ring, double ring, or preformed bitumastic sealant.
6. Steps: Steel reinforced polypropylene plastic steps per ASTM 4101, cast into base, riser and top sections at 12 inch intervals.
7. Frame and cover: ASTM A48, Class 35B gray iron.
 - a. Frame size: 24 inch inside diameter, by 9 inch riser with 4 inch width flange.
 - b. Cover: 26 inch diameter, indented top design, with lettering "SANITARY SEWER" cast into cover.
8. Joint Sealant: ASTM C 990 (ASTM C 990M), bitumen or butyl rubber.
9. Pipe connectors: ASTM C923, resilient type.
 - a. Provide "boot" type nitrile rubber connections at locations indicated on Drawings.
10. Con^{mic}Shield® with CONTINT shall be added to all precast manholes in accordance with the manufacturer's recommendations.
 - a. Cast-in-place concrete invert fill and collars inside the manhole shall contain Con^{mic}Shield® with CONTINT per manufacturer's recommendation.

2.3 ACCESSORIES

- A. Cleanouts: Cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.
- B. Underground Warning Tape: Polyethylene plastic tape with magnetic detectable conductor, 6 inches wide by 4 mils thick.
 1. Imprint warning tape with "CAUTION – SEWER SERVICE LINE BURIED BELOW" in large black letters.
- C. Bedding Materials: As specified under Section 312000.
- D. Fill Materials: As specified under Section 312000.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
 1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Trenching: Comply with requirements of Section 312000.
 1. Grade trench bottom to provide smooth, firm, stable, and rock free foundation throughout length of pipe.
 2. Remove unstable, soft, and unsuitable materials from surface upon which pipe is to lay.
 - a. Backfill with bedding materials.
 3. Shape bottom of trench to fit design of pipe.
 - a. Fill unevenness with tamped bedding materials.
 - b. Dig bell holes at each pipe joint to assure continuous bearing of pipe.

- B. Install bedding material at trench bottom in accordance with Section 312000.
 - 1. Install bedding materials in continuous layers not exceeding 6 inches in compacted depth, to total depths indicated on Drawings.
 - 2. Compact bedding materials as specified under Section 312000.

- C. Pipe Installation: Comply pipe manufacturer's instructions.
 - 1. Install pipe beginning at low point of system, true to grades and alignment indicated on Drawings and unbroken continuity of invert.
 - 2. Install PVC pipe in accordance with ASTM D2855 and ASTM F447.
 - 3. Place bell ends or groove ends of piping facing upstream.
 - 4. Install gaskets in accordance with manufacturer's instructions.
 - 5. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.
 - 6. Clean interior of piping as Work progresses.
 - 7. Maintain swab or drag line and pull past each joint as it is completed.
 - 8. Install plugs in ends of incomplete piping at end of each day and whenever Work stops.

- D. Install manholes complete with accessories indicated on Drawings.
 - 1. Comply with ASTM C891.
 - 2. Form continuous concrete channel and benches between inlets and outlets.
 - 3. Install top of frames and covers flush with adjacent paved surfaces.
 - a. Install top of frame 3 inches above adjacent landscaped surfaces.

- E. Install clean-outs and extension from sewer pipe to clean-out at grade at locations indicated on Drawings.
 - 1. Set cleanout frame and cover in concrete pad, 18 inches by 18 inches by 12 inches deep, except at where location is in concrete paving.
 - 2. Set top of cleanout 1 inch above surrounding grade.
 - 3. Set top of cleanout flush with surrounding pavement.

- F. Tap Connections:
 - 1. Make connections to existing sanitary sewer and underground to comply with requirements of this Section, as indicated on Drawings.

- G. Install underground warning tape continuous buried 6 inches below finish grade, above pipe line.
 - 1. Coordinate with Section 312000.

- H. Backfilling: Comply with requirements of Section 312000.

3.3 CLEANING

- A. Flush piping between manholes and other structures if required by authority having jurisdiction.
 - 1. Remove collected debris.

3.4 FIELD QUALITY CONTROL

- A. Tests:
 - 1. Perform testing of completed system in accordance with local authorities having jurisdiction.

2. Perform the following tests in accordance with APWA Street Construction and Material Specifications, Division II, Section 2509.
 - a. Infiltration-exfiltration air test.
 - b. Deflection test.

- B. Inspections:
 1. Perform inspections in accordance with APWA Street Construction and Material Specifications, Division II, Section 2509.
 2. Inspect interior of piping to determine whether line displacement or other damage has occurred.
 3. Make inspections after pipe between manholes and manhole locations has been installed and approximately 2 feet of backfill material in place.
 - a. Reinspect at completion of Project.
 4. If inspections indicate poor alignment, debris, displaced pipe, infiltration, or other defects, correct such defects and reinspect.
 - a. Defects requiring correction include the following:
 - 1) Alignment: Less than full diameter of inside of pipe is visible between structures.
 - 2) Deflection: Flexible piping with deflection that prevents passage of ball or cylinder of size not less than 92.5 percent of piping diameter.
 - 3) Crushed, broken, cracked, or otherwise damaged piping.
 - 4) Infiltration: Water leakage into piping.
 - 5) Exfiltration: Water leakage from or around piping.

- C. Video Inspections:
 1. Provide CCTV video footage of sanitary sewer lines to owner prior to substantial completion and acceptance by owner.

3.5 PROTECTION

- A. Protect installed sewage system from damage and/or displacement until backfilling operation is complete.

END OF SECTION

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SECTION 33 41 00 - STORM UTILITY DRAINAGE PIPING

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Storm sewage piping.
 - 2. Junction boxes.
 - 3. Inlets.
 - 4. Yard drains.
 - 5. Related accessories.

- B. Related Sections:
 - 1. Section 033000 – Cast-In-Place Concrete.
 - 2. Section 312000 – Earth Moving.
 - 3. Section 312316 – Excavation.
 - 4. Section 334613 – Foundation Drainage.

1.2 SUBMITTALS

- A. Submit in accordance with Division 1 unless otherwise indicated.

- B. Product Data: Manufacturer's specifications and technical data on the following:
 - 1. Piping.
 - 2. Fittings.
 - 3. Yard Drains.
 - 4. Cleanouts.

- C. Shop Drawings: Indicate dimensions, description of materials, general construction, specific modifications, component connections, and installation procedures, plus the following specific requirements:
 - 1. Include junction boxes, inlets, frames, covers, and grates.

- D. Contract Closeout Submittals: Submit in accordance with Division 1.
 - 1. Project Record Documents.
 - a. Accurately record location of underground utilities, by horizontal dimensions from above grade permanent fixtures, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.

- B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
 - 1. Not less than 3 years experience with systems.
 - 2. Successfully completed not less than 5 comparable scale projects using this system.

1.4 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.
- B. Storage and Protection: Comply with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Reinforced Concrete Pipe: ASTM C76, Class III.
 - 1. Fittings: Same strength of adjoining pipe.
 - 2. Joints:
 - a. Gaskets: Contractor has option of the following:
 - 1) ASTM C443, flat gaskets cemented to pipe tongue or spigot.
 - 2) ASTM C443 O-ring gaskets.
 - 3) ASTM C443 roll-on gaskets.
- B. Polyvinyl Chloride (PVC) Pipe and Fittings: ASTM D3034, SDR 21.
 - 1. Solvent cement: ASTM D2564.
- C. High Density Polyethylene (HDPE) pipe and fittings: AASHTO M252, Type S; AASHTO M294, Type S.
- D. Concrete: Comply with requirements of Section 033000.
- E. High Density Polypropylene Pipe (HDPP):
 - 1. Dual wall pipe and fittings 12 inch through 24 inch diameter shall conform to ASTM F2736. Triple wall pipe 30 inch through 60 inch shall conform to ASTM F2881, except as otherwise specified herein.
 - 2. Pipe shall be joined using a bell & spigot joint meeting the requirements of ASTM F2881 or AASHTO M330. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.
 - 3. Fittings shall conform to ASTM F2881 or AASHTO M330. Bell and spigot connections shall utilize a welded or integral bell and valley or inline gaskets meeting the watertight joint performance requirements of ASTM D3212.
 - 4. High Density Polyethylene Pipe (HDPE) is not equivalent to polypropylene pipe and shall not be considered as an acceptable substitute.

2.2 COMPONENTS

- A. Junction Boxes: ASTM C858, precast reinforced concrete.
 - 1. Base section:

- a. Floor slab; 8 inch thick.
 - b. Walls: 6 inch thick.
 - c. Base riser section: 6 inch thick.
 2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.
 3. Top section: Concentric cone, eccentric cone, or flat slab type, as indicated on Drawings.
 - a. Top of cone to match grade rings.
 4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
 5. Gasket: ASTM C443, rubber.
 6. Steps: Cast iron steps, cast into base, riser and top sections at 16 inch intervals.
 7. Frame and cover: ASTM A48, Class 35B gray iron.
 - a. Frame size: 24 inch diameter, by 9 inch riser with 4 inch width flange.
 - b. Cover: 26 inch diameter, indented top design, with lettering "STORM SEWER" cast into cover.
 8. Pipe connections: ASTM C923, resilient type.
- B. Inlets: ASTM C858, precast reinforced concrete
1. Base section:
 - a. Floor slab: 8 inch thick.
 - b. Walls: 6 inch thick.
 - c. Base riser section: 6 inch thick.
 2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.
 3. Top section: Flat slab type.
 - a. Opening to match grade rings.
 4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
 5. Gasket: ASTM C443, rubber.
 6. Steps: Steel reinforced plastic steps, cast into base, riser and top sections at 16 inch intervals.
 7. Pipe connections: ASTM C923, resilient type.
- C. Yard Drains:
1. Size: 12 inches by 12 inches unless otherwise indicated on Drawings.
 2. Body: ASTM F794, polyvinyl chloride (PVC).
 3. Grate: ASTM A48, Class 30B cast iron, hinged type with traffic rating of H-20 approved for use in pedestrian applications.
 4. Acceptable manufacturers and product:
 - a. Nyloplast America, Inc.: Inline Drain.
 - b. Comparable products of other manufacturers.

2.3 ACCESSORIES

- A. Cleanouts: Cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.
- B. Underground Warning Tape: Polyethylene plastic tape, 6 inches wide by 4 mils thick.
 1. Imprint warning tape with "CAUTION – SEWER SERVICE LINE BURIED BELOW" in large black letters.
- C. Bedding Materials: As specified under Section 312000.
- D. Backfill Materials: As specified under Section 312000.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Trenching: Comply with requirements of Section 312000.
1. Grade trench bottom to provide smooth, firm, stable, and rock free foundation throughout length of pipe.
 2. Remove unstable, soft, and unsuitable materials from surface upon which pipe is to lay.
 - a. Backfill with bedding material.
 3. Shape bottom of trench to fit design of pipe.
 - a. Fill unevenness with tamped bedding material.
 - b. Dig bell holes at each pipe joint to assure continuous bearing of pipe.
- B. Install bedding material at trench bottom in accordance with Section 312000.
1. Install bedding materials in continuous layers not exceeding 6 inches in compacted depth, to total depths indicated on Drawings.
 2. Compact bedding materials as specified under Section 312000.
- C. Pipe Installation: Comply with pipe manufacturers instructions.
1. Install pipe beginning at low point of system, true to grades and alignment indicated on Drawings and unbroken continuity of invert.
 2. Install concrete pipe in accordance with ACPA Concrete Piping Installation Manual.
 3. Install polyethylene corrugated pipe in accordance with ASTM D2321.
 - a. Install fittings in accordance with manufacturer's instructions.
 4. Install PVC pipe in accordance with ASTM D2855 and ASTM F402.
 5. Place bell ends or groove ends of piping facing upstream.
 6. Install gaskets in accordance with manufacturer's instructions.
 7. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.
 8. Clean interior of piping as Work progresses.
 9. Maintain swab or drag line and pull past each joint as it is completed.
 10. Install plugs in ends of incomplete piping at end of each day.
- D. Install junction boxes complete with accessories indicated on Drawings.
1. Comply with ASTM C891.
 2. Form continuous concrete channel and benches between inlets and outlets.
 3. Install top of frames and covers flush with adjacent paved surfaces.
 - a. Install top of frame flush with adjacent landscaped surfaces, unless otherwise indicated on Drawings.
- E. Install inlets complete with accessories indicated on Drawings.
1. Comply with ASTM C891.
 2. Form continuous concrete channel and benches between inlets and outlets.
 3. Install top of frames and covers flush with adjacent paved surfaces.

- a. Install top of frame flush with adjacent landscaped surfaces.
- F. Install cleanouts and extension from storm drainage pipe to cleanout at grade at locations indicated on Drawings.
 - 1. Set cleanout frame and cover in concrete pad, 18 inches by 18 inches by 12 inches deep except at where location is in concrete paving.
 - 2. Set top of cleanout 1 inch above surrounding earth grade.
 - 3. Set top of cleanout flush with surrounding pavement.
- G. Tap Connections:
 - 1. Make connections to existing storm sewer and underground structures to comply with requirements of this Section, as indicated on Drawings.
- H. Install underground warning tape continuous buried 6 inches below finish grade, above pipe line.
 - 1. Coordinate with Section 312000.
- I. Backfilling: Comply with requirements of Section 312000.

3.3 PROTECTION

3.4 Protect installed sewage system from damage of displacement until backfilling operation is complete.SUMMARY

- A. Section Includes:
 - 1. Storm sewage piping.
 - 2. Junction boxes.
 - 3. Inlets.
 - 4. Yard drains.
 - 5. Related accessories.
- B. Related Sections:
 - 1. Section 033000 – Cast-In-Place Concrete.
 - 2. Section 312000 – Earth Moving.
 - 3. Section 312316 – Excavation.
 - 4. Section 334613 – Foundation Drainage.

3.5 SUBMITTALS

- A. Submit in accordance with Division 1 unless otherwise indicated.
- B. Product Data: Manufacturer's specifications and technical data on the following:
 - 1. Piping.
 - 2. Fittings.
 - 3. Yard Drains.
 - 4. Cleanouts.
- C. Shop Drawings: Indicate dimensions, description of materials, general construction, specific modifications, component connections, and installation procedures, plus the following specific requirements:
 - 1. Include junction boxes, inlets, frames, covers, and grates.

- D. Contract Closeout Submittals: Submit in accordance with Division 1.
 - 1. Project Record Documents.
 - a. Accurately record location of underground utilities, by horizontal dimensions from above grade permanent fixtures, elevations or inverts, and slope gradients.

3.6 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
- B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
 - 1. Not less than 3 years experience with systems.
 - 2. Successfully completed not less than 5 comparable scale projects using this system.

3.7 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.
- B. Storage and Protection: Comply with manufacturer's recommendations.

PART 4 - PRODUCTS

4.1 MATERIALS

- A. Reinforced Concrete Pipe: ASTM C76, Class III.
 - 1. Fittings: Same strength of adjoining pipe.
 - 2. Joints:
 - a. Gaskets: Contractor has option of the following:
 - 1) ASTM C443, flat gaskets cemented to pipe tongue or spigot.
 - 2) ASTM C443 O-ring gaskets.
 - 3) ASTM C443 roll-on gaskets.
- B. Polyvinyl Chloride (PVC) Pipe and Fittings: ASTM D3034, SDR 21.
 - 1. Solvent cement: ASTM D2564.
- C. High Density Polyethylene (HDPE) pipe and fittings: AASHTO M252, Type S; AASHTO M294, Type S.
- D. Concrete: Comply with requirements of Section 033000.
- E. High Density Polypropylene Pipe (HDPP):
 - 1. Dual wall pipe and fittings 12 inch through 24 inch diameter shall conform to ASTM F2736. Triple wall pipe 30 inch through 60 inch shall conform to ASTM F2881, except as otherwise specified herein.

2. Pipe shall be joined using a bell & spigot joint meeting the requirements of ASTM F2881 or AASHTO M330. The joint shall be watertight according to the requirements of ASTM D3212. Gaskets shall meet the requirements of ASTM F477. Gasket shall be installed by the pipe manufacturer and covered with a removable, protective wrap to ensure the gasket is free from debris. A joint lubricant available from the manufacturer shall be used on the gasket and bell during assembly. 12- through 60-inch (300 to 1500 mm) diameters shall have an exterior bell wrap installed by the manufacturer.
3. Fittings shall conform to ASTM F2881 or AASHTO M330. Bell and spigot connections shall utilize a welded or integral bell and valley or inline gaskets meeting the watertight joint performance requirements of ASTM D3212.
4. High Density Polyethylene Pipe (HDPE) is not equivalent to polypropylene pipe and shall not be considered as an acceptable substitute.

4.2 COMPONENTS

- A. Junction Boxes: ASTM C858, precast reinforced concrete.
 1. Base section:
 - a. Floor slab; 8 inch thick.
 - b. Walls: 6 inch thick.
 - c. Base riser section: 6 inch thick.
 2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.
 3. Top section: Concentric cone, eccentric cone, or flat slab type, as indicated on Drawings.
 - a. Top of cone to match grade rings.
 4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
 5. Gasket: ASTM C443, rubber.
 6. Steps: Cast iron steps, cast into base, riser and top sections at 16 inch intervals.
 7. Frame and cover: ASTM A48, Class 35B gray iron.
 - a. Frame size: 24 inch diameter, by 9 inch riser with 4 inch width flange.
 - b. Cover: 26 inch diameter, indented top design, with lettering "STORM SEWER" cast into cover.
 8. Pipe connections: ASTM C923, resilient type.
- B. Inlets: ASTM C858, precast reinforced concrete
 1. Base section:
 - a. Floor slab: 8 inch thick.
 - b. Walls: 6 inch thick.
 - c. Base riser section: 6 inch thick.
 2. Riser section: 48 inch diameter unless otherwise indicated on Drawings, with 6 inch thick walls.
 3. Top section: Flat slab type.
 - a. Opening to match grade rings.
 4. Grade rings: Reinforced concrete rings, 4 to 9 inches thick.
 5. Gasket: ASTM C443, rubber.
 6. Steps: Steel reinforced plastic steps, cast into base, riser and top sections at 16 inch intervals.
 7. Pipe connections: ASTM C923, resilient type.
- C. Yard Drains:
 1. Size: 12 inches by 12 inches unless otherwise indicated on Drawings.
 2. Body: ASTM F794, polyvinyl chloride (PVC).
 3. Grate: ASTM A48, Class 30B cast iron, hinged type with traffic rating of H-20 approved for use in pedestrian applications.

4. Acceptable manufacturers and product:
 - a. Nyloplast America, Inc.: Inline Drain.
 - b. Comparable products of other manufacturers.

4.3 ACCESSORIES

- A. Cleanouts: Cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, secured, scoriated cast-iron cover.
- B. Underground Warning Tape: Polyethylene plastic tape, 6 inches wide by 4 mils thick.
 1. Imprint warning tape with "CAUTION – SEWER SERVICE LINE BURIED BELOW" in large black letters.
- C. Bedding Materials: As specified under Section 312000.
- D. Backfill Materials: As specified under Section 312000.

PART 5 - EXECUTION

5.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
 1. Do not proceed until unsatisfactory conditions have been corrected.

5.2 INSTALLATION

- A. Trenching: Comply with requirements of Section 312000.
 1. Grade trench bottom to provide smooth, firm, stable, and rock free foundation throughout length of pipe.
 2. Remove unstable, soft, and unsuitable materials from surface upon which pipe is to lay.
 - a. Backfill with bedding material.
 3. Shape bottom of trench to fit design of pipe.
 - a. Fill unevenness with tamped bedding material.
 - b. Dig bell holes at each pipe joint to assure continuous bearing of pipe.
- B. Install bedding material at trench bottom in accordance with Section 312000.
 1. Install bedding materials in continuous layers not exceeding 6 inches in compacted depth, to total depths indicated on Drawings.
 2. Compact bedding materials as specified under Section 312000.
- C. Pipe Installation: Comply with pipe manufacturers instructions.
 1. Install pipe beginning at low point of system, true to grades and alignment indicated on Drawings and unbroken continuity of invert.
 2. Install concrete pipe in accordance with ACPA Concrete Piping Installation Manual.
 3. Install polyethylene corrugated pipe in accordance with ASTM D2321.
 - a. Install fittings in accordance with manufacturer's instructions.
 4. Install PVC pipe in accordance with ASTM D2855 and ASTM F402.
 5. Place bell ends or groove ends of piping facing upstream.

6. Install gaskets in accordance with manufacturer's instructions.
 7. Install bedding at sides and over top of pipe to minimum compacted thickness of 12 inches.
 8. Clean interior of piping as Work progresses.
 9. Maintain swab or drag line and pull past each joint as it is completed.
 10. Install plugs in ends of incomplete piping at end of each day.
- D. Install junction boxes complete with accessories indicated on Drawings.
1. Comply with ASTM C891.
 2. Form continuous concrete channel and benches between inlets and outlets.
 3. Install top of frames and covers flush with adjacent paved surfaces.
 - a. Install top of frame flush with adjacent landscaped surfaces, unless otherwise indicated on Drawings.
- E. Install inlets complete with accessories indicated on Drawings.
1. Comply with ASTM C891.
 2. Form continuous concrete channel and benches between inlets and outlets.
 3. Install top of frames and covers flush with adjacent paved surfaces.
 - a. Install top of frame flush with adjacent landscaped surfaces.
- F. Install cleanouts and extension from storm drainage pipe to cleanout at grade at locations indicated on Drawings.
1. Set cleanout frame and cover in concrete pad, 18 inches by 18 inches by 12 inches deep except at where location is in concrete paving.
 2. Set top of cleanout 1 inch above surrounding earth grade.
 3. Set top of cleanout flush with surrounding pavement.
- G. Tap Connections:
1. Make connections to existing storm sewer and underground structures to comply with requirements of this Section, as indicated on Drawings.
- H. Install underground warning tape continuous buried 6 inches below finish grade, above pipe line.
1. Coordinate with Section 312000.
- I. Backfilling: Comply with requirements of Section 312000.

5.3 PROTECTION

- A. Protect installed sewage system from damage of displacement until backfilling operation is complete.

END OF SECTION

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SECTION 33 46 00 - SUBDRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Sub-grade drainage system.
 - 2. Related accessories.
- B. Related Sections:
 - 1. Section 312000 – Earth Moving.

1.2 SUBMITTALS

- A. Submit in accordance with Division 1 unless otherwise indicated.
- B. Product Data: Manufacturer's specifications and technical data including the following:
 - 1. Detailed specifications of construction and fabrication of the following:
 - a. Pipe drainage products and accessories.
 - b. Filter fabric.
- C. Samples:
 - 1. Filter fabric.
- D. Contract Closeout Submittals: Submit in accordance with Division 1.
 - 1. Project Record Documents.
 - a. Accurately record location of underground utilities, by horizontal dimensions from above grade permanent fixtures, elevations or inverts, and slope gradients.

1.3 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.
- B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
 - 1. Not less than 3 years experience with systems.
 - 2. Successfully completed not less than 5 comparable scale projects using this system.

1.4 DELIVERY, STORAGE, AND HANDLING

- 1. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.
- 2. Storage and Protection: Comply with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. High Density Polyethylene (HDPE) pipe and fittings: AASHTO M252, Type S; AASHTO M294, Type S. All joints shall meet the requirements of a soiltight joint unless otherwise specified.
 - 1. Perforation: Class II perforation per AASHTO M252 and M294.
- B. Fittings: As required for installation of drainage system.
- C. Filter Aggregate and Bedding Materials: Granular Fill as specified under Section 312000.
- D. Geotextile Filter Fabrics
 - 1. Description: Fabric of polypropylene (PP) or polyester fibers or combination of both, with flow rate range from 110 to 330 gpm/sq. ft. (4480 to 13 440 L/min. per sq. m) when tested according to ASTM D 4491.
- E. Structure Type: Nonwoven, needle-punched continuous filament.
 - 1. Survivability: AASHTO M 288 Class 2
 - 2. Styles: Flat and sock.

2.2 ACCESSORIES

- A. Cleanouts: Cast-iron ferrule and countersunk brass cleanout plug, with round cast-iron access frame and heavy-duty, cast-iron cover.
- B. Underground Warning Tape: Polyethylene plastic tape with magnetic detectable conductor, 6 inches wide by 4 mils. Thick.
 - 1. Imprint warning tape with "CAUTION- SEWER SERVICE LINE BURIED BELOW" in large black letters.
- C. Bedding Materials: As specified under Section 312000.
- D. Fill Materials: As specified under Section 312000.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
 - 1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Preparation:
 - 1. Grade bottom of excavations to provide smooth, firm, stable, and rock free foundation throughout length of pipe.
 - 2. Remove unstable, soft, and unsuitable materials from surface upon which pipe is to lay.

- a. Backfill with clean sand or pea gravel.
3. Shape bottom of excavation to fit design of pipe.
 - a. Fill unevenness with tamped sand backfill
4. Remove large stones or other hard matter which could damage drainage pipe or impede consistent backfilling or compaction.

3.3 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Install pipe beginning at low point of system, true to grades and alignment indicated, with maximum variation from true slope of 1/8 inch in 10 feet.
 1. Install polyethylene corrugated pipe in accordance with ASTM D2321.
 - a. Install fittings in accordance with manufacturer's instructions.
 2. Cap upper ends of pipe.
- C. Install filter fabric over subgrade in area to receive perforated pipe.
 1. Place 2 inch deep by not less than 12 inch wide bedding aggregate over filter fabric.
- D. Install pipe over bedding aggregate with perforations facing down.
 1. Mechanically join pipe ends.
- E. Install filter aggregate at sides and top of pipe in 4 inch lifts.
 1. Do not displace or damage pipe when placing filter aggregate.
 2. Provide top cover of filter aggregate of not less than 24 inches of depth, and as indicated on Drawings.
 3. Level top of aggregate cover.
- F. Wrap filter fabric over aggregate cover prior to backfilling.
- G. Coordinate final backfilling and compaction operations with Sections 312000.
 1. Do not allow backfilling operations to commence without observation of completed system by Engineer.
 2. Do not allow drainage pipe to be displaced during backfilling and compaction operations.
- H. Connect drainage pipe to storm drainage system using unperforated pipe or through installed sleeves.

3.4 FIELD QUALITY CONTROL

- A. Provide in accordance with Division 1.
- B. Inspections: Allow Engineer to observe installed system prior to installation of filter aggregate cover.
 1. Tests: Upon completion of installation, test drainage pipe for free flow of water.

END OF SECTION

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SECTION 33 46 13 - FOUNDATION DRAINAGE

PART 1 - GENERAL

1.1 SUMMARY

- A. Section Includes:
 - 1. Building perimeter drainage system.
 - 2. Retaining wall drainage system.
 - 3. Under slab-on-fill drainage system.
 - 4. Related accessories.

- B. Related Sections:
 - 1. Section 312000 – Earth Moving.
 - 2. Section 334100 - Storm Utility Drainage Piping.

1.2 SUBMITTALS

- A. Submit in accordance with Division 1 unless otherwise indicated.

1.3 PRODUCT DATA

- A. Manufacturer's specifications and technical data including the following:
 - 1. Pipe drainage products and accessories.
 - 2. Filter fabric.

- B. Samples:
 - 1. Submit samples of the following:
 - 2. Filter fabric.

- C. Contract Closeout Submittals: Submit in accordance with Division 1.

- D. Project Record Documents.
 - 1. Accurately record location of underground utilities, by horizontal dimensions from above grade permanent fixtures, elevations or inverts, and slope gradients.

1.4 QUALITY ASSURANCE

- A. Manufacturer's Qualifications: Not less than 5 years experience in the actual production of specified products.

- B. Installer's Qualifications: Firm experienced in installation of systems similar in complexity to those required for this Project, plus the following:
 - 1. Not less than 3 years experience with systems.
 - 2. Successfully completed not less than 5 comparable scale projects using this system.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Packing and Shipping: Deliver products in original unopened packaging with legible manufacturer's identification.
- B. Storage and Protection: Comply with manufacturer's recommendations.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. High Density Polyethylene (HDPE) pipe and fittings: AASHTO M252, Type S; AASHTO M294, Type S. All joints shall meet the requirements of a soil-tight joint unless otherwise specified.
 - 1. Perforation: Class II perforation per AASHTO M252 and M294.
- B. Fittings: As required for installation of drainage system.
- C. Filter Aggregate and Bedding Materials: Granular Fill as specified under Section 312000.
- D. Drainage Panels: Prefabricated geocomposite, 36 to 60 inches (915 to 1525 mm) wide with drainage core faced with geotextile filter fabric.
 - 1. Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:
 - 2. Comparable product by one of the following:
 - a. American Wick Drain.
 - b. Cosella-Dorcken Products, Inc.
 - c. Eljen Corporation.
 - d. Greenstreak.
 - e. JDR Enterprises, Inc.
 - f. Midwest Diversified Technologies Incorporated.
 - g. TenCate Geosynthetics.
 - h. Trace-LINQ Inc.
 - 3. Drainage Core: Three-dimensional, nonbiodegradable, molded PP.
 - a. Minimum Compressive Strength: 10,000 lbf/sq. ft. (479 kPa) when tested according to ASTM D 1621.
 - b. Minimum In-Plane Flow Rate: 2.8 gpm/ft. (35 L/min. per m) of unit width at hydraulic gradient of 1.0 and compressive stress of 25 psig (172 kPa) when tested according to ASTM D 4716.
 - 4. Filter Fabric: Nonwoven needle-punched geotextile, manufactured for subsurface drainage, made from polyolefins or polyesters; with elongation greater than 50 percent; complying with the following properties determined according to AASHTO M 288:
 - a. Survivability: Class 1.
 - b. Apparent Opening Size: No. 40 (0.425-mm) sieve, maximum.
 - c. Permittivity: 0.5 per second, minimum.
 - 5. Film Backing: Polymeric film bonded to drainage core surface.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Verification of Conditions: Examine areas and conditions under which Work is to be performed and identify conditions detrimental to proper and timely completion.
 - 1. Do not proceed until unsatisfactory conditions have been corrected.

3.2 PREPARATION

- A. Preparation
 - 1. Grade bottom of excavations to provide smooth, firm, stable, and rock free foundation throughout length of pipe.
 - 2. Remove unstable, soft, and unsuitable materials from surface upon which pipe is to lay.
 - a. Backfill with clean sand or pea gravel.
 - 3. Shape bottom of excavation to fit design of pipe.
 - a. Fill unevenness with tamped sand backfill.
 - 4. Remove large stones or other hard matter which could damage drainage pipe or impede consistent backfilling or compaction.

3.3 INSTALLATION

- A. Comply with manufacturer's instructions.
- B. Install pipe beginning at low point of system, true to grades and alignment indicated, with maximum variation from true slope of 1/8 inch in 10 feet.
 - 1. Install PVC pipe in accordance with ASTM D2855 and ASTM F402.
 - 2. Cap upper ends of pipe.
- C. Install filter fabric over subgrade in area to receive perforated pipe.
 - 1. Place 2 inch deep by not less than 12 inch wide bedding aggregate over filter fabric.
- D. Install pipe over bedding aggregate with perforations facing down.
 - 1. Mechanically join pipe ends.
- E. Install drainage panel over waterproofing in accordance with manufacturer's instructions.
 - 1. Overlay drainage panel filter fabric in the direction of water flow at panel joints.
 - 2. Peel back lower 15 inches of fabric and wrap fabric around drain pipe, tucking fabric securely under pipe.
 - 3. Coordinate installation with Division 7.
- F. Install filter aggregate at sides and top of pipe in 4 inch lifts.
 - 1. Do not displace or damage pipe when placing filter aggregate.
 - 2. Provide top cover of filter aggregate of not less than 24 inches of depth, and as indicated on Drawings.
 - 3. Level top of aggregate cover.
- G. Wrap filter fabric over aggregate cover prior to backfilling.
- H. Coordinate final backfilling and compaction operations with Sections 312000.

1. Do not allow backfilling operations to commence without observation of completed system by Engineer.
 2. Do not allow drainage pipe to be displaced during backfilling and compaction operations.
- I. Connect drainage pipe to storm drainage system using unperforated pipe or through installed sleeves.

3.4 FIELD QUALITY CONTROL

- A. Provide in accordance with Division 1.
- B. Inspections: Allow Engineer to observe installed system prior to installation of filter aggregate cover.
- C. Tests: Upon completion of installation, test drainage pipe for free flow of water.

END OF SECTION

SECTION 33 73 13 - LIQUID FILLED UTILITY TRANSFORMERS

PART 1 - GENERAL

- A. This Section includes the following types of transformers with medium-voltage primaries:
 - 1. Pad-mounted, liquid-filled transformers.

1.2 RELATED SECTIONS INCLUDE THE FOLLOWING:

- A. Division 26 Section "General Electrical Requirements" for general requirements and related documents that apply to this section.
- B. Division 26 Section "Common Work Results for Electrical" for raceways, conductors, cables, and cords.
- C. Division 26 Section "Equipment Wiring Systems" for electrical connections to equipment specified under other sections, Divisions, or furnished by the owner.
- D. Division 26 Section "Medium voltage Cables".
- E. Division 26 Section "Low-voltage Electrical Power Conductors and Cables".
- F. Division 26 Section "Grounding and Bonding For Electrical Systems".
- G. Division 26 Section "Raceway and Boxes for Electrical Systems".
- H. Division 26 Section "Underground Ducts and Raceways for Electrical Systems".
- I. Division 26 Section "Identification for Electrical Systems".
- J. Division 26 Section "Overcurrent Protection Device Coordination Study".
- K. Division 26 Section "Fuses".

1.3 SUBMITTALS

- A. General: Submit the following in accordance with Division 16 Section "General Electrical Requirements".
- B. Product data: Include rated nameplate data, capacities, weights, dimensions, colors, minimum clearances, installed devices and features, location of each field connection, and performance for each type and size of transformer indicated.
 - 1. Medium-voltage Transformers.
- C. Source quality-control test reports.
- D. Field quality-control test reports.
- E. Follow-up service reports.
- F. Operation and Maintenance Data: For transformer and accessories to include in emergency, operation, and maintenance manuals.

1.4 DEFINITIONS

- A. NETA ATS: Acceptance Testing Specification.

1.5 QUALITY ASSURANCE

- A. Product Options: Drawings indicate size, profiles, and dimensional requirements of transformers and are based on the specific system indicated.

- B. Electrical Components, Devices, and Accessories: Listed and labeled as defined in NFPA 70, Article 100, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use.
- C. Comply with IEEE C2.
- D. Comply with ANSI C57.12.10, ANSI C57.12.28, IEEE C57.12.70, and IEEE C57.12.80.
- E. Comply with NFPA 70.
- F. Transformers shall meet the requirements of the most current version of federal law 10 CFR Part 431 "Energy Efficiency Program for Certain Commercial and Industrial Equipment".

1.6 DELIVERY, STORAGE, AND HANDLING

- A. Store transformers protected from weather and so condensation will not form on or in units. Provide temporary heating according to manufacturer's written instructions.

1.7 COORDINATION

- A. Coordinate size and location of concrete bases. Cast anchor-bolt inserts into bases. Concrete, reinforcement, and formwork requirements are specified in Division 3.
- B. Coordinate installation of louvers, doors, spill retention areas, and sumps. Coordinate installation so no piping or conduits are installed in space allocated for medium-voltage transformers except those directly associated with transformers.

1.8 QUALIFICATIONS

- A. Provide products listed and classified by Underwriters Laboratories, Inc (UL) as suitable for the purpose specified and indicated.
- B. Materials shall be manufactured by Companies specializing in the products specified in this section with minimum 3 years documented experience.

PART 2 - PRODUCTS AND MATERIALS

2.1 MANUFACTURERS

- A. Manufacturers: Subject to compliance with requirements, provide products by one of the following:
 1. Acme Electric Corporation; Power Distribution Products Division.
 2. Cooper Industries; Cooper Power Systems Division.
 3. Eaton Electrical Inc.; Cutler Hammer Products.
 4. Federal Pacific Transformer Company; Division of Electro-Mechanical Corp.
 5. GE Electrical Distribution & Control.
 6. Hammond Manufacturing; Transformer Group.
 7. ABB; Kuhlman Electric Corporation
 8. CG Global; Pauwels Transformers,.
 9. Pioneer Transformers.
 10. Siemens Energy & Automation, Inc.
 11. Square D; Schneider Electric.
 12. Uptegraff, R. E. Mfg. Co.

13. Virginia Transformer Corp.

2.2 PAD-MOUNTED, THREE-PHASE, LIQUID-FILLED TRANSFORMERS

- A. Description: ANSI C57.12.13, ANSI C57.12.26, IEEE C57.12.00, pad-mounted, 2-winding transformers. Stainless-steel tank base, cabinet, and sills.
 - 1. Windings: Copper
- B. Insulating Liquid: Less flammable, edible-seed-oil based, and UL listed as complying with NFPA 70 requirements for fire point of not less than 300 deg C when tested according to ASTM D 92. Liquid shall be biodegradable and nontoxic.
- C. Insulation Temperature Rise: 65 deg C when operated at rated kVA output in a 40 deg C ambient temperature. Transformer shall be rated to operate at rated kilovolt ampere in an average ambient temperature of 30 deg C over 24 hours with a maximum ambient temperature of 40 deg C without loss of service life expectancy.
- D. Basic Impulse Level: 95 kV.
- E. Full-Capacity Voltage Taps: Four 2.5 percent taps, 2 above and 2 below rated high voltage; with externally operable tap changer for de-energized use and with position indicator and padlock hasp.
- F. High-Voltage Switch: 300 A, make-and-latch rating of 10-kA RMS, symmetrical, arranged for radial feed with 3-phase, 2-position, gang-operated, load-break switch that is oil immersed in transformer tank with hook-stick operating handle in primary compartment.
- G. Primary Fuses: 15-kV fuse assembly with fuses complying with IEEE C37.47.
 - 1. Bay-O-Net liquid-immersed fuses in series with liquid-immersed current-limiting fuses. Bay-O-Net fuses shall be externally replaceable without opening transformer tank.
 - 2. Bay-O-Net liquid-immersed current-limiting fuses that are externally replaceable without opening transformer tank.
- H. High-Voltage Terminations and Equipment: Dead front with universal-type bushing wells for dead-front bushing-well inserts, complying with IEEE 386 and including the following:
 - 1. Dead front, radial feed: Three (3) – 600A primary bushing, suitable for delta connection of 13,800V dead break elbow connectors.
 - 2. Surge Arresters: 10kV MCOV dead-front, elbow-type, metal-oxide-varistor units.
 - 3. Parking Stands: One for each high-voltage bushing well.
 - 4. Portable Insulated Bushings: Arranged for parking insulated, high-voltage, load-break cable terminators; one for each primary feeder conductor terminating at transformer.
- I. Accessories:
 - 1. Drain Valve: 1 inch (25 mm), with sampling device.
 - 2. Dial-type thermometer.
 - 3. Liquid-level gage.
 - 4. Pressure-vacuum gage.
 - 5. Pressure Relief Device: Self-sealing with an indicator.
 - 6. Mounting provisions for low-voltage current transformers.
 - 7. Secondary barrier to isolate from primary section.

2.3 IDENTIFICATION DEVICES

- A. Nameplates: Engraved, laminated-plastic or metal nameplate for each transformer, mounted with corrosion-resistant screws. Nameplates and label products are specified in Division 16 Section "Electrical Identification."

2.4 SOURCE QUALITY CONTROL

- A. Factory Tests: Perform design and routine tests according to standards specified for components. Conduct transformer tests according to federal law 10 CFR Part 431 and IEEE C57.12.90.
- B. Factory Tests: Perform the following factory-certified tests on each transformer:
 - 1. Resistance measurements of all windings on rated-voltage connection and on tap extreme connections.
 - 2. Ratios on rated-voltage connection and on tap extreme connections.
 - 3. Polarity and phase relation on rated-voltage connection.
 - 4. No-load loss at rated voltage on rated-voltage connection.
 - 5. Excitation current at rated voltage on rated-voltage connection.
 - 6. Impedance and load loss at rated current on rated-voltage connection and on tap extreme connections.
 - 7. Applied potential.
 - 8. Induced potential.
 - 9. Temperature Test: If transformer is supplied with auxiliary cooling equipment to provide more than one rating, test at lowest kilovolt-ampere Class OA or Class AA rating and highest kilovolt-ampere Class OA/FA or Class AA/FA rating.
 - a. Temperature test is not required if record of temperature test on an essentially duplicate unit is available.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Examine areas and conditions for compliance with requirements for medium-voltage transformers.
- B. Examine roughing-in of conduits and grounding systems to verify the following:
 - 1. Wiring entries comply with layout requirements.
 - 2. Entries are within conduit-entry tolerances specified by manufacturer and no feeders will have to cross section barriers to reach load or line lugs.
- C. Examine walls, floors, roofs, and concrete bases for suitable mounting conditions where transformers will be installed.
- D. Verify that ground connections are in place and that requirements in Division 16 Section "Grounding and Bonding" have been met. Maximum ground resistance shall be 5 ohms at location of transformer.
- E. Proceed with installation only after unsatisfactory conditions have been corrected.

3.2 INSTALLATION

- A. Install transformers on concrete bases.

1. Maintain minimum clearances and workspace at equipment according to manufacturer's written instructions, NFPA 70, and the local utility companies.

B. IDENTIFICATION

1. Identify field-installed wiring and components and provide warning signs as specified in Division 26 Section "Identification for Electrical Systems."
2. In addition to normal information, the following items shall be included on the nameplate:
 - a. kVA ratings
 - b. Primary voltage
 - c. Secondary voltage
 - d. BIL ratings
 - e. Temperature ratings
 - f. Primary and secondary voltages for each tap setting
 - g. Date of Manufacture
 - h. Name of Manufacturer
 - i. Type of conductor in windings
 - j. Impedance expressed in percentage
 - k. Detail circuit diagrams of primary switch configuration and switch ratings.
 - l. Delta-wye diagram details the relationship of primary to secondary bushings
 - m. Statement "Transformer filled with less-flammable fluid".
 - n. Statement "Transformer filled with fluid containing no detectable PCB's at time of manufacture".
 - o. Total weight of unit in pounds
 - p. Weight of unit without oil.
3. Transformer shall have a blue "CONTAINS NO PCBs" label placed inside of the secondary compartment door and another same label placed on the outside of the tank.
4. Transformer shall have a "Danger-High Voltage" label on the outside of the primary compartment door meeting all applicable standards.
5. Transformer shall have "Secondary Barrier Installed" label installed on the outside of the secondary compartment door.

C. CONNECTIONS

1. Ground equipment according to Division 26 Section "Grounding and Bonding for Electrical Systems."
2. Connect wiring according to Division 26 Section "Low Voltage Electrical Power Conductors and Cables."

D. PAINTING

1. Unit shall be painted Munsell green #7.0GY.29/1.5 with a minimum thickness of 2.5 MIL.
2. A small container of touch up paint shall be supplied with the transformer and given to the system owner.

E. FIELD QUALITY CONTROL

1. Perform the following field tests and inspections and prepare test reports:
 - a. system at substation is tested at specified value or less.
 - b. After installing transformers and after electrical circuitry has been energized, test for compliance with requirements.
 - c. Perform visual and mechanical inspection and electrical test stated in NETA ATS. Certify compliance with test parameters.
 - d. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
2. Remove and replace malfunctioning units and retest as specified above.
3. Test Reports: Prepare written reports to record the following:
 - a. Test procedures used.
 - b. Test results that comply with requirements.
 - c. Test results that do not comply with requirements and corrective actions taken to achieve compliance with requirements.

3.3 CLEANING

- A. Clean exposed surfaces to remove splatters and restore finish.

END OF SECTION

OUTSIDE AIR REQUIREMENTS, ASHRAE 62.1-2016 (IP)

SYSTEM DESIGNATION	SYSTEM TYPE	SINGLE-ZONE SYSTEMS ONLY		MULTI-ZONE SYSTEMS ONLY	FLOOR AREA SERVED BY SYSTEM [A _s] (SF)	SYSTEM AVERAGED AREA BASED OUTDOOR AIR RATE [P _s] (CFM/SF)	SYSTEM POPULATION [P _s] (PEOPLE)	SYSTEM AVERAGED PEOPLE BASED OUTDOOR AIR RATE (CFM/P)	REQUIRED OA INTAKE FLOW [V _{ot}] (CFM)	REQUIRED DCV OA INTAKE FLOW [V _{o2}] (CFM)	DESIGN OA INTAKE FLOW (CFM)	NOTES
		SINGLE-ZONE SYSTEM ASSOCIATED VENTILATION ZONE	SINGLE ZONE WORST CASE ZONE AIR DISTRIBUTION EFFECTIVENESS [E _z]	SYSTEM VENTILATION EFFICIENCY [E _v]								
RTU 1/2	SINGLE ZONE	PRACTICE FIELD - TEAM	0.80	-	78,000	0.180	150	20.00	21,300	17,550	21,300	
RTU 3	MULTIZONE (RTU 3)	-	-	0.92	9,874	0.040	108	5.00	1,020	N/A	1,020	
TOTALS									22,320	17,550	22,320	

GENERAL NOTES:

1. VENTILATION CALCULATIONS BASED ON ASHRAE STANDARD 62.1-2016.
2. SYSTEM POPULATIONS BASED ON MAX SEATING AND/OR CODE MAXIMUM VALUES.
3. SINGLE ZONE SYSTEMS (V_{ot} = V_{o2}): SYSTEM VENTILATION EFFICIENCY CALCULATION IS NOT REQUIRED FOR SINGLE ZONE SYSTEMS. WORST CASE AIR DISTRIBUTION EFFECTIVENESS BETWEEN HEATING AND COOLING MODES OF OPERATION IS SHOWN IN TABLE.

NOTES:

PROJECT INFORMATION

Location
Building owner
Program user
Company
Comments

By **HENDERSON ENGINEERS**
Dataset name **C:\TRACE700\2054521 PROJECT TIGER.TRC**

Calculation time **01:58 PM on 06/21/2021**
TRACE® 700 version **6.3.5**

Location **Whiteman AFB, Missouri**
Latitude **39.0 deg**
Longitude **93.0 deg**
Time Zone **6**
Elevation **838 ft**
Barometric pressure **29.0 in. Hg**

Air density **0.0736 lb/cu ft**
Air specific heat **0.2444 Btu/lb·°F**
Density-specific heat product **1.0799 Btu/h·cfm·°F**
Latent heat factor **4,753.5 Btu·min/h·cu ft**
Enthalpy factor **4.4178 lb·min/hr·cu ft**

Summer design dry bulb **95.0 °F**
Summer design wet bulb **78.0 °F**
Winter design dry bulb **0.0 °F**
Summer clearness number **0.97**
Winter clearness number **0.97**
Summer ground reflectance **0.20**
Winter ground reflectance **0.20**
Carbon Dioxide Level **400 ppm**

Design simulation period **January - December**
Cooling load methodology **RTS (Heat Balance)**
Heating load methodology **UATD**



Load / Airflow Summary

By HENDERSON ENGINEERS

System	Zone	Room **	Floor Area ft²	People #	Coil	Coil	Space	Air Changes ach/hr	VAV	VAV Minimum %	Main Coil	Heating	Percent				
					Cooling Sensible Btu/h	Cooling Total Btu/h	Design Max SA cfm		Minimum SA cfm		Heating Sensible Btu/h	Fan Max SA cfm	Clg	Htg			
Alternative 1																	
		108 Electrical			Rm Peak	210	0.0	15,783	15,783	726	17.29	218	30	-956	0	0.0	0.0
	CRU 1				Zn Peak	210	0.0	15,783	15,783	726			30	-956	0	0.0	0.0
	CRU 1				Zn Block	210	0.0	15,783	15,783	726			30	-956	0	0.0	0.0
		109 IT			Rm Peak	120	0.0	36,580	36,580	1,691	70.46	507	30	-270	0	0.0	0.0
	CRU 2				Zn Peak	120	0.0	36,580	36,580	1,691			30	-270	0	0.0	0.0
	CRU 2				Zn Block	120	0.0	36,580	36,580	1,691			30	-270	0	0.0	0.0
		110 E Elec			Rm Peak	55	0.0	2,225	2,225	102	9.26	31	30	-124	0	0.0	0.0
	CRU 3				Zn Peak	55	0.0	2,225	2,225	102			30	-124	0	0.0	0.0
	CRU 3				Zn Block	55	0.0	2,225	2,225	102			30	-124	0	0.0	0.0
	Mini Splits				Sys Peak	385	0.0	54,589	54,589	2,519				-1,350	0	0.0	0.0
	Mini Splits				Sys Block	385	0.0	54,489	54,489	2,519				-1,350	0	0.0	0.0
		101 Playing Field			Rm Peak	78,000	150.0	1,539,843	2,578,410	47,384	0.73	14,215	30	-2,208,257	0	45.0	100.0
	Practice Field				Sys Peak	78,000	150.0	1,539,843	2,578,410	47,384				-2,208,257	0	45.0	100.0
	Practice Field				Sys Block	78,000	150.0	1,539,843	2,578,410	47,385				-2,208,257	0	45.0	100.0
		105 Restroom			Rm Peak	362	0.0	2,298	2,578	97	1.04	0	0	-3,323	97	10.0	10.0
		106 Exam Stor			Rm Peak	155	0.3	2,510	7,883	104	2.59	0	0	-3,559	104	10.0	10.0
		107 Turf Management			Rm Peak	969	1.9	7,572	9,318	312	1.61	0	0	-10,727	312	10.0	10.0
		111 Exam			Rm Peak	210	2.1	3,954	5,121	168	3.99	0	0	-5,758	168	10.0	10.0
		112 Field Equipment			Rm Peak	625	1.3	7,008	8,694	299	2.39	0	0	-10,256	299	10.0	10.0
		201 Recruit Level			Rm Peak	1,700	30.0	31,896	43,899	1,349	5.01	0	0	-46,320	1,349	10.0	10.0
		201A Storage			Rm Peak	217	0.4	2,282	2,821	98	2.86	0	0	-3,373	98	10.0	10.0
		302 RR			Rm Peak	350	0.0	4,573	5,104	206	2.94	0	0	-7,058	206	10.0	10.0
		303 RR			Rm Peak	341	0.0	5,501	6,436	232	3.40	0	0	-7,953	232	10.0	10.0
		304 Viewing Platform			Rm Peak	1,950	50.0	78,270	96,796	3,292	6.64	0	0	-113,026	3,292	10.0	10.0
		C301 Circ			Rm Peak	300	0.0	1,452	1,680	56	0.94	0	0	-1,938	56	10.0	10.0
		L101 Player Lobby			Rm Peak	915	20.0	17,989	25,826	853	3.61	0	0	-29,292	853	10.0	10.0
		L301 Donor Lobby			Rm Peak	366	6.0	6,954	9,411	283	3.86	0	0	-9,700	283	10.0	10.0
		Stairs			Rm Peak	200	0.0	47,017	52,677	2,192	16.44	0	0	-75,255	2,192	10.0	10.0
	RTU 3				Zn Peak	8,660	112.0	219,277	278,242	9,541			0	-327,537	9,541	10.0	10.0
	RTU 3				Zn Block	8,660	112.0	173,719	239,654	9,541			0	-327,537	9,541	10.0	10.0
	RTU 3				Sys Peak	8,660	112.0	219,277	278,242	9,541				-327,537	9,541	10.0	10.0
	RTU 3				Sys Block	8,660	112.0	173,719	239,654	9,541				-327,537	9,541	10.0	10.0

* This report does not display heating only systems.

PEAK COOLING LOADS

MAIN SYSTEM

By HENDERSON ENGINEERS

System	Zone	Room	Floor Area ft ²	SPACE								COIL							
				Peak Time Mo/Hr	OA Condition		Room Dry Bulb °F	Supply Dry Bulb °F	Space Air Flow cfm	Space Sensible Load Btu/h	Space Latent Load Btu/h	Peak Time Mo/Hr	OA Condition		Supply Dry Bulb °F	Coil Airflow cfm	Coil Sensible Load Btu/h	Coil Latent Load Btu/h	
					DB °F	WB °F							DB °F	WB °F					
Alternative 1																			
		V101 Vestibule	Peak	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 1	Peak	0		0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 1	Block	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		113 Water	Peak	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 2	Peak	0		0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 2	Block	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		V301 Vestibule	Peak	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 3	Peak	0		0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 3	Block	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		301 Janitor	Peak	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 4	Peak	0		0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		UH 4	Block	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		Heating Only	Peak	0		0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		Heating Only	Block	0	0/0	0	0	0.0	0.0	0	0	0	0	0	0	0	0		
		108 Electrical	Peak	210	7/11	86	73	75.0	55.0	726	15,683	0	7/11	86	73	55.0	726	15,783	0
		CRU 1	Peak	210		86	73	75.0	55.0	726	15,683	0		86	73	55.0	726	15,783	0
		CRU 1	Block	210	7/11	86	73	75.0	55.0	726	15,683	0	7/11	86	73	55.0	726	15,783	0
		109 IT	Peak	120	7/15	95	78	75.0	55.0	1,691	36,523	0	7/15	95	78	55.0	1,691	36,580	0
		CRU 2	Peak	120		95	78	75.0	55.0	1,691	36,523	0		95	78	55.0	1,691	36,580	0
		CRU 2	Block	120	7/15	95	78	75.0	55.0	1,691	36,523	0	7/15	95	78	55.0	1,691	36,580	0
		110 E Elec	Peak	55	7/15	95	78	75.0	55.0	102	2,199	0	7/15	95	78	55.0	102	2,225	0
		CRU 3	Peak	55		95	78	75.0	55.0	102	2,199	0		95	78	55.0	102	2,225	0
		CRU 3	Block	55	7/15	95	78	75.0	55.0	102	2,199	0	7/15	95	78	55.0	102	2,225	0
		Mini Splits	Peak	385		95	78	75.0	55.0	2,519	54,405	0		95	78	55.0	2,519	54,589	0
		Mini Splits	Block	385	7/15	95	78	75.0	55.0	2,519	54,305	0	7/15	95	78	55.0	2,514	54,489	0
		101 Playing Field	Peak	78,000	8/15	94	79	75.0	53.6	47,384	1,096,146	150,000	8/15	94	79	53.6	47,384	1,539,843	1,038,567
		Practice Field	Peak	78,000		94	79	75.0	53.6	47,384	1,096,146	150,000		94	79	53.6	47,384	1,539,843	1,038,567
		Practice Field	Block	78,000	8/15	94	79	75.0	53.6	47,385	1,096,146	150,000	8/15	94	79	53.6	47,385	1,539,843	1,038,567
		105 Restroom	Peak	362	6/10	78	71	75.0	55.0	97	2,090	0	6/10	78	71	55.0	97	2,298	280
		106 Exam Stor	Peak	155	7/15	95	78	75.0	55.0	104	2,239	4,912	8/15	94	79	55.2	104	2,510	5,373
		107 Turf Management	Peak	969	7/11	86	73	75.0	55.0	312	6,748	485	7/15	95	78	56.0	312	7,572	1,746
		111 Exam	Peak	210	7/11	86	73	75.0	55.0	168	3,622	420	8/15	94	79	56.0	168	3,954	1,166
		112 Field Equipment	Peak	625	7/12	90	75	75.0	55.0	299	6,452	313	8/13	92	78	55.9	299	7,008	1,685
		201 Recruit Level	Peak	1,700	6/10	78	71	75.0	55.0	1,349	29,141	6,000	8/15	94	79	56.1	1,349	31,896	12,003

			SPACE									COIL						
System	Zone	Room	Floor Area ft²	Peak Time Mo/Hr	OA Condition		Room Dry	Supply Dry	Space Air	Space Sensible	Space Latent	Peak Time Mo/Hr	OA Condition		Supply Dry	Coil Airflow	Coil Sensible	Coil Latent
					DB °F	WB °F	Bulb °F	Bulb °F	Flow cfm	Load Btu/h	Load Btu/h		DB °F	WB °F	Dry Bulb °F	Airflow cfm	Load Btu/h	Load Btu/h
		201A Storage	217	Peak	9/12	79	71	75.0	55.0	98	2,122	8 /13	92	78	56.2	98	2,282	538
		302 RR	350	Peak	6/8	73	69	75.0	55.0	206	4,440	6 /8	73	69	55.0	206	4,573	531
		303 RR	341	Peak	7/18	90	73	75.0	55.0	232	5,003	7 /15	95	78	55.7	232	5,501	935
		304 Viewing Platform	1,950	Peak	7/18	90	73	75.0	55.0	3,292	71,108	7 /18	90	73	55.0	3,292	78,270	18,526
		C301 Circ	300	Peak	7/15	95	78	75.0	55.0	56	1,219	7 /15	95	78	55.0	56	1,452	228
		L101 Player Lobby	915	Peak	6/8	73	69	75.0	55.0	853	18,429	8 /14	94	79	58.3	853	17,989	7,837
		L301 Donor Lobby	366	Peak	7/15	95	78	75.0	55.0	283	6,103	8 /15	94	79	55.2	283	6,954	2,457
		Stairs	200	Peak	6/8	73	69	75.0	55.0	2,192	47,345	6 /8	73	69	55.0	2,192	47,017	5,660
		RTU 3	8,660	Peak		75	69	75.0	55.0	9,541	206,063		95	78	55.6	9,541	219,277	58,965
		RTU 3	8,660	Block	6/9	75	69	75.0	55.0	9,541	161,234	7 /15	95	78	60.8	9,541	173,719	65,935
RTU 3			8,660	Peak		75	69	75.0	55.0	9,541	206,063		95	78	55.6	9,541	219,277	58,965
RTU 3			8,660	Block	6/9	75	69	75.0	55.0	9,541	161,234	7 /15	95	78	60.8	9,541	173,719	65,935

PEAK HEATING LOADS
MAIN SYSTEM
 By HENDERSON ENGINEERS

Peak Time	OA Condition	
	DB °F	WB °F
Htg Design	0	-3

System	Zone	Room	Block or Peak	Floor Area ft²	SPACE			COIL			
					Room Dry Bulb °F	Supply Dry Bulb °F	Space Air Flow cfm	Space Sensible Load Btu/h	Supply Dry Bulb °F	Coil Air Flow cfm	Coil Sensible Load Btu/h
Alternative 1											
		V101 Vestibule	Peak	100	70.0	125.0	56	-3,349	125.0	56	-3,349
	UH 1		Peak	100	70.0	125.0	56	-3,349	125.0	56	-3,349
	UH 1		Block	100	70.0	125.0	56	-3,349	125.0	56	-3,349
		113 Water	Peak	152	70.0	125.0	18	-1,085	125.0	18	-1,085
	UH 2		Peak	152	70.0	125.0	18	-1,085	125.0	18	-1,085
	UH 2		Block	152	70.0	125.0	18	-1,085	125.0	18	-1,085
		V301 Vestibule	Peak	100	70.0	125.0	41	-2,463	125.0	41	-2,463
	UH 3		Peak	100	70.0	125.0	41	-2,463	125.0	41	-2,463
	UH 3		Block	100	70.0	125.0	41	-2,463	125.0	41	-2,463
		301 Janitor	Peak	217	70.0	125.0	21	-1,271	125.0	21	-1,271
	UH 4		Peak	217	70.0	125.0	21	-1,271	125.0	21	-1,271
	UH 4		Block	217	70.0	125.0	21	-1,271	125.0	21	-1,271
			Peak	569	70.0	125.0	138	-8,168	125.0	138	-8,168
			Block	569	70.0	125.0	138	-8,168	125.0	138	-8,168
		108 Electrical	Peak	210	70.0	74.1	218	-956	74.1	218	-956
	CRU 1		Peak	210	70.0	74.1	218	-956	74.1	218	-956
	CRU 1		Block	210	70.0	74.1	218	-956	74.1	218	-956
		109 IT	Peak	120	70.0	70.5	507	-270	70.5	507	-270
	CRU 2		Peak	120	70.0	70.5	507	-270	70.5	507	-270
	CRU 2		Block	120	70.0	70.5	507	-270	70.5	507	-270
		110 E Elec	Peak	55	70.0	73.8	31	-124	73.8	31	-124
	CRU 3		Peak	55	70.0	73.8	31	-124	73.8	31	-124
	CRU 3		Block	55	70.0	73.8	31	-124	73.8	31	-124
			Peak	385	70.0	71.7	756	-1,350	71.7	756	-1,350
			Block	385	70.0	71.7	756	-1,350	71.7	756	-1,350
		101 Playing Field	Peak	78,000	70.0	109.0	14,215	-598,158	109.0	14,215	-2,208,257
			Peak	78,000	70.0	109.0	14,215	-598,158	109.0	14,215	-2,208,257
			Block	78,000	70.0	109.0	14,215	-598,158	109.0	14,215	-2,208,257
		105 Restroom	Peak	362	70.0	94.8	97	-2,591	94.8	97	-3,323
		106 Exam Stor	Peak	155	70.0	94.8	104	-2,776	94.8	104	-3,559
		107 Turf Management	Peak	969	70.0	94.8	312	-8,365	94.8	312	-10,727
		111 Exam	Peak	210	70.0	94.8	168	-4,490	94.8	168	-5,758
		112 Field Equipment	Peak	625	70.0	94.8	299	-7,998	94.8	299	-10,256

Peak Time	OA Condition	
	DB °F	WB °F
Htg Design	0	-3

System	Zone	Room	Block or Peak	Floor Area ft²	SPACE			COIL			
					Room Dry Bulb °F	Supply Dry Bulb °F	Space Air Flow cfm	Space Sensible Load Btu/h	Supply Dry Bulb °F	Coil Air Flow cfm	Coil Sensible Load Btu/h
		201 Recruit Level	Peak	1,700	70.0	94.8	1,349	-36,121	94.8	1,349	-46,320
		201A Storage	Peak	217	70.0	94.8	98	-2,630	94.8	98	-3,373
		302 RR	Peak	350	70.0	94.8	206	-5,504	94.8	206	-7,058
		303 RR	Peak	341	70.0	94.8	232	-6,202	94.8	232	-7,953
		304 Viewing Platform	Peak	1,950	70.0	94.8	3,292	-88,138	94.8	3,292	-113,026
		C301 Circ	Peak	300	70.0	94.8	56	-1,511	94.8	56	-1,938
		L101 Player Lobby	Peak	915	70.0	94.8	853	-22,842	94.8	853	-29,292
		L301 Donor Lobby	Peak	366	70.0	94.8	283	-7,564	94.8	283	-9,700
		Stairs	Peak	200	70.0	94.8	2,192	-58,684	94.8	2,192	-75,255
		RTU 3	Peak	8,660	70.0	94.8	9,541	-255,415	94.8	9,541	-327,537
		RTU 3	Block	8,660	70.0	94.8	9,541	-255,415	94.8	9,541	-327,537
RTU 3			Peak	8,660	70.0	94.8	9,541	-255,415	94.8	9,541	-327,537
RTU 3			Block	8,660	70.0	94.8	9,541	-255,415	94.8	9,541	-327,537

System Checksums

By HENDERSON ENGINEERS

Heating Only

Unit Heaters

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design		Mo/Hr: Heating Design		Mo/Hr: Heating Design		Cooling	Heating	
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0		OADB: 0		OADB: 0		SADB	0.0	125.0
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	0.0	66.0
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)	Return	0.0	70.0
Envelope Loads				Envelope Loads				Envelope Loads				Fn MtrTD	0.0	0.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	Skylite Solar	0	0.00	Fn BldTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	Skylite Cond	0	0.00	Fn Frict	0.0	0.0
Roof Cond	0	0	0	0	0	Roof Cond	0	6.55	Roof Cond	-535	6.55	AIRFLOWS		
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00	Glass Solar	0	0.00	Diffuser	0	138
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	-5,202	63.68	Glass/Door Cond	-5,202	63.68	Terminal	0	138
Wall Cond	0	0	0	0	0	Wall Cond	-2,236	29.77	Wall Cond	-2,431	29.77	Main Fan	0	138
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00	Partition/Door	0	0.00	Sec Fan	0	0
Floor	0	0	0	0.00	0	Floor	0	0.00	Floor	0	0.00	Nom Vent	0	0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	Adjacent Floor	0.00	0.00	AHU Vent	0	0
Infiltration	0	0	0	0	0	Infiltration	0	0.00	Infiltration	0	0.00	Infil	0	0
Sub Total ==>	0	0	0	0	0	Sub Total ==>	-7,437	100.00	Sub Total ==>	-8,168	100.00	MinStop/Rh	0	0
Internal Loads				Internal Loads				Internal Loads				Return	0	138
Lights	0	0	0	0	0	Lights	0	0.00	Lights	0	0.00	Exhaust	0	0
People	0	0	0	0	0	People	0	0.00	People	0	0.00	Rm Exh	0	0
Misc	0	0	0	0	0	Misc	0	0.00	Misc	0	0.00	Auxiliary	0	0
Sub Total ==>	0	0	0	0	0	Sub Total ==>	0	0.00	Sub Total ==>	0	0.00	Leakage Dwn	0	0
Ceiling Load				Ceiling Load				Ceiling Load				Leakage Ups	0	0
Ceiling Load	0	0	0	0	0	Ceiling Load	-730	0.00	Ceiling Load	-730	0.00	ENGINEERING CKS		
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00	Ventilation Load	0	0.00	% OA	0.0	0.0
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0	Adj Air Trans Heat	0	0	cfm/ft²	0.00	0.24
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0.00	Ov/Undr Sizing	0	0.00	cfm/ton	0.00	
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0.00	Exhaust Heat	0	0.00	ft²/ton	0.00	
Exhaust Heat	0	0	0	0	0	OA Preheat Diff.	0	0.00	OA Preheat Diff.	0	0.00	Btu/hr-ft²	0.00	-14.35
Sup. Fan Heat	0	0	0	0	0	RA Preheat Diff.	0	0.00	RA Preheat Diff.	0	0.00	No. People	0	
Ret. Fan Heat	0	0	0	0	0	Additional Reheat	0	0.00	Additional Reheat	0	0.00			
Duct Heat Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00	Underflr Sup Ht Pkup	0	0.00			
Underflr Sup Ht Pkup	0	0	0	0	0	Supply Air Leakage	0	0.00	Supply Air Leakage	0	0.00			
Supply Air Leakage	0	0	0	0	0	Grand Total ==>	-8,168	100.00	Grand Total ==>	-8,168	100.00			
Grand Total ==>	0	0	0	100.00	0	Grand Total ==>	-8,168	100.00	Grand Total ==>	-8,168	100.00			

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0								

AREAS			
	Gross Total	Glass	
		ft²	(%)
Floor	569		
Part	0		
Int Door	1		
ExFlr	0		
Roof	252	0	0
Wall	719	172	24
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-8.2			

System Checksums

By HENDERSON ENGINEERS

Mini Splits

Single Zone Variable Air Volume

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design			Cooling			Heating		
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 95		OADB: 0			SADB			Ra Plenum		
	Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return	Fn MtrTD	Fn BldTD	Fn Frict	
	Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens		75.1	0.0	0.0	0.0	
							Btu/h	Btu/h		75.1	0.0	0.0	0.0	
Envelope Loads				Envelope Loads										
Skylite Solar	0	0	0	0	0	0	0	0	0.00					
Skylite Cond	0	0	0	0	0	0	0	0	0.00					
Roof Cond	937	0	937	2	937	2	-868	-868	64.27					
Glass Solar	0	0	0	0	0	0	0	0	0.00					
Glass/Door Cond	0	0	0	0	0	0	0	0	0.00					
Wall Cond	333	0	333	1	333	1	-482	-482	35.73					
Partition/Door	0	0	0	0	0	0	0	0	0.00					
Floor	0	0	0	0	0.00	0	0	0	0.00					
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Infiltration	0	0	0	0	0	0	0	0	0.00					
<i>Sub Total ==></i>	1,269	0	1,269	2	1,269	2	-1,350	-1,350	100.00					
Internal Loads				Internal Loads										
Lights	736	184	920	2	736	1	0	0	0.00					
People	0	0	0	0	0	0	0	0	0.00					
Misc	52,300	0	52,300	96	52,300	96	0	0	0.00					
<i>Sub Total ==></i>	53,036	184	53,220	98	53,036	98	0	0	0.00					
Ceiling Load	0	0	0	0	0	0	0	0	0.00					
Ventilation Load	0	0	0	0	0	0	0	0	0.00					
Adj Air Trans Heat	0	0	0	0	0	0	0	0	0					
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0	0.00					
Ov/Undr Sizing	0	0	0	0	0	0	0	0	0.00					
Exhaust Heat	0	0	0	0	0	0	0	0	0.00					
Sup. Fan Heat	0	0	0	0	0	0	0	0	0.00					
Ret. Fan Heat	0	0	0	0	0	0	0	0	0.00					
Duct Heat Pkup	0	0	0	0	0	0	0	0	0.00					
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0	0.00					
Supply Air Leakage	0	0	0	0	0	0	0	0	0.00					
<i>Grand Total ==></i>	54,305	184	54,489	100.00	54,305	100.00	-1,350	-1,350	100.00					

TEMPERATURES		
	Cooling	Heating
SADB	55.0	71.7
Ra Plenum	75.0	70.0
Return	75.1	70.0
Ret/OA	75.1	70.0
Fn MtrTD	0.0	0.0
Fn BldTD	0.0	0.0
Fn Frict	0.0	0.0

AIRFLOWS		
	Cooling	Heating
Diffuser	2,519	756
Terminal	2,519	756
Main Fan	2,519	756
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	756	756
Return	2,519	756
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	6.54	1.96
cfm/ton	554.75	
ft²/ton	84.79	
Btu/hr-ft²	141.53	-3.51
No. People	0	

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	4.5	54.5	54.5	2,514	75.1	56.8	41.8	55.0	48.4	41.6
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	4.5	54.5								

AREAS			
	Gross Total	Glass	
		ft²	(%)
Floor	385		
Part	0		
Int Door	1		
ExFlr	0		
Roof	385	0	0
Wall	108	0	0
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1.4			

System Checksums

By HENDERSON ENGINEERS

Practice Field

Single Zone Variable Air Volume

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 8 / 15		Mo/Hr: 8 / 15		Mo/Hr: Heating Design			Cooling		Heating	SADB	53.6	109.0
Outside Air:		OADB/WB/HR: 94 / 79 / 129		OADB: 94		OADB: 0			Ra Plenum		70.0	75.0	70.0	
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict		
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Tot Sens Btu/h		83.7	0.0	0.0	0.0		
Envelope Loads				Envelope Loads							AIRFLOWS			
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	Diffuser		47,385	14,215		
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	Terminal		47,385	14,215		
Roof Cond	98,296	0	98,296	4	98,296	Roof Cond	-175,778	10.51	Main Fan		47,385	14,215		
Glass Solar	293,860	0	293,860	11	293,860	Glass Solar	0	0.00	Sec Fan		0	0		
Glass/Door Cond	79,802	0	79,802	3	79,802	Glass/Door Cond	-310,220	18.55	Nom Vent		21,300	14,215		
Wall Cond	128,867	0	128,867	5	128,867	Wall Cond	-112,161	6.71	AHU Vent		21,300	14,215		
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00	Infil		0	0		
Floor	0	0	0	0	0.00	Floor	0	0.00	MinStop/Rh		14,215	14,215		
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	Return		47,385	14,215		
Infiltration	0	0	0	0	0	Infiltration	0	0.00	Exhaust		21,300	14,215		
Sub Total ==>	600,825	0	600,825	23	600,825	Sub Total ==>	-598,158	35.76	Rm Exh		0	0		
Internal Loads				Internal Loads							ENGINEERING CKS			
Lights	266,214	0	266,214	10	266,214	Lights	0	0.00	% OA		45.0	100.0		
People	246,000	0	246,000	10	96,000	People	0	0.00	cfm/ft²		0.61	0.18		
Misc	133,107	0	133,107	5	133,107	Misc	0	0.00	cfm/ton		220.53			
Sub Total ==>	645,321	0	645,321	25	495,321	Sub Total ==>	0	0.00	ft²/ton		363.01			
Ceiling Load	0	0	0	0	0	Ceiling Load	0	0.00	Btu/hr-ft²		33.06	-21.45		
Ventilation Load	0	0	1,332,264	52	0	Ventilation Load	0	64.24	No. People		150			
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat	0	0	0	0	0	OA Preheat Diff.	0	0.00						
Sup. Fan Heat	0	0	0	0	0	RA Preheat Diff.	0	0.00						
Ret. Fan Heat	0	0	0	0	0	Additional Reheat	0	0.00						
Duct Heat Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00						
Underflr Sup Ht Pkup	0	0	0	0	0	Supply Air Leakage	0	0.00						
Supply Air Leakage	0	0	0	0	0	Grand Total ==>	-598,158	100.00						
Grand Total ==>	1,246,146	0	2,578,410	100.00	1,096,146	Grand Total ==>	-1,672,719	100.00						

COOLING COIL SELECTION									AREAS			HEATING COIL SELECTION					
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Lvg	Capacity	Coil Airflow	Ent	Lvg
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb							
Main Clg	214.9	2,578.4	1,539.8	47,385	83.7	70.5	94.7	53.6	53.5	63.0	Floor	78,000	-1,672.7	14,215	0.0	109.0	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0	
											ExFlr	0	0.0	0	0.0	0.0	
Total	214.9	2,578.4									Roof	78,000	0.0	0	0.0	0.0	
											Wall	35,371	10,258	29	0.0	0.0	
											Ext Door	0	0	0	0.0	0.0	
											Total	-1,672.7					

System Checksums

By HENDERSON ENGINEERS

RTU 3

Single Zone

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: Sum of		Mo/Hr: Heating Design		Mo/Hr: Heating Design				Cooling	Heating	
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: Peaks		OADB: 0		OADB: 0				SADB	55.0	94.8
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	75.0	70.0
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)	Return	75.7	70.0
Envelope Loads				Envelope Loads								Ret/OA	77.6	63.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn BldTD	0.0	0.0
Roof Cond	10,838	0	10,838	4	9,341	5	Roof Cond	-13,160	-13,160	4.02		Fn Frict	0.0	0.0
Glass Solar	68,390	0	68,390	25	72,416	35	Glass Solar	0	0	0.00				
Glass/Door Cond	4,294	0	4,294	2	3,113	2	Glass/Door Cond	-50,897	-50,897	15.54				
Wall Cond	26,016	0	26,016	9	30,484	15	Wall Cond	-22,498	-22,498	6.87				
Partition/Door	0	0	0	0	0	0	Partition/Door	0	0	0.00				
Floor	0	0	0	0	0.00	0	Floor	0	0	0.00				
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	0.00				
Infiltration	0	0	0	0	0	0	Infiltration	0	0	0.00				
Sub Total ==>	109,538	0	109,538	39	115,353	56	Sub Total ==>	-86,555	-86,555	26.43				
Internal Loads				Internal Loads								AIRFLOWS		
Lights	28,352	7,088	35,440	13	28,352	14	Lights	0	0	0.00		Diffuser	9,541	9,541
People	50,589	0	50,589	18	28,008	14	People	0	0	0.00		Terminal	9,541	9,541
Misc	39,184	0	39,184	14	34,350	17	Misc	0	0	0.00		Main Fan	9,541	9,541
Sub Total ==>	118,125	7,088	125,213	45	90,710	44	Sub Total ==>	0	0	0.00		Sec Fan	0	0
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0	0.00		Nom Vent	954	954
Ventilation Load	0	0	44,199	16	0	0	Ventilation Load	0	-72,122	22.02		AHU Vent	954	954
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0		Infil	0	0
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	-168,860	-168,860	51.55		MinStop/Rh	0	0
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0	0.00		Return	9,541	9,541
Exhaust Heat	-709	-709	0	0	0	0	OA Preheat Diff.	0	0	0.00		Exhaust	954	954
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0	0.00		Rm Exh	0	0
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00		Auxiliary	0	0
Duct Heat Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00		Leakage Dwn	0	0
Underflr Sup Ht Pkup	0	0	0	0	0	0	Supply Air Leakage	0	0	0.00		Leakage Ups	0	0
Supply Air Leakage	0	0	0	0	0	0	Grand Total ==>	-255,415	-327,537	100.00		ENGINEERING CKS		
Grand Total ==>	227,664	6,379	278,242	100.00	206,063	100.00	Grand Total ==>	-255,415	-327,537	100.00		% OA	10.0	10.0

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	23.2	278.2	219.3	9,541	77.6	63.5	67.9	55.0	53.6	60.9
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	23.2	278.2								

AREAS			
	Gross Total	Glass ft²	(%)
Floor	8,660		
Part	0		
Int Door	1		
ExFlr	0		
Roof	5,840	0	0
Wall	6,720	1,683	25
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-327.5	9,541	63.0	94.8
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-327.5			

Zone Checksums

By HENDERSON ENGINEERS

101 Playing Field

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 8 / 15		Mo/Hr: 8 / 15		Mo/Hr: Heating Design			Cooling			Heating		
Outside Air:		OADB/WB/HR: 94 / 79 / 129		OADB: 94		OADB: 0			SADB			Ra Plenum		
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict	
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	Btu/h	Btu/h	Btu/h	
Envelope Loads				Envelope Loads										
Skylite Solar	0	0	0	0	0	0	0	0.00						
Skylite Cond	0	0	0	0	0	0	0	0.00						
Roof Cond	98,296	0	98,296	4	98,296	9	-175,778	10.51						
Glass Solar	293,860	0	293,860	11	293,860	27	0	0.00						
Glass/Door Cond	79,802	0	79,802	3	79,802	7	-310,220	18.55						
Wall Cond	128,867	0	128,867	5	128,867	12	-112,161	6.71						
Partition/Door	0	0	0	0	0	0	0	0.00						
Floor	0	0	0	0	0.00	0	0	0.00						
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00						
Infiltration	0	0	0	0	0	0	0	0.00						
Sub Total ==>	600,825	0	600,825	23	600,825	55	-598,158	35.76						
Internal Loads				Internal Loads										
Lights	266,214	0	266,214	10	266,214	24	0	0.00						
People	246,000	0	246,000	10	96,000	9	0	0.00						
Misc	133,107	0	133,107	5	133,107	12	0	0.00						
Sub Total ==>	645,321	0	645,321	25	495,321	45	0	0.00						
Ceiling Load	0	0	0	0	0	0	0	0.00						
Ventilation Load	0	0	1,332,264	52	0	0	-1,074,561	64.24						
Adj Air Trans Heat	0	0	0	0	0	0	0	0						
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0.00						
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00						
Exhaust Heat	0	0	0	0	0	0	0	0.00						
Sup. Fan Heat	0	0	0	0	0	0	0	0.00						
Ret. Fan Heat	0	0	0	0	0	0	0	0.00						
Duct Heat Pkup	0	0	0	0	0	0	0	0.00						
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00						
Supply Air Leakage	0	0	0	0	0	0	0	0.00						
Grand Total ==>	1,246,146	0	2,578,410	100.00	1,096,146	100.00	-598,158	-1,672,719	100.00					

AIRFLOWS		
	Cooling	Heating
Diffuser	47,384	14,215
Terminal	47,384	14,215
Main Fan	47,384	14,215
Sec Fan	0	0
Nom Vent	21,300	14,215
AHU Vent	21,300	14,215
Infil	0	0
MinStop/Rh	14,215	14,215
Return	47,384	14,215
Exhaust	21,300	14,215
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	45.0	100.0
cfm/ft²	0.61	0.18
cfm/ton	220.52	
ft²/ton	363.01	
Btu/hr-ft²	33.06	-21.45
No. People	150	

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	214.9	2,578.4	1,539.8	47,384	83.7	70.5	94.7	53.6	53.5	63.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	214.9	2,578.4								

AREAS			
	Gross Total	Glass ft²	(%)
Floor	78,000		
Part	0		
Int Door	1		
ExFlr	0		
Roof	78,000	0	0
Wall	35,371	10,258	29
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1,672.7			

Zone Checksums

By HENDERSON ENGINEERS

CRU 1

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES					
Peaked at Time:		Mo/Hr: 7 / 11		Mo/Hr: 7 / 11		Mo/Hr: Heating Design			Cooling			Heating				
Outside Air:		OADB/WB/HR: 86 / 73 / 106		OADB: 86		OADB: 0			SADB			Ra Plenum				
	Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return	Fn MtrTD	Fn BldTD	Fn Frict			
	Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens		75.1	0.0	0.0	0.0			
							Btu/h	Btu/h		75.1	0.0	0.0	0.0			
Envelope Loads				Envelope Loads							AIRFLOWS					
Skylite Solar	0	0	0	0	0	0	Skylite Solar	0	0.00	Cooling			Heating			
Skylite Cond	0	0	0	0	0	0	Skylite Cond	0	0.00	Diffuser	726	218				
Roof Cond	287	0	287	2	287	2	Roof Cond	-473	49.52	Terminal	726	218				
Glass Solar	0	0	0	0	0	0	Glass Solar	0	0.00	Main Fan	726	218				
Glass/Door Cond	0	0	0	0	0	0	Glass/Door Cond	0	0.00	Sec Fan	0	0				
Wall Cond	653	0	653	4	653	4	Wall Cond	-482	50.48	Nom Vent	0	0				
Partition/Door	0	0	0	0	0	0	Partition/Door	0	0.00	AHU Vent	0	0				
Floor	0	0	0	0	0.00	0	Floor	0	0.00	Infil	0	0				
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	MinStop/Rh	218	218				
Infiltration	0	0	0	0	0	0	Infiltration	0	0.00	Return	726	218				
Sub Total ==>	940	0	940	6	940	6	Sub Total ==>	-956	100.00	Exhaust	0	0				
Internal Loads				Internal Loads							Cooling			Heating		
Lights	401	100	502	3	401	3	Lights	0	0.00	Rm Exh	0	0				
People	0	0	0	0	0	0	People	0	0.00	Auxiliary	0	0				
Misc	14,341	0	14,341	91	14,341	91	Misc	0	0.00	Leakage Dwn	0	0				
Sub Total ==>	14,743	100	14,843	94	14,743	94	Sub Total ==>	0	0.00	Leakage Ups	0	0				
Ceiling Load				Ceiling Load							ENGINEERING CKS					
Ventilation Load	0	0	0	0	0	0	Ventilation Load	0	0.00	% OA	0.0	0.0				
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	cfm/ft²	3.46	1.04				
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	0	0.00	cfm/ton	552.09					
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0.00	ft²/ton	159.66					
Exhaust Heat	0	0	0	0	0	0	OA Preheat Diff.	0	0.00	Btu/hr-ft²	75.16	-4.55				
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0.00	No. People	0					
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0.00							
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0.00							
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00							
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0.00							
Grand Total ==>	15,683	100	15,783	100.00	15,683	100.00	Grand Total ==>	-956	-956	100.00						

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION			
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Capacity	Coil Airflow	Ent	Lvg	
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F
Main Clg	1.3	15.8	15.8	726	75.1	56.8	41.8	55.0	48.4	41.6	Floor	210	-1.0	218	70.0	74.1
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0
											ExFlr	0	0.0	0	0.0	0.0
Total	1.3	15.8									Roof	210	0.0	0	0.0	0.0
											Wall	108	0.0	0	0.0	0.0
											Ext Door	0	0.0	0	0.0	0.0
											Total	-1.0				

Zone Checksums

By HENDERSON ENGINEERS

CRU 2

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 95		OADB: 0						SADB	55.0	70.5
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	75.0	70.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	75.0	70.0
Envelope Loads				Envelope Loads								Ret/OA	75.0	70.0
Skylite Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn BldTD	0.0	0.0
Roof Cond	293	0	293	1	293	1	-270	100.00	-270	-270	100.00	Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	0	0	0.00	0	0	0.00			
Glass/Door Cond	0	0	0	0	0	0	0	0.00	0	0	0.00			
Wall Cond	0	0	0	0	0	0	0	0.00	0	0	0.00			
Partition/Door	0	0	0	0	0	0	0	0.00	0	0	0.00			
Floor	0	0	0	0	0.00	0	0	0.00	0	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Infiltration	0	0	0	0	0	0	0	0.00	0	0	0.00			
<i>Sub Total ==></i>	293	0	293	1	293	1	-270	100.00	-270	-270	100.00			
Internal Loads				Internal Loads										
Lights	229	57	287	1	229	1	0	0.00	0	0	0.00	AIRFLOWS		
People	0	0	0	0	0	0	0	0.00	0	0	0.00	Diffuser	1,691	507
Misc	36,000	0	36,000	98	36,000	99	0	0.00	0	0	0.00	Terminal	1,691	507
<i>Sub Total ==></i>	36,229	57	36,287	99	36,229	99	0	0.00	0	0	0.00	Main Fan	1,691	507
Ceiling Load	0	0	0	0	0	0	0	0.00	0	0	0.00	Sec Fan	0	0
Ventilation Load	0	0	0	0	0	0	0	0.00	0	0	0.00	Nom Vent	0	0
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	AHU Vent	0	0
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	Infil	0	0
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	MinStop/Rh	507	507
Exhaust Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Return	1,691	507
Sup. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Exhaust	0	0
Ret. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Rm Exh	0	0
Duct Heat Pkup	0	0	0	0	0	0	0	0.00	0	0	0.00	Auxiliary	0	0
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00	0	0	0.00	Leakage Dwn	0	0
Supply Air Leakage	0	0	0	0	0	0	0	0.00	0	0	0.00	Leakage Ups	0	0
Grand Total ==>	36,523	57	36,580	100.00	36,523	100.00	-270	100.00	-270	-270	100.00			

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION					
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Lvg	Capacity	Coil Airflow	Ent	Lvg	
	ton	MBh			MBh	cfm	°F	°F	gr/lb	°F								°F
Main Clg	3.1	36.6	36.6	1,691	75.0	56.8	41.8	55.0	48.4	41.6	Floor	120		Main Htg	-0.3	507	70.0	70.5
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		Preheat	0.0	0	0.0	0.0
											ExFlr	0						
Total	3.1	36.6									Roof	120	0	Humidif	0.0	0	0.0	0.0
											Wall	0	0	Opt Vent	0.0	0	0.0	0.0
											Ext Door	0	0	Total	-0.3			

Zone Checksums

By HENDERSON ENGINEERS

CRU 3

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 95		OADB: 0						SADB	55.0	73.8
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Return	75.2	70.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Ret/OA	75.2	70.0
Envelope Loads				Envelope Loads								Fn MtrTD	0.0	0.0
Skylite Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn BldTD	0.0	0.0
Skylite Cond	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn Frict	0.0	0.0
Roof Cond	135	0	135	6	135	6	-124	100.00	-124	-124	100.00			
Glass Solar	0	0	0	0	0	0	0	0.00	0	0	0.00			
Glass/Door Cond	0	0	0	0	0	0	0	0.00	0	0	0.00			
Wall Cond	0	0	0	0	0	0	0	0.00	0	0	0.00			
Partition/Door	0	0	0	0	0	0	0	0.00	0	0	0.00			
Floor	0	0	0	0	0.00	0	0	0.00	0	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Infiltration	0	0	0	0	0	0	0	0.00	0	0	0.00			
<i>Sub Total ==></i>	135	0	135	6	135	6	-124	100.00	-124	-124	100.00			
Internal Loads				Internal Loads								AIRFLOWS		
Lights	105	26	131	6	105	5	0	0.00	0	0	0.00	Cooling	Heating	
People	0	0	0	0	0	0	0	0.00	0	0	0.00	Diffuser	102	31
Misc	1,959	0	1,959	88	1,959	89	0	0.00	0	0	0.00	Terminal	102	31
<i>Sub Total ==></i>	2,064	26	2,090	94	2,064	94	0	0.00	0	0	0.00	Main Fan	102	31
Ceiling Load	0	0	0	0	0	0	0	0.00	0	0	0.00	Sec Fan	0	0
Ventilation Load	0	0	0	0	0	0	0	0.00	0	0	0.00	Nom Vent	0	0
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	AHU Vent	0	0
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	Infil	0	0
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	MinStop/Rh	31	31
Exhaust Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Return	102	31
Sup. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Exhaust	0	0
Ret. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Rm Exh	0	0
Duct Heat Pkup	0	0	0	0	0	0	0	0.00	0	0	0.00	Auxiliary	0	0
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00	0	0	0.00	Leakage Dwn	0	0
Supply Air Leakage	0	0	0	0	0	0	0	0.00	0	0	0.00	Leakage Ups	0	0
<i>Grand Total ==></i>	2,199	26	2,225	100.00	2,199	100.00	-124	100.00	-124	-124	100.00	ENGINEERING CKS		
												% OA	0.0	0.0
												cfm/ft²	1.85	0.56
												cfm/ton	549.06	
												ft²/ton	296.57	
												Btu/hr-ft²	40.46	-2.25
												No. People	0	

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	ft² (%)	Capacity	Coil Airflow	Ent °F	Lvg °F
	ton	MBh			MBh	cfm	°F	°F	gr/lb	°F							
Main Clg	0.2	2.2	2.2	102	75.2	56.8	41.8	55.0	48.4	41.6	Floor	55					
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0					
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1					
											ExFlr	0					
Total	0.2	2.2									Roof	55	0	0			
											Wall	0	0	0			
											Ext Door	0	0	0			

Zone Checksums

By HENDERSON ENGINEERS

RTU 3

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES					
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 6 / 9		Mo/Hr: Heating Design			Cooling		Heating	SADB	55.0	94.8		
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 75		OADB: 0			Ra Plenum		75.0	70.0	Return	75.7	70.0	
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict				
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Tot Sens Btu/h	(%)	77.6	0.0	0.0	0.0				
Envelope Loads				Envelope Loads							AIRFLOWS					
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	Diffuser		9,541	9,541	Terminal		9,541	9,541
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	Main Fan		9,541	9,541	Sec Fan		0	0
Roof Cond	10,838	0	10,838	4	9,341	5	-13,160	4.02	Nom Vent		954	954	AHU Vent		954	954
Glass Solar	68,390	0	68,390	25	72,416	35	0	0.00	Infil		0	0	MinStop/Rh		0	0
Glass/Door Cond	4,294	0	4,294	2	3,113	2	-50,897	15.54	Return		9,541	9,541	Return		9,541	9,541
Wall Cond	26,016	0	26,016	9	30,484	15	-22,498	6.87	Exhaust		954	954	Rm Exh		0	0
Partition/Door	0	0	0	0	0	0	0	0.00	Auxiliary		0	0	Leakage Dwn		0	0
Floor	0	0	0	0	0.00	0	0	0.00	Leakage Ups		0	0	ENGINEERING CKS			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	% OA		10.0	10.0	Cooling		10.0	10.0
Infiltration	0	0	0	0	0	0	0	0.00	cfm/ft²		1.10	1.10	cfm/ton		411.49	411.49
Sub Total ==>	109,538	0	109,538	39	115,353	56	-86,555	26.43	ft²/ton		373.49	373.49	Btu/hr-ft²		32.13	-37.82
Internal Loads				Internal Loads							No. People		112			
Lights	28,352	7,088	35,440	13	28,352	14	0	0.00	Ceiling Load		0	0	Heating		0	0
People	50,589	0	50,589	18	28,008	14	0	0.00	Ventilation Load		0	-72,122	Leakage		0	0
Misc	39,184	0	39,184	14	34,350	17	0	0.00	Adj Air Trans Heat		0	0	Supply Air Leakage		0	0
Sub Total ==>	118,125	7,088	125,213	45	90,710	44	0	0.00	Ov/Undr Sizing		-168,860	-168,860	Underflr Sup Ht Pkup		0	0
Ceiling Load	0	0	0	0	0	0	0	0.00	Exhaust Heat		0	0	Supply Air Leakage		0	0
Ventilation Load	0	0	44,199	16	0	0	0	0.00	OA Preheat Diff.		0	0	Grand Total ==>		227,664	6,379
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00	RA Preheat Diff.		0	0	278,242		100.00	206,063
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0.00	Additional Reheat		0	0	206,063		100.00	206,063
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00	System Plenum Heat		0	0	-255,415		-327,537	100.00
Exhaust Heat	0	-709	-709	0	0	0	0	0.00	Underflr Sup Ht Pkup		0	0	-327,537		100.00	-255,415
Sup. Fan Heat	0	0	0	0	0	0	0	0.00	Supply Air Leakage		0	0	-327,537		100.00	-327,537
Ret. Fan Heat	0	0	0	0	0	0	0	0.00	Grand Total ==>		227,664	6,379	278,242		100.00	206,063
Duct Heat Pkup	0	0	0	0	0	0	0	0.00	227,664		6,379	278,242		100.00	206,063	
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00	6,379		278,242	100.00		206,063		
Supply Air Leakage	0	0	0	0	0	0	0	0.00	278,242		100.00	206,063				

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR		Leave DB/WB/HR			Gross Total	Glass	Capacity	Coil Airflow	Ent	Lvg				
ton	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft² (%)	MBh	cfm	°F	°F				
Main Clg	23.2	278.2	219.3	9,541	77.6	63.5	67.9	55.0	53.6	60.9	Floor	8,660	-327.5	9,541	63.0	94.8	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0	
											ExFlr	0	0.0	0	0.0	0.0	
Total	23.2	278.2									Roof	5,840	0	0	0.0	0.0	
											Wall	6,720	1,683	25	0.0	0.0	
											Ext Door	0	0	0	0.0	0.0	
											Total	-327.5					

Zone Checksums

By HENDERSON ENGINEERS

UH 1

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0						SADB	0.0	125.0
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	0.0	66.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	0.0	70.0
Envelope Loads				Envelope Loads								Ret/OA	0.0	70.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn BldTD	0.0	0.0
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00				Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00				AIRFLOWS		
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	-3,024	90.30				Diffuser	0	56
Wall Cond	0	0	0	0	0	Wall Cond	-197	11.14				Terminal	0	56
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00				Main Fan	0	56
Floor	0	0	0	0	0	Floor	0	0.00				Sec Fan	0	0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00				Nom Vent	0	0
Infiltration	0	0	0	0	0	Infiltration	0	0.00				AHU Vent	0	0
Sub Total ==>	0	0	0	0	0	Sub Total ==>	-3,221	101.44				Infil	0	0
Internal Loads				Internal Loads								MinStop/Rh	0	0
Lights	0	0	0	0	0	Lights	0	0.00				Return	0	56
People	0	0	0	0	0	People	0	0.00				Exhaust	0	0
Misc	0	0	0	0	0	Misc	0	0.00				Rm Exh	0	0
Sub Total ==>	0	0	0	0	0	Sub Total ==>	0	0.00				Auxiliary	0	0
Ceiling Load				Ceiling Load								Leakage Dwn	0	0
	0	0	0	0	0		-128	0.00				Leakage Ups	0	0
Ventilation Load				Ventilation Load								ENGINEERING CKS		
	0	0	0	0	0		0	0.00				% OA	0.0	0.0
Adj Air Trans Heat				Adj Air Trans Heat								cfm/ft²	0.00	0.56
	0	0	0	0	0		0	0.00				cfm/ton	0.00	
Dehumid. Ov Sizing				Ov/Undr Sizing								ft²/ton	0.00	
	0	0	0	0	0		0	0.00				Btu/hr-ft²	0.00	-33.49
Ov/Undr Sizing				Exhaust Heat								No. People	0	
	0	0	0	0	0		0	0.00						
Exhaust Heat				OA Preheat Diff.										
	0	0	0	0	0		0	0.00						
Sup. Fan Heat				RA Preheat Diff.										
	0	0	0	0	0		0	0.00						
Ret. Fan Heat				Additional Reheat										
	0	0	0	0	0		0	0.00						
Duct Heat Pkup				System Plenum Heat										
	0	0	0	0	0		48	-1.44						
Underflr Sup Ht Pkup				Underflr Sup Ht Pkup										
	0	0	0	0	0		0	0.00						
Supply Air Leakage				Supply Air Leakage										
	0	0	0	0	0		0	0.00						
Grand Total ==>	0	0	0	100.00	0	Grand Total ==>	-3,349	-3,349	100.00					

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION						
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Lvg	Capacity	Coil Airflow	Ent	Lvg		
	ton	MBh			MBh	cfm	°F	°F	gr/lb	°F								°F	gr/lb
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Floor	100		Main Htg	-3.4	56	70.0	125.0	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		Aux Htg	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		Preheat	0.0	0	0.0	0.0	
											ExFlr	0							
Total	0.0	0.0									Roof	0	0	Humidif	0.0	0	0.0	0.0	
											Wall	186	100	54	Opt Vent	0.0	0	0.0	0.0
											Ext Door	0	0	0	Total	-3.4			

Zone Checksums

By HENDERSON ENGINEERS

UH 2

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0						SADB	0.0	125.0
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	0.0	66.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	0.0	70.0
Envelope Loads				Envelope Loads								Ret/OA	0.0	70.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn BldTD	0.0	0.0
Roof Cond	0	0	0	0	0	Roof Cond	0	29.73				Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00						
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00						
Wall Cond	0	0	0	0	0	Wall Cond	-890	82.67						
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00						
Floor	0	0	0	0.00	0	Floor	0	0.00						
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00						
Infiltration	0	0	0	0	0	Infiltration	0	0.00						
Sub Total ==>	0	0	0	0	0	Sub Total ==>	-890	112.41						
Internal Loads				Internal Loads										
Lights	0	0	0	0	0	Lights	0	0.00						
People	0	0	0	0	0	People	0	0.00						
Misc	0	0	0	0	0	Misc	0	0.00						
Sub Total ==>	0	0	0	0	0	Sub Total ==>	0	0.00						
Ceiling Load	0	0	0	0	0	Ceiling Load	-195	0.00						
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00						
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing			0	0	0	Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0		0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat		0	0	0	0	OA Preheat Diff.	0	0.00						
Sup. Fan Heat			0	0	0	RA Preheat Diff.	0	0.00						
Ret. Fan Heat			0	0	0	Additional Reheat		0.00						
Duct Heat Pkup			0	0	0	System Plenum Heat		135	-12.41					
Underflr Sup Ht Pkup			0	0	0	Underflr Sup Ht Pkup		0	0.00					
Supply Air Leakage			0	0	0	Supply Air Leakage		0	0.00					
Grand Total ==>	0	0	0	100.00	0	Grand Total ==>	-1,085	-1,085	100.00					

AIRFLOWS		
	Cooling	Heating
Diffuser	0	18
Terminal	0	18
Main Fan	0	18
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	0	18
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	0.00	0.12
cfm/ton	0.00	
ft²/ton	0.00	
Btu/hr-ft²	0.00	-7.14
No. People	0	

COOLING COIL SELECTION									
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR		Leave DB/WB/HR			
	ton	MBh	cfm	°F	°F	°F	°F	gr/lb	gr/lb
Main Clg	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Aux Clg	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0							

AREAS			
	Gross Total	Glass	
		ft²	(%)
Floor	152		
Part	0		
Int Door	1		
ExFlr	0		
Roof	152	0	0
Wall	201	0	0
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity	Coil Airflow	Ent	Lvg
	MBh	cfm	°F	°F
Main Htg	-1.1	18	70.0	125.0
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1.1			

Zone Checksums

By HENDERSON ENGINEERS

UH 3

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0						SADB	0.0	125.0
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	0.0	66.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	0.0	70.0
Envelope Loads				Envelope Loads								Ret/OA	0.0	70.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn BldTD	0.0	0.0
Roof Cond	0	0	0	0	0	Roof Cond	0	8.62				Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00						
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	-2,177	88.42						
Wall Cond	0	0	0	0	0	Wall Cond	-157	6.52						
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00						
Floor	0	0	0	0	0	Floor	0	0.00						
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00						
Infiltration	0	0	0	0	0	Infiltration	0	0.00						
Sub Total ==>	0	0	0	0	0	Sub Total ==>	-2,334	103.56						
Internal Loads				Internal Loads										
Lights	0	0	0	0	0	Lights	0	0.00						
People	0	0	0	0	0	People	0	0.00						
Misc	0	0	0	0	0	Misc	0	0.00						
Sub Total ==>	0	0	0	0	0	Sub Total ==>	0	0.00						
Ceiling Load	0	0	0	0	0	Ceiling Load	-128	0.00						
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00						
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing			0	0	0	Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0		0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat		0	0	0	0	OA Preheat Diff.	0	0.00						
Sup. Fan Heat			0	0	0	RA Preheat Diff.	0	0.00						
Ret. Fan Heat			0	0	0	Additional Reheat	0	0.00						
Duct Heat Pkup			0	0	0	System Plenum Heat	88	-3.56						
Underflr Sup Ht Pkup			0	0	0	Underflr Sup Ht Pkup	0	0.00						
Supply Air Leakage			0	0	0	Supply Air Leakage	0	0.00						
Grand Total ==>	0	0	0	100.00	0	Grand Total ==>	-2,463	100.00						

AIRFLOWS

	Cooling	Heating
Diffuser	0	41
Terminal	0	41
Main Fan	0	41
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	0	41
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS

	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	0.00	0.41
cfm/ton	0.00	
ft²/ton	0.00	
Btu/hr-ft²	0.00	-24.63
No. People	0	

COOLING COIL SELECTION

	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR		Leave DB/WB/HR					
	ton	MBh	cfm	°F	°F	°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Aux Clg	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0									

AREAS

	Gross Total	Glass	
		ft²	(%)
Floor	100		
Part	0		
Int Door	1		
ExFlr	0		
Roof	100	0	0
Wall	108	72	67
Ext Door	0	0	0

HEATING COIL SELECTION

	Capacity	Coil Airflow	Ent	Lvg
	MBh	cfm	°F	°F
Main Htg	-2.5	41	70.0	125.0
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-2.5			

Zone Checksums

By HENDERSON ENGINEERS

UH 4

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0						SADB	0.0	125.0
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	0.0	66.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	0.0	70.0
Envelope Loads				Envelope Loads								Ret/OA	0.0	70.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn BldTD	0.0	0.0
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00				Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00						
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00						
Wall Cond	0	0	0	0	0	Wall Cond	-992	78.70						
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00						
Floor	0	0	0	0.00	0	Floor	0	0.00						
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00						
Infiltration	0	0	0	0	0	Infiltration	0	0.00						
Sub Total ==>	0	0	0	0	0	Sub Total ==>	-992	78.70						
Internal Loads				Internal Loads										
Lights	0	0	0	0	0	Lights	0	0.00						
People	0	0	0	0	0	People	0	0.00						
Misc	0	0	0	0	0	Misc	0	0.00						
Sub Total ==>	0	0	0	0	0	Sub Total ==>	0	0.00						
Ceiling Load	0	0	0	0	0	Ceiling Load	-279	0.00						
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00						
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing			0	0	0	Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0		0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat		0	0	0	0	OA Preheat Diff.	0	0.00						
Sup. Fan Heat			0	0	0	RA Preheat Diff.	0	0.00						
Ret. Fan Heat			0	0	0	Additional Reheat		0.00						
Duct Heat Pkup			0	0	0	System Plenum Heat		-271	21.30					
Underflr Sup Ht Pkup			0	0	0	Underflr Sup Ht Pkup		0	0.00					
Supply Air Leakage			0	0	0	Supply Air Leakage		0	0.00					
Grand Total ==>	0	0	0	100.00	0	Grand Total ==>	-1,271	-1,271	100.00					

AIRFLOWS		
	Cooling	Heating
Diffuser	0	21
Terminal	0	21
Main Fan	0	21
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	0	21
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	0.00	0.10
cfm/ton	0.00	
ft²/ton	0.00	
Btu/hr-ft²	0.00	-5.86
No. People	0	

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0								

AREAS			
	Gross Total	Glass ft²	(%)
Floor	217		
Part	0		
Int Door	1		
ExFlr	0		
Roof	0	0	0
Wall	224	0	0
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-1.3	21	70.0	125.0
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1.3			

Room Checksums

By HENDERSON ENGINEERS

101 Playing Field

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES							
Peaked at Time:		Mo/Hr: 8 / 15		Mo/Hr: 8 / 15		Mo/Hr: Heating Design			Cooling			Heating						
Outside Air:		OADB/WB/HR: 94 / 79 / 129		OADB: 94		OADB: 0			SADB			Ra Plenum						
	Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return			Ret/OA					
	Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens		Fn MtrTD			Fn BldTD					
							Btu/h	Btu/h		Fn Frict								
Envelope Loads				Envelope Loads							AIRFLOWS							
Skylite Solar	0	0	0	0	0	0	Skylite Solar	0	0.00	Diffuser			Cooling			Heating		
Skylite Cond	0	0	0	0	0	0	Skylite Cond	0	0.00	Terminal			47,384			14,215		
Roof Cond	98,296	0	98,296	4	98,296	9	Roof Cond	-175,778	10.51	Main Fan			47,384			14,215		
Glass Solar	293,860	0	293,860	11	293,860	27	Glass Solar	0	0.00	Sec Fan			0			0		
Glass/Door Cond	79,802	0	79,802	3	79,802	7	Glass/Door Cond	-310,220	18.55	Nom Vent			21,300			14,215		
Wall Cond	128,867	0	128,867	5	128,867	12	Wall Cond	-112,161	6.71	AHU Vent			21,300			14,215		
Partition/Door	0	0	0	0	0	0	Partition/Door	0	0.00	Infil			0			0		
Floor	0	0	0	0	0.00	0	Floor	0	0.00	MinStop/Rh			14,215			14,215		
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	Return			47,384			14,215		
Infiltration	0	0	0	0	0	0	Infiltration	0	0.00	Exhaust			21,300			14,215		
Sub Total ==>	600,825	0	600,825	23	600,825	55	Sub Total ==>	-598,158	35.76	Rm Exh			0			0		
Internal Loads				Internal Loads							ENGINEERING CKS							
Lights	266,214	0	266,214	10	266,214	24	Lights	0	0.00	% OA			45.0			100.0		
People	246,000	0	246,000	10	96,000	9	People	0	0.00	cfm/ft²			0.61			0.18		
Misc	133,107	0	133,107	5	133,107	12	Misc	0	0.00	cfm/ton			220.52					
Sub Total ==>	645,321	0	645,321	25	495,321	45	Sub Total ==>	0	0.00	ft²/ton			363.01					
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0.00	Btu/hr-ft²			33.06			-21.45		
Ventilation Load	0	0	1,332,264	52	0	0	Ventilation Load	0	64.24	No. People			150.0			1.9/1000 ft²		
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0									
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	0	0.00									
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0.00									
Exhaust Heat	0	0	0	0	0	0	OA Preheat Diff.	0	0.00									
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0.00									
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0.00									
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0.00									
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00									
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0.00									
Grand Total ==>	1,246,146	0	2,578,410	100.00	1,096,146	100.00	Grand Total ==>	-598,158	-1,672,719	100.00								

COOLING COIL SELECTION											AREAS				HEATING COIL SELECTION				
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	ft² (%)	Capacity	Coil Airflow	Ent °F	Lvg °F		
	ton	MBh			MBh	cfm	°F	°F	gr/lb	°F								°F	gr/lb
Main Clg	214.9	2,578.4	1,539.8	47,384	83.7	70.5	94.7	53.6	53.5	63.0	Floor	78,000	Main Htg	-1,672.7	14,215	0.0	109.0		
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0		
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0		
											ExFlr	0	Humidif	0.0	0	0.0	0.0		
Total	214.9	2,578.4									Roof	78,000	Opt Vent	0.0	0	0.0	0.0		
											Wall	35,371	Total	-1,672.7					
											Ext Door	0							

Room Checksums

By HENDERSON ENGINEERS

105 Restroom

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES					
Peaked at Time:		Mo/Hr: 6 / 10		Mo/Hr: 6 / 10		Mo/Hr: Heating Design			Cooling			Heating				
Outside Air:		OADB/WB/HR: 78 / 71 / 106		OADB: 78		OADB: 0			SADB			Ra Plenum				
	Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return	Fn MtrTD	Fn BldTD	Fn Frict			
	Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens		76.9	0.0	0.0	0.0			
							Btu/h	Btu/h		77.0	0.0	0.0	0.0			
Envelope Loads				Envelope Loads							AIRFLOWS					
Skylite Solar	0	0	0	0	0	0	Skylite Solar	0	0.00	Cooling			Heating			
Skylite Cond	0	0	0	0	0	0	Skylite Cond	0	0.00	Diffuser	97	97	97	97		
Roof Cond	0	0	0	0	0	0	Roof Cond	0	0.00	Terminal	97	97	97	97		
Glass Solar	0	0	0	0	0	0	Glass Solar	0	0.00	Main Fan	97	97	97	97		
Glass/Door Cond	0	0	0	0	0	0	Glass/Door Cond	0	0.00	Sec Fan	0	0	0	0		
Wall Cond	1,300	0	1,300	50	1,300	62	Wall Cond	-900	27.08	Nom Vent	10	10	10	10		
Partition/Door	0	0	0	0	0	0	Partition/Door	0	0.00	AHU Vent	10	10	10	10		
Floor	0	0	0	0	0.00	0	Floor	0	0.00	Infil	0	0	0	0		
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	MinStop/Rh	0	0	0	0		
Infiltration	0	0	0	0	0	0	Infiltration	0	0.00	Return	97	97	97	97		
Sub Total ==>	1,300	0	1,300	50	1,300	62	Sub Total ==>	-900	27.08	Exhaust	10	10	10	10		
Internal Loads				Internal Loads							ENGINEERING CKS					
Lights	791	198	988	38	791	38	Lights	0	0.00	% OA	10.0	10.0	10.0	10.0		
People	0	0	0	0	0	0	People	0	0.00	cfm/ft²	0.27	0.27	0.27	0.27		
Misc	0	0	0	0	0	0	Misc	0	0.00	cfm/ton	450.57	450.57	450.57	450.57		
Sub Total ==>	791	198	988	38	791	38	Sub Total ==>	0	0.00	ft²/ton	1,685.10	1,685.10	1,685.10	1,685.10		
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0.00	Btu/hr-ft²	7.12	-9.18	-9.18	-9.18		
Ventilation Load	0	0	309	12	0	0	Ventilation Load	0	22.02	No. People	0.0	0.0/1000 ft²	0.0/1000 ft²	0.0/1000 ft²		
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0							
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	-1,691	50.90							
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0.00							
Exhaust Heat	0	-20	-20	-1	0	0	OA Preheat Diff.	0	0.00							
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0.00							
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0.00							
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0.00							
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00							
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0.00							
Grand Total ==>	2,090	178	2,578	100.00	2,090	100.00	Grand Total ==>	-2,591	-3,323	100.00						

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Capacity	Coil Airflow	Ent	Lvg		
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F	
Main Clg	0.2	2.6	2.3	97	77.0	63.1	67.3	55.0	54.1	63.0	Floor	362	-3.3	97	63.0	94.8	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0	
											ExFlr	0	0.0	0	0.0	0.0	
Total	0.2	2.6									Roof	0	0.0	0	0.0	0.0	
											Wall	202	0.0	0	0.0	0.0	
											Ext Door	0	0.0	0	0.0	0.0	
											Total	-3.3					

Room Checksums

By HENDERSON ENGINEERS

106 Exam Stor

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES		
Peaked at Time:		Mo/Hr: 8 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design							
Outside Air:		OADB/WB/HR: 94 / 79 / 129		OADB: 95		OADB: 0							
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Cooling	Heating			
Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens						
Envelope Loads				Envelope Loads							AIRFLOWS		
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	Cooling		Heating		
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	Diffuser	104	104		
Roof Cond	358	0	358	5	379	Roof Cond	-349	9.81	Terminal	104	104		
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00	Main Fan	104	104		
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00	Sec Fan	0	0		
Wall Cond	0	0	0	0	0	Wall Cond	0	0.00	Nom Vent	10	10		
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00	AHU Vent	10	10		
Floor	0	0	0	0	0.00	Floor	0	0.00	Infil	0	0		
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	MinStop/Rh	0	0		
Infiltration	0	0	0	0	0	Infiltration	0	0.00	Return	104	104		
Sub Total ==>	358	0	358	5	379	Sub Total ==>	-349	9.81	Exhaust	10	10		
Internal Loads				Internal Loads							ENGINEERING CKS		
Lights	339	85	423	5	339	Lights	0	0.00	% OA	10.0	10.0		
People	155	0	155	2	78	People	0	0.00	cfm/ft²	0.67	0.67		
Misc	6,278	0	6,278	80	1,444	Misc	0	0.00	cfm/ton	157.84			
Sub Total ==>	6,772	85	6,856	87	1,860	Sub Total ==>	0	0.00	ft²/ton	235.95			
Ceiling Load	0	0	0	0	0	Ceiling Load	0	0.00	Btu/hr-ft²	50.86	-22.96		
Ventilation Load	0	0	677	9	0	Ventilation Load	0	22.02	No. People	0.3	2.0/1000 ft²		
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0					
Dehumid. Ov Sizing			0	0		Ov/Undr Sizing	-2,426	68.17					
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0.00					
Exhaust Heat		-8	-8	0		OA Preheat Diff.	0	0.00					
Sup. Fan Heat		0	0	0		RA Preheat Diff.	0	0.00					
Ret. Fan Heat		0	0	0		Additional Reheat	0	0.00					
Duct Heat Pkup		0	0	0		System Plenum Heat	0	0.00					
Underflr Sup Ht Pkup		0	0	0		Underflr Sup Ht Pkup	0	0.00					
Supply Air Leakage		0	0	0		Supply Air Leakage	0	0.00					
Grand Total ==>	7,130	76	7,883	100.00	2,239	Grand Total ==>	-2,776	-3,560	100.00				

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION						
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Lvg	Capacity	Coil Airflow	Ent	Lvg		
	ton	MBh			MBh	cfm	°F	°F	gr/lb	°F								°F	gr/lb
Main Clg	0.7	7.9	2.5	104	77.6	63.8	69.6	55.0	0.0	0.0	Floor	155		Main Htg	-3.6	104	63.0	94.8	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		Aux Htg	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		Preheat	0.0	0	0.0	0.0	
											ExFlr	0		Humidif	0.0	0	0.0	0.0	
Total	0.7	7.9									Roof	155	0	0	Opt Vent	0.0	0	0.0	0.0
											Wall	0	0	0	Total	-3.6			
											Ext Door	0	0	0					

Room Checksums

By HENDERSON ENGINEERS

107 Turf Management

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 11		Mo/Hr: Heating Design								
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 86		OADB: 0								
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Cooling	Heating	
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)			
Envelope Loads				Envelope Loads							AIRFLOWS			
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Cooling	Heating	
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Diffuser	312	312
Roof Cond	2,304	0	2,304	25	1,255	19	Roof Cond	-2,184	-2,184	20.36		Terminal	312	312
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00				Main Fan	312	312
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00				Sec Fan	0	0
Wall Cond	1,516	0	1,516	16	2,892	43	Wall Cond	-2,171	-2,171	20.24		Nom Vent	31	31
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00				AHU Vent	31	31
Floor	0	0	0	0	0.00	0	Floor	0	0	0.00		Infil	0	0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	0.00		MinStop/Rh	0	0
Infiltration	0	0	0	0	0	0	Infiltration	0	0	0.00		Return	312	312
Sub Total ==>	3,820	0	3,820	41	4,147	61	Sub Total ==>	-4,354	-4,354	40.59		Exhaust	31	31
Internal Loads				Internal Loads							ENGINEERING CKS			
Lights	2,117	529	2,646	28	2,117	31	Lights	0	0	0.00		% OA	10.0	10.0
People	969	0	969	10	485	7	People	0	0	0.00		cfm/ft²	0.32	0.32
Misc	0	0	0	0	0	0	Misc	0	0	0.00		cfm/ton	402.40	
Sub Total ==>	3,086	529	3,615	39	2,601	39	Sub Total ==>	0	0	0.00		ft²/ton	1,247.92	
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0	0.00		Btu/hr-ft²	9.62	-11.07
Ventilation Load	0	0	1,936	21	0	0	Ventilation Load	0	-2,362	22.02		No. People	1.9	2.0/1000 ft²
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0				
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	-4,010	-4,010	37.39				
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0	0.00				
Exhaust Heat	0	-53	-53	-1	0	0	OA Preheat Diff.	0	0	0.00				
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0	0.00				
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00				
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0	0.00				
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00				
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0	0.00				
Grand Total ==>	6,905	476	9,318	100.00	6,748	100.00	Grand Total ==>	-8,365	-10,727	100.00				

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg	
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb		ft² (%)	MBh	cfm	°F	°F	
Main Clg	0.8	9.3	7.6	312	78.4	64.0	68.9	55.0	53.9	62.3	Floor	969	-10.7	312	63.0	94.8	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0	
											ExFlr	0	0.0	0	0.0	0.0	
Total	0.8	9.3									Roof	969	0.0	0	0.0	0.0	
											Wall	486	0.0	0	0.0	0.0	
											Ext Door	0	0	0	0.0	0.0	
											Total	-10.7					

Room Checksums

By HENDERSON ENGINEERS

108 Electrical

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 7 / 11		Mo/Hr: 7 / 11		Mo/Hr: Heating Design			Cooling			Heating		
Outside Air:		OADB/WB/HR: 86 / 73 / 106		OADB: 86		OADB: 0			SADB			Ra Plenum		
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict	
Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens							
Envelope Loads				Envelope Loads										
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00						
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00						
Roof Cond	287	0	287	2	287	Roof Cond	-473	49.52						
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00						
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00						
Wall Cond	653	0	653	4	653	Wall Cond	-482	50.48						
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00						
Floor	0	0	0	0	0.00	Floor	0	0.00						
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00						
Infiltration	0	0	0	0	0	Infiltration	0	0.00						
<i>Sub Total ==></i>	940	0	940	6	940	<i>Sub Total ==></i>	-956	100.00						
Internal Loads				Internal Loads							AIRFLOWS			
Lights	401	100	502	3	401	Lights	0	0.00						
People	0	0	0	0	0	People	0	0.00						
Misc	14,341	0	14,341	91	14,341	Misc	0	0.00						
<i>Sub Total ==></i>	14,743	100	14,843	94	14,743	<i>Sub Total ==></i>	0	0.00						
Ceiling Load	0	0	0	0	0	Ceiling Load	0	0.00						
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00						
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat	0	0	0	0	0	OA Preheat Diff.	0	0.00						
Sup. Fan Heat	0	0	0	0	0	RA Preheat Diff.	0	0.00						
Ret. Fan Heat	0	0	0	0	0	Additional Reheat	0	0.00						
Duct Heat Pkup	0	0	0	0	0	System Plenum Heat	0	0.00						
Underflr Sup Ht Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00						
Supply Air Leakage	0	0	0	0	0	Supply Air Leakage	0	0.00						
<i>Grand Total ==></i>	15,683	100	15,783	100.00	15,683	<i>Grand Total ==></i>	-956	100.00						

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION					
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg		
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb		ft² (%)	MBh	cfm	°F	°F		
Main Clg	1.3	15.8	15.8	726	75.1	56.8	41.8	55.0	48.4	41.6	Floor	210		Main Htg	-1.0	218	70.0	74.1
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		Preheat	0.0	0	0.0	0.0
											ExFlr	0						
Total	1.3	15.8									Roof	210	0	Humidif	0.0	0	0.0	0.0
											Wall	108	0	Opt Vent	0.0	0	0.0	0.0
											Ext Door	0	0	Total	-1.0			

Room Checksums

By HENDERSON ENGINEERS

109 IT

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design			Cooling			Heating		
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 95		OADB: 0			SADB			Ra Plenum		
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict	
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Space Sens	Tot Sens	(%)	Btu/h	Btu/h	Btu/h	Btu/h	Btu/h	
Envelope Loads				Envelope Loads										
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00						
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00						
Roof Cond	293	0	293	1	293	Roof Cond	-270	100.00						
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00						
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00						
Wall Cond	0	0	0	0	0	Wall Cond	0	0.00						
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00						
Floor	0	0	0	0	0.00	Floor	0	0.00						
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00						
Infiltration	0	0	0	0	0	Infiltration	0	0.00						
Sub Total ==>	293	0	293	1	293	Sub Total ==>	-270	100.00						
Internal Loads				Internal Loads										
Lights	229	57	287	1	229	Lights	0	0.00						
People	0	0	0	0	0	People	0	0.00						
Misc	36,000	0	36,000	98	36,000	Misc	0	0.00						
Sub Total ==>	36,229	57	36,287	99	36,229	Sub Total ==>	0	0.00						
Ceiling Load	0	0	0	0	0	Ceiling Load	0	0.00						
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00						
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing			0	0		Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0		0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat		0	0	0		OA Preheat Diff.	0	0.00						
Sup. Fan Heat			0	0		RA Preheat Diff.	0	0.00						
Ret. Fan Heat			0	0		Additional Reheat	0	0.00						
Duct Heat Pkup			0	0		System Plenum Heat	0	0.00						
Underflr Sup Ht Pkup			0	0		Underflr Sup Ht Pkup	0	0.00						
Supply Air Leakage			0	0		Supply Air Leakage	0	0.00						
Grand Total ==>	36,523	57	36,580	100.00	36,523	Grand Total ==>	-270	100.00						

AIRFLOWS		
	Cooling	Heating
Diffuser	1,691	507
Terminal	1,691	507
Main Fan	1,691	507
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	507	507
Return	1,691	507
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	14.09	4.23
cfm/ton	554.75	
ft²/ton	39.37	
Btu/hr-ft²	304.83	-2.25
No. People	0.0	0.0/1000 ft²

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	3.1	36.6	36.6	1,691	75.0	56.8	41.8	55.0	48.4	41.6
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	3.1	36.6								

AREAS			
	Gross Total	Glass ft²	(%)
Floor	120		
Part	0		
Int Door	1		
ExFlr	0		
Roof	120	0	0
Wall	0	0	0
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Main Htg	-0.3	507	70.0	70.5
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-0.3			

Room Checksums

By HENDERSON ENGINEERS

110 E Elec

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 95		OADB: 0						SADB	55.0	73.8
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	75.0	70.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	75.2	70.0
Envelope Loads				Envelope Loads								Fn MtrTD	0.0	0.0
Skylite Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn BldTD	0.0	0.0
Skylite Cond	0	0	0	0	0	0	0	0.00	0	0	0.00	Fn Frict	0.0	0.0
Roof Cond	135	0	135	6	135	6	-124	100.00	-124	-124	100.00			
Glass Solar	0	0	0	0	0	0	0	0.00	0	0	0.00			
Glass/Door Cond	0	0	0	0	0	0	0	0.00	0	0	0.00			
Wall Cond	0	0	0	0	0	0	0	0.00	0	0	0.00			
Partition/Door	0	0	0	0	0	0	0	0.00	0	0	0.00			
Floor	0	0	0	0	0.00	0	0	0.00	0	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00			
Infiltration	0	0	0	0	0	0	0	0.00	0	0	0.00			
Sub Total ==>	135	0	135	6	135	6	-124	100.00	-124	-124	100.00			
Internal Loads				Internal Loads								AIRFLOWS		
Lights	105	26	131	6	105	5	0	0.00	0	0	0.00	Cooling	Heating	
People	0	0	0	0	0	0	0	0.00	0	0	0.00	Diffuser	102	31
Misc	1,959	0	1,959	88	1,959	89	0	0.00	0	0	0.00	Terminal	102	31
Sub Total ==>	2,064	26	2,090	94	2,064	94	0	0.00	0	0	0.00	Main Fan	102	31
Ceiling Load	0	0	0	0	0	0	0	0.00	0	0	0.00	Sec Fan	0	0
Ventilation Load	0	0	0	0	0	0	0	0.00	0	0	0.00	Nom Vent	0	0
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	AHU Vent	0	0
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	Infil	0	0
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	MinStop/Rh	31	31
Exhaust Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Return	102	31
Sup. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Exhaust	0	0
Ret. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	Rm Exh	0	0
Duct Heat Pkup	0	0	0	0	0	0	0	0.00	0	0	0.00	Auxiliary	0	0
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00	0	0	0.00	Leakage Dwn	0	0
Supply Air Leakage	0	0	0	0	0	0	0	0.00	0	0	0.00	Leakage Ups	0	0
Grand Total ==>	2,199	26	2,225	100.00	2,199	100.00	-124	100.00	-124	-124	100.00	ENGINEERING CKS		
												% OA	0.0	0.0
												cfm/ft²	1.85	0.56
												cfm/ton	549.06	
												ft²/ton	296.57	
												Btu/hr-ft²	40.46	-2.25
												No. People	0.0	0.0/1000 ft²

COOLING COIL SELECTION											AREAS			HEATING COIL SELECTION				
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg		
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F		
Main Clg	0.2	2.2	2.2	102	75.2	56.8	41.8	55.0	48.4	41.6	Floor	55	Main Htg	-0.1	31	70.0	73.8	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0	
											ExFlr	0	Humidif	0.0	0	0.0	0.0	
Total	0.2	2.2									Roof	55	Opt Vent	0.0	0	0.0	0.0	
											Wall	0	Total	-0.1				
											Ext Door	0						

Project Name:

Dataset Name: 2054521 PROJECT TIGER.TRC

TRACE® 700 v6.3.5 calculated at 01:58 PM on 06/21/2021

Alternative - 1 System Checksums Report Page 7 of 22

Room Checksums

By HENDERSON ENGINEERS

111 Exam

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time: Mo/Hr: 8 / 15				Mo/Hr: 7 / 11				Mo/Hr: Heating Design						
Outside Air: OADB/WB/HR: 94 / 79 / 129				OADB: 86				OADB: 0						
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Cooling	Heating	
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h				
Envelope Loads						Envelope Loads								
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	0	0	0.00	SADB	55.0	94.8
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	0	0	0.00	Ra Plenum	75.0	70.0
Roof Cond	480	0	480	9	286	8	Roof Cond	8.22	-473	-473	8.22	Return	76.0	70.0
Glass Solar	0	0	0	0	0	0	Glass Solar	0.00	0	0	0.00	Ret/OA	77.8	63.0
Glass/Door Cond	0	0	0	0	0	0	Glass/Door Cond	0.00	0	0	0.00	Fn MtrTD	0.0	0.0
Wall Cond	324	0	324	6	690	19	Wall Cond	8.84	-509	-509	8.84	Fn BldTD	0.0	0.0
Partition/Door	0	0	0	0	0	0	Partition/Door	0.00	0	0	0.00	Fn Frict	0.0	0.0
Floor	0	0	0	0	0.00	0	Floor	0.00	0	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	0.00	0.00			
Infiltration	0	0	0	0	0	0	Infiltration	0	0	0	0.00			
Sub Total ==>	804	0	804	16	976	27	Sub Total ==>	17.06	-982	-982	17.06			
Internal Loads							Internal Loads							
Lights	688	172	860	17	688	19	Lights	0	0	0	0.00	Diffuser	168	168
People	945	0	945	18	525	14	People	0	0	0	0.00	Terminal	168	168
Misc	1,433	0	1,433	28	1,433	40	Misc	0	0	0	0.00	Main Fan	168	168
Sub Total ==>	3,067	172	3,239	63	2,647	73	Sub Total ==>	0	0	0	0.00	Sec Fan	0	0
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0	0	0.00	Nom Vent	17	17
Ventilation Load	0	0	1,096	21	0	0	Ventilation Load	0	-1,268	22.02	AHU Vent	17	17	
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0	0.00	Infil	0	0
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	-3,508	-3,508	60.92	MinStop/Rh	0	0	
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0	0.00	Return	168	168	
Exhaust Heat	-17	-17	0	0	0	0	OA Preheat Diff.	0	0	0.00	Exhaust	17	17	
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0	0.00	Rm Exh	0	0	
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00	Auxiliary	0	0	
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0	0.00	Leakage Dwn	0	0	
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00	Leakage Ups	0	0	
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0	0.00				
Grand Total ==>	3,870	155	5,121	100.00	3,622	100.00	Grand Total ==>	-4,490	-5,758	100.00				

AIRFLOWS		
	Cooling	Heating
Diffuser	168	168
Terminal	168	168
Main Fan	168	168
Sec Fan	0	0
Nom Vent	17	17
AHU Vent	17	17
Infil	0	0
MinStop/Rh	0	0
Return	168	168
Exhaust	17	17
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	10.0	10.0
cfm/ft²	0.80	0.80
cfm/ton	393.05	
ft²/ton	492.13	
Btu/hr-ft²	24.38	-27.42
No. People	2.1	10.0/1000 ft²

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION			
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Capacity	Coil Airflow	Ent	Lvg	
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F
Main Clg	0.4	5.1	4.0	168	77.8	63.9	69.6	55.0	53.5	60.9	Floor	210	-5.8	168	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	0.0	0	0.0	0.0
											ExFlr	0	0.0	0	0.0	0.0
Total	0.4	5.1									Roof	210	0.0	0	0.0	0.0
											Wall	114	0.0	0	0.0	0.0
											Ext Door	0	0	0	0	0.0
													-5.8	0	0.0	0.0

Room Checksums

By HENDERSON ENGINEERS

112 Field Equipment

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES		
Peaked at Time:		Mo/Hr: 8 / 13		Mo/Hr: 7 / 12		Mo/Hr: Heating Design			Cooling		Heating		
Outside Air:		OADB/WB/HR: 92 / 78 / 131		OADB: 90		OADB: 0			SADB		Ra Plenum	Return	
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict	
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Tot Sens Btu/h						
Envelope Loads				Envelope Loads									
Skylite Solar	0	0	0	0	0	0	0	0.00					
Skylite Cond	0	0	0	0	0	0	0	0.00					
Roof Cond	1,196	0	1,196	14	1,053	16	-1,408	13.73					
Glass Solar	0	0	0	0	0	0	0	0.00					
Glass/Door Cond	0	0	0	0	0	0	0	0.00					
Wall Cond	3,282	0	3,282	38	3,721	58	-2,747	26.78					
Partition/Door	0	0	0	0	0	0	0	0.00					
Floor	0	0	0	0	0.00	0	0	0.00					
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00					
Infiltration	0	0	0	0	0	0	0	0.00					
Sub Total ==>	4,479	0	4,479	52	4,775	74	-4,155	40.51					
Internal Loads				Internal Loads							AIRFLOWS		
Lights	1,365	341	1,707	20	1,365	21	0	0.00					
People	625	0	625	7	313	5	0	0.00					
Misc	0	0	0	0	0	0	0	0.00					
Sub Total ==>	1,990	341	2,332	27	1,678	26	0	0.00					
Ceiling Load	0	0	0	0	0	0	0	0.00					
Ventilation Load	0	0	1,918	22	0	0	-2,258	22.02					
Adj Air Trans Heat	0	0	0	0	0	0	0	0					
Dehumid. Ov Sizing	0	0	0	0	0	0	-3,843	37.47					
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00					
Exhaust Heat	0	-34	-34	0	0	0	0	0.00					
Sup. Fan Heat	0	0	0	0	0	0	0	0.00					
Ret. Fan Heat	0	0	0	0	0	0	0	0.00					
Duct Heat Pkup	0	0	0	0	0	0	0	0.00					
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00					
Supply Air Leakage	0	0	0	0	0	0	0	0.00					
Grand Total ==>	6,469	307	8,694	100.00	6,452	100.00	-7,998	-10,256	100.00				

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION					
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Ent	Lvg				
	ton	MBh			MBh	cfm	°F	°F	gr/lb	°F					°F	gr/lb	ft²	(%)
Main Clg	0.7	8.7	7.0	299	77.6	63.9	69.8	55.0	54.1	63.0	Floor	625		Main Htg	-10.3	299	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		Preheat	0.0	0	0.0	0.0
											ExFlr	0		Humidif	0.0	0	0.0	0.0
Total	0.7	8.7									Roof	625	0	Opt Vent	0.0	0	0.0	0.0
											Wall	615	0	Total	-10.3			
											Ext Door	0	0					

Room Checksums

By HENDERSON ENGINEERS

113 Water

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES					
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design			Cooling		Heating	SADB	0.0	125.0		
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0			Ra Plenum		66.0	Return	0.0	70.0		
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict				
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Tot Sens Btu/h		0.0	0.0	0.0	0.0				
Envelope Loads				Envelope Loads							AIRFLOWS					
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	Cooling		Heating					
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	Diffuser		0		18			
Roof Cond	0	0	0	0	0	Roof Cond	0	29.73	Terminal		0		18			
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00	Main Fan		0		18			
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00	Sec Fan		0		0			
Wall Cond	0	0	0	0	0	Wall Cond	-890	82.67	Nom Vent		0		0			
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00	AHU Vent		0		0			
Floor	0	0	0	0	0	Floor	0	0.00	Infil		0		0			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	MinStop/Rh		0		0			
Infiltration	0	0	0	0	0	Infiltration	0	0.00	Return		0		18			
Sub Total ==>	0	0	0	0	0	Sub Total ==>	-890	112.41	Exhaust		0		0			
Internal Loads				Internal Loads							Rm Exh		0		0	
Lights	0	0	0	0	0	Lights	0	0.00	Auxiliary		0		0			
People	0	0	0	0	0	People	0	0.00	Leakage Dwn		0		0			
Misc	0	0	0	0	0	Misc	0	0.00	Leakage Ups		0		0			
Sub Total ==>	0	0	0	0	0	Sub Total ==>	0	0.00								
Ceiling Load	0	0	0	0	0	Ceiling Load	-195	0.00								
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00								
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0								
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0.00								
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0.00								
Exhaust Heat	0	0	0	0	0	OA Preheat Diff.	0	0.00								
Sup. Fan Heat	0	0	0	0	0	RA Preheat Diff.	0	0.00								
Ret. Fan Heat	0	0	0	0	0	Additional Reheat	0	0.00								
Duct Heat Pkup	0	0	0	0	0	System Plenum Heat	135	-12.41								
Underflr Sup Ht Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00								
Supply Air Leakage	0	0	0	0	0	Supply Air Leakage	0	0.00								
Grand Total ==>	0	0	0	100.00	0	Grand Total ==>	-1,085	100.00								

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION					
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Ent	Lvg				
	ton	MBh			MBh	cfm	°F	°F	gr/lb	°F					°F	gr/lb	ft²	(%)
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Floor	152		Main Htg	-1.1	18	70.0	125.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		Preheat	0.0	0	0.0	0.0
											ExFlr	0						
Total	0.0	0.0									Roof	152	0	Humidif	0.0	0	0.0	0.0
											Wall	201	0	Opt Vent	0.0	0	0.0	0.0
											Ext Door	0	0	Total	-1.1			

Room Checksums

By HENDERSON ENGINEERS

201 Recruit Level

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 8 / 15		Mo/Hr: 6 / 10		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 94 / 79 / 129		OADB: 78		OADB: 0						SADB	55.0	94.8
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	75.0	70.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	76.2	70.0
Envelope Loads				Envelope Loads								Ret/OA	78.0	63.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	0	0	0.00	Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	0	0	0.00	Fn BldTD	0.0	0.0
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00	0	0	0.00	Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00	0	0	0.00			
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00	0	0	0.00			
Wall Cond	1,452	0	1,452	3	3,075	11	Wall Cond	-2,249	-2,249	4.85				
Partition/Door	0	0	0	0	0	0	Partition/Door	0	0	0.00				
Floor	0	0	0	0	0.00	0	Floor	0	0	0.00				
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	0.00				
Infiltration	0	0	0	0	0	0	Infiltration	0	0	0.00				
Sub Total ==>	1,452	0	1,452	3	3,075	11	Sub Total ==>	-2,249	-2,249	4.85				
Internal Loads				Internal Loads								AIRFLOWS		
Lights	6,963	1,741	8,703	20	6,963	24	Lights	0	0	0.00	Diffuser	1,349	1,349	
People	13,500	0	13,500	31	7,500	26	People	0	0	0.00	Terminal	1,349	1,349	
Misc	11,604	0	11,604	26	11,604	40	Misc	0	0	0.00	Main Fan	1,349	1,349	
Sub Total ==>	32,067	1,741	33,807	77	26,067	89	Sub Total ==>	0	0	0.00	Sec Fan	0	0	
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0	0.00	Nom Vent	135	135	
Ventilation Load	0	0	8,813	20	0	0	Ventilation Load	0	-10,200	22.02	AHU Vent	135	135	
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0	Infil	0	0	
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	-33,872	-33,872	73.13	MinStop/Rh	0	0	
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0	0.00	Return	1,349	1,349	
Exhaust Heat	0	-174	-174	0	0	0	OA Preheat Diff.	0	0	0.00	Exhaust	135	135	
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0	0.00	Rm Exh	0	0	
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00	Auxiliary	0	0	
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0	0.00	Leakage Dwn	0	0	
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00	Leakage Ups	0	0	
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0	0.00	ENGINEERING CKS			
Grand Total ==>	33,519	1,567	43,899	100.00	29,141	100.00	Grand Total ==>	-36,121	-46,320	100.00	% OA	10.0	10.0	

COOLING COIL SELECTION											AREAS				HEATING COIL SELECTION				
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg			
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F			
Main Clg	3.7	43.9	31.9	1,349	78.0	64.0	69.6	55.0	52.9	58.3	Floor	1,700	Main Htg	-46.3	1,349	63.0	94.8		
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0		
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0		
											ExFlr	0	Humidif	0.0	0	0.0	0.0		
Total	3.7	43.9									Roof	0	Opt Vent	0.0	0	0.0	0.0		
											Wall	504	Total	-46.3					
											Ext Door	0							

Room Checksums

By HENDERSON ENGINEERS

201A Storage

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 8 / 13		Mo/Hr: 9 / 12		Mo/Hr: Heating Design						Cooling		Heating
Outside Air:		OADB/WB/HR: 92 / 78 / 131		OADB: 79		OADB: 0						SADB	55.0	94.8
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total	Space Sensible	Percent Of Total	Space Peak	Coil Peak	Percent	Space Sens	Tot Sens	Of Total	Return	75.0	70.0
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)	Ret/OA	77.7	63.0
Envelope Loads				Envelope Loads								Fn MtrTD	0.0	0.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	0	0	0.00	Fn BldTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	0	0	0.00	Fn Frict	0.0	0.0
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00	0	0	0.00			
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00	0	0	0.00			
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00	0	0	0.00			
Wall Cond	1,414	0	1,414	50	73	Wall Cond	-792	23.49	-792	-792	23.49			
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00	0	0	0.00			
Floor	0	0	0	0	0	Floor	0	0.00	0	0	0.00			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	0.00	0.00	0.00			
Infiltration	0	0	0	0	0	Infiltration	0	0.00	0	0	0.00			
<i>Sub Total ==></i>	1,414	0	1,414	50	73	<i>Sub Total ==></i>	-792	23.49	-792	-792	23.49			
Internal Loads				Internal Loads								AIRFLOWS		
Lights	474	119	593	21	22	Lights	0	0.00	0	0	0.00	Diffuser	98	98
People	195	0	195	7	5	People	0	0.00	0	0	0.00	Terminal	98	98
Misc	0	0	0	0	0	Misc	0	0.00	0	0	0.00	Main Fan	98	98
<i>Sub Total ==></i>	669	119	788	28	27	<i>Sub Total ==></i>	0	0.00	0	0	0.00	Sec Fan	0	0
Ceiling Load Ventilation Load Adj Air Trans Heat Dehumid. Ov Sizing Ov/Undr Sizing Exhaust Heat Sup. Fan Heat Ret. Fan Heat Duct Heat Pkup Underflr Sup Ht Pkup Supply Air Leakage	0 0 0 0 0 -12 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	0 631 0 0 0 -12 0 0 0 0 0	0 22 0 0 0 0 0 0 0 0 0	0 0 0 0 0 0 0 0 0 0 0	Ceiling Load Ventilation Load Adj Air Trans Heat Ov/Undr Sizing Exhaust Heat OA Preheat Diff. RA Preheat Diff. Additional Reheat System Plenum Heat Underflr Sup Ht Pkup Supply Air Leakage	0 0 0 -1,838 0 0 0 0 0 0 0 0	0.00 22.02 0 54.49 0.00 0.00 0.00 0.00 0.00 0.00 0.00 0.00	0 -743 0 -1,838 0 0 0 0 0 0 0 0	0.00 0.00 0.00 54.49 0.00 0.00 0.00 0.00 0.00 0.00 0.00	Nom Vent AHU Vent Infil MinStop/Rh Return Exhaust Rm Exh Auxiliary Leakage Dwn Leakage Ups	10 10 0 0 98 10 0 0 0 0 0	10 10 0 0 98 10 0 0 0 0 0	
<i>Grand Total ==></i>	2,083	107	2,821	100.00	2,122	100.00	<i>Grand Total ==></i>	-2,630	-3,373	100.00	ENGINEERING CKS			
											% OA	10.0	10.0	
											cfm/ft²	0.45	0.45	
											cfm/ton	417.96		
											ft²/ton	923.21		
											Btu/hr-ft²	13.00	-15.54	
											No. People	0.4	2.0/1000 ft²	

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg	
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F	
Main Clg	0.2	2.8	2.3	98	77.7	63.9	69.8	55.0	54.2	63.6	Floor	217	Main Htg	-3.4	98	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0
											ExFlr	0	Humidif	0.0	0	0.0	0.0
Total	0.2	2.8									Roof	0	Opt Vent	0.0	0	0.0	0.0
											Wall	177	Total	-3.4			
											Ext Door	0					

Room Checksums

By HENDERSON ENGINEERS

301 Janitor

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design			Cooling			Heating		
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0			SADB			Ra Plenum		
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Return	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict	
Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens		0.0	0.0	0.0	0.0	0.0	
Envelope Loads				Envelope Loads										
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00						
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00						
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00						
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00						
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00						
Wall Cond	0	0	0	0	0	Wall Cond	-992	78.70						
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00						
Floor	0	0	0	0	0.00	Floor	0	0.00						
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00						
Infiltration	0	0	0	0	0	Infiltration	0	0.00						
<i>Sub Total ==></i>	0	0	0	0	0	<i>Sub Total ==></i>	-992	78.70						
Internal Loads				Internal Loads										
Lights	0	0	0	0	0	Lights	0	0.00						
People	0	0	0	0	0	People	0	0.00						
Misc	0	0	0	0	0	Misc	0	0.00						
<i>Sub Total ==></i>	0	0	0	0	0	<i>Sub Total ==></i>	0	0.00						
Ceiling Load	0	0	0	0	0	Ceiling Load	-279	0.00						
Ventilation Load	0	0	0	0	0	Ventilation Load	0	0.00						
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing			0	0		Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0		0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat		0	0	0		OA Preheat Diff.	0	0.00						
Sup. Fan Heat			0	0		RA Preheat Diff.	0	0.00						
Ret. Fan Heat			0	0		Additional Reheat	0	0.00						
Duct Heat Pkup			0	0		System Plenum Heat	-271	21.30						
Underflr Sup Ht Pkup			0	0		Underflr Sup Ht Pkup	0	0.00						
Supply Air Leakage			0	0		Supply Air Leakage	0	0.00						
Grand Total ==>	0	0	0	100.00	0	Grand Total ==>	-1,271	100.00						

AIRFLOWS		
	Cooling	Heating
Diffuser	0	21
Terminal	0	21
Main Fan	0	21
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	0	21
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	0.00	0.10
cfm/ton	0.00	
ft²/ton	0.00	
Btu/hr-ft²	0.00	-5.86
No. People	0.0	0.0/1000 ft²

COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0								

AREAS			
	Gross Total	Glass	
		ft²	(%)
Floor	217		
Part	0		
Int Door	1		
ExFlr	0		
Roof	0	0	0
Wall	224	0	0
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1.3			

Room Checksums

By HENDERSON ENGINEERS

302 RR

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES		
Peaked at Time:		Mo/Hr: 6 / 8			Mo/Hr: 6 / 8		Mo/Hr: Heating Design										
Outside Air:		OADB/WB/HR: 73 / 69 / 101			OADB: 73		OADB: 0										
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total	Space Sensible	Percent Of Total	Space Peak	Coil Peak	Percent Of Total	Space Sens	Coil Peak Tot Sens	Percent Of Total	SADB	Cooling	Heating			
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)						
Envelope Loads					Envelope Loads										AIRFLOWS		
Skylite Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	Diffuser	206	206			
Skylite Cond	0	0	0	0	0	0	0	0.00	0	0	0.00	Terminal	206	206			
Roof Cond	16	0	16	0	16	0	-789	11.18	0	0	0.00	Main Fan	206	206			
Glass Solar	2,984	0	2,984	58	2,984	67	0	0.00	0	0	0.00	Sec Fan	0	0			
Glass/Door Cond	-113	0	-113	-2	-113	-3	-2,177	30.85	-2,177	-2,177	30.85	Nom Vent	21	21			
Wall Cond	790	0	790	15	790	18	-965	13.67	-965	-965	13.67	AHU Vent	21	21			
Partition/Door	0	0	0	0	0	0	0	0.00	0	0	0.00	Infil	0	0			
Floor	0	0	0	0	0.00	0	0	0.00	0	0	0.00	MinStop/Rh	0	0			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Return	206	206			
Infiltration	0	0	0	0	0	0	0	0.00	0	0	0.00	Exhaust	21	21			
Sub Total ==>	3,676	0	3,676	72	3,676	83	-3,931	55.70	-3,931	-3,931	55.70	Rm Exh	0	0			
Internal Loads					Internal Loads										ENGINEERING CKS		
Lights	765	191	956	19	765	17	0	0.00	0	0	0.00	% OA	10.0	10.0			
People	0	0	0	0	0	0	0	0.00	0	0	0.00	cfm/ft²	0.59	0.59			
Misc	0	0	0	0	0	0	0	0.00	0	0	0.00	cfm/ton	483.34				
Sub Total ==>	765	191	956	19	765	17	0	0.00	0	0	0.00	ft²/ton	822.85				
Ceiling Load	0	0	0	0	0	0	-1,573	22.28	-1,573	-1,573	22.28	Btu/hr-ft²	14.58	-20.16			
Ventilation Load	0	0	492	10	0	0	0	0.00	0	0	0.00	No. People	0.0	0.0/1000 ft²			
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00	0	0	0.00						
Dehumid. Ov Sizing			0	0			0	0.00	0	0	0.00						
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00						
Exhaust Heat		-19	-19	0			0	0.00	0	0	0.00						
Sup. Fan Heat		0	0	0			0	0.00	0	0	0.00						
Ret. Fan Heat		0	0	0			0	0.00	0	0	0.00						
Duct Heat Pkup		0	0	0			0	0.00	0	0	0.00						
Underflr Sup Ht Pkup		0	0	0			0	0.00	0	0	0.00						
Supply Air Leakage		0	0	0			0	0.00	0	0	0.00						
Grand Total ==>	4,440	172	5,104	100.00	4,440	100.00	-5,504	100.00	-5,504	-7,058	100.00						

COOLING COIL SELECTION										AREAS				HEATING COIL SELECTION				
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass	Capacity		Coil Airflow	Ent	Lvg		
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F		
Main Clg	0.4	5.1	4.6	206	75.6	62.6	66.8	55.0	54.1	63.0	Floor	350	Main Htg	-7.1	206	63.0	94.8	
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0	
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0	
											ExFlr	0						
Total	0.4	5.1									Roof	350	Humidif	0.0	0	0.0	0.0	
											Wall	288	Opt Vent	0.0	0	0.0	0.0	
											Ext Door	0	Total	-7.1				

Room Checksums

By HENDERSON ENGINEERS

303 RR

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES			
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 18		Mo/Hr: Heating Design			Cooling		Heating			
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 90		OADB: 0			SADB		Ra Plenum	Return		
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict		
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Tot Sens Btu/h							
Envelope Loads				Envelope Loads							AIRFLOWS			
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00	Cooling		Heating			
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00	Diffuser	232	232			
Roof Cond	814	0	814	13	631	Roof Cond	-768	9.66	Terminal	232	232			
Glass Solar	1,120	0	1,120	17	1,309	Glass Solar	0	0.00	Main Fan	232	232			
Glass/Door Cond	1,006	0	1,006	16	731	Glass/Door Cond	-3,765	47.34	Sec Fan	0	0			
Wall Cond	1,147	0	1,147	18	1,588	Wall Cond	-1,668	20.97	Nom Vent	23	23			
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00	AHU Vent	23	23			
Floor	0	0	0	0	0.00	Floor	0	0.00	Infil	0	0			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	MinStop/Rh	0	0			
Infiltration	0	0	0	0	0	Infiltration	0	0.00	Return	232	232			
Sub Total ==>	4,088	0	4,088	64	4,259	Sub Total ==>	-6,202	77.98	Exhaust	23	23			
Internal Loads				Internal Loads							ENGINEERING CKS			
Lights	745	186	931	14	745	Lights	0	0.00	% OA	10.0	10.0			
People	0	0	0	0	0	People	0	0.00	cfm/ft²	0.68	0.68			
Misc	0	0	0	0	0	Misc	0	0.00	cfm/ton	431.94				
Sub Total ==>	745	186	931	14	745	Sub Total ==>	0	0.00	ft²/ton	635.79				
Ceiling Load	0	0	0	0	0	Ceiling Load	0	0.00	Btu/hr-ft²	18.87	-23.32			
Ventilation Load	0	0	1,436	22	0	Ventilation Load	0	22.02	No. People	0.0	0.0/1000 ft²			
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0						
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0.00						
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0.00						
Exhaust Heat	0	-19	-19	0	0	OA Preheat Diff.	0	0.00						
Sup. Fan Heat	0	0	0	0	0	RA Preheat Diff.	0	0.00						
Ret. Fan Heat	0	0	0	0	0	Additional Reheat	0	0.00						
Duct Heat Pkup	0	0	0	0	0	System Plenum Heat	0	0.00						
Underflr Sup Ht Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00						
Supply Air Leakage	0	0	0	0	0	Supply Air Leakage	0	0.00						
Grand Total ==>	4,833	168	6,436	100.00	5,003	100.00	Grand Total ==>	-6,202	-7,953	100.00				

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass ft²	Glass (%)	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb							
Main Clg	0.5	6.4	5.5	232	77.7	63.7	68.9	55.0	54.4	64.1	Floor	341	Main Htg	-8.0	232	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0
											ExFlr	0	Humidif	0.0	0	0.0	0.0
Total	0.5	6.4									Roof	341	Opt Vent	0.0	0	0.0	0.0
											Wall	498	Total	-8.0			
											Ext Door	0					

Room Checksums

By HENDERSON ENGINEERS

304 Viewing Platform

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 18			Mo/Hr: 7 / 18		Mo/Hr: Heating Design							Cooling	Heating		
Outside Air:		OADB/WB/HR: 90 / 73 / 101			OADB: 90		OADB: 0							SADB	55.0	94.8	
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Coil Peak Tot Sens	Percent Of Total	Return					
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)	Fn MtrTD					
Envelope Loads					Envelope Loads										AIRFLOWS		
Skylite Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	Diffuser	3,292	3,292			
Skylite Cond	0	0	0	0	0	0	0	0.00	0	0	0.00	Terminal	3,292	3,292			
Roof Cond	4,092	0	4,092	4	4,092	6	-5,237	4.63	-5,237	-5,237	17.02	Main Fan	3,292	3,292			
Glass Solar	15,745	0	15,745	16	15,745	22	0	0.00	0	0	0.00	Sec Fan	0	0			
Glass/Door Cond	3,732	0	3,732	4	3,732	5	-19,234	8.05	-19,234	-19,234	29.70	Nom Vent	329	329			
Wall Cond	13,742	0	13,742	14	13,742	19	-9,102	0.00	-9,102	-9,102	0.00	AHU Vent	329	329			
Partition/Door	0	0	0	0	0	0	0	0.00	0	0	0.00	Infil	0	0			
Floor	0	0	0	0	0.00	0	0	0.00	0	0	0.00	MinStop/Rh	0	0			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Return	3,292	3,292			
Infiltration	0	0	0	0	0	0	0	0.00	0	0	0.00	Exhaust	329	329			
Sub Total ==>	37,311	0	37,311	39	37,311	52	-33,573		-33,573	-33,573		Rm Exh	0	0			
Internal Loads					Internal Loads										ENGINEERING CKS		
Lights	7,986	1,997	9,983	10	7,986	11	0	0.00	0	0	0.00	% OA	10.0	10.0			
People	22,500	0	22,500	23	12,500	18	0	0.00	0	0	0.00	cfm/ft²	1.69	1.69			
Misc	13,311	0	13,311	14	13,311	19	0	0.00	0	0	0.00	cfm/ton	408.17				
Sub Total ==>	43,797	1,997	45,794	47	33,797	48	0	0.00	0	0	0.00	ft²/ton	241.75				
Ceiling Load	0	0	0	0	0	0	-54,565	48.28	-54,565	-54,565		Btu/hr-ft²	49.64	-57.96			
Ventilation Load	0	0	13,891	14	0	0	0	0.00	0	0	0.00	No. People	50.0	25.6/1000 ft²			
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00	0	-24,888	22.02						
Dehumid. Ov Sizing			0	0			0	0.00	0	0	0.00						
Ov/Undr Sizing	0		0	0	0	0	0	0.00	0	0	0.00						
Exhaust Heat		-200	-200	0			0	0.00	0	0	0.00						
Sup. Fan Heat			0	0			0	0.00	0	0	0.00						
Ret. Fan Heat		0	0	0			0	0.00	0	0	0.00						
Duct Heat Pkup		0	0	0			0	0.00	0	0	0.00						
Underflr Sup Ht Pkup			0	0			0	0.00	0	0	0.00						
Supply Air Leakage		0	0	0			0	0.00	0	0	0.00						
Grand Total ==>	81,108	1,797	96,796	100.00	71,108	100.00	-88,138		-88,138	-113,026	100.00						

COOLING COIL SELECTION										AREAS				HEATING COIL SELECTION						
Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR		Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg						
ton	MBh	cfm	°F	°F	°F	°F		ft²	(%)	MBh	cfm	°F	°F							
Main Clg	8.1	96.8	78.3	3,292	77.0	63.1	66.8	55.0	53.0	58.6	Floor	1,950				Main Htg	-113.0	3,292	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0				Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1				Preheat	0.0	0	0.0	0.0
											ExFlr	0				Humidif	0.0	0	0.0	0.0
Total	8.1	96.8									Roof	2,324	0	0		Opt Vent	0.0	0	0.0	0.0
											Wall	2,674	636	24		Total	-113.0			
											Ext Door	0	0	0						

Room Checksums

By HENDERSON ENGINEERS

C301 Circ

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES		
Peaked at Time:		Mo/Hr: 7 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design						Cooling	Heating	
Outside Air:		OADB/WB/HR: 95 / 78 / 122		OADB: 95		OADB: 0						SADB	55.0	94.8
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	75.0	70.0
Btu/h	Btu/h	Btu/h		Btu/h		Btu/h	Btu/h		Btu/h	Btu/h		Return	77.0	70.0
Envelope Loads				Envelope Loads								Rt/OA	78.8	63.0
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn MtrTD	0.0	0.0
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn BldTD	0.0	0.0
Roof Cond	728	0	728	43	728	60	Roof Cond	-676	-676	34.88		Fn Frict	0.0	0.0
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00						
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	0	0.00						
Wall Cond	0	0	0	0	0	Wall Cond	0	0.00						
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00						
Floor	0	0	0	0	0.00	0	Floor	0	0	0.00				
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	0.00				
Infiltration	0	0	0	0	0	0	Infiltration	0	0	0.00				
<i>Sub Total ==></i>	728	0	728	43	728	60	<i>Sub Total ==></i>	-676	-676	34.88				
Internal Loads				Internal Loads										
Lights	491	123	614	37	491	40	Lights	0	0	0.00				
People	0	0	0	0	0	0	People	0	0	0.00				
Misc	0	0	0	0	0	0	Misc	0	0	0.00				
<i>Sub Total ==></i>	491	123	614	37	491	40	<i>Sub Total ==></i>	0	0	0.00				
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0	0.00				
Ventilation Load	0	0	350	21	0	0	Ventilation Load	0	-427	22.02				
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0				
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	-835	-835	43.10				
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0	0.00				
Exhaust Heat	0	-12	-12	-1	0	0	OA Preheat Diff.	0	0	0.00				
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0	0.00				
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00				
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0	0.00				
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00				
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0	0.00				
Grand Total ==>	1,219	111	1,680	100.00	1,219	100.00	Grand Total ==>	-1,511	-1,938	100.00				

AIRFLOWS		
	Cooling	Heating
Diffuser	56	56
Terminal	56	56
Main Fan	56	56
Sec Fan	0	0
Nom Vent	6	6
AHU Vent	6	6
Infil	0	0
MinStop/Rh	0	0
Return	56	56
Exhaust	6	6
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	10.0	10.0
cfm/ft²	0.19	0.19
cfm/ton	403.32	
ft²/ton	2,143.18	
Btu/hr-ft²	5.60	-6.46
No. People	0.0	0.0/1000 ft²

COOLING COIL SELECTION										
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	0.1	1.7	1.5	56	78.8	64.1	68.9	55.0	54.1	63.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.1	1.7								

AREAS			
	Gross Total	Glass	
		ft²	(%)
Floor	300		
Part	0		
Int Door	1		
ExFlr	0		
Roof	300	0	0
Wall	0	0	0
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity	Coil Airflow	Ent	Lvg
	MBh	cfm	°F	°F
Main Htg	-1.9	56	63.0	94.8
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-1.9			

Room Checksums

By HENDERSON ENGINEERS

L101 Player Lobby

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES				
Peaked at Time:		Mo/Hr: 8 / 14		Mo/Hr: 6 / 8		Mo/Hr: Heating Design			Cooling		Heating	SADB	55.0	94.8	
Outside Air:		OADB/WB/HR: 94 / 79 / 129		OADB: 73		OADB: 0			Ra Plenum		75.0	70.0	Return	76.0	70.0
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Ret/OA <th>Fn MtrTD <th>Fn BldTD <th>Fn Frict <td colspan="3"></td> </th></th></th>	Fn MtrTD <th>Fn BldTD <th>Fn Frict <td colspan="3"></td> </th></th>	Fn BldTD <th>Fn Frict <td colspan="3"></td> </th>	Fn Frict <td colspan="3"></td>			
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Tot Sens Btu/h	(%)	77.8	0.0	0.0	0.0			
Envelope Loads				Envelope Loads							AIRFLOWS				
Skylite Solar	0	0	0	0	0	0	0	0.00	Diffuser		853	853			
Skylite Cond	0	0	0	0	0	0	0	0.00	Terminal		853	853			
Roof Cond	0	0	0	0	0	0	0	0.00	Main Fan		853	853			
Glass Solar	901	0	901	3	4,729	26	0	0.00	Sec Fan		0	0			
Glass/Door Cond	752	0	752	3	-157	-1	-3,024	10.32	Nom Vent		85	85			
Wall Cond	339	0	339	1	425	2	-523	1.78	AHU Vent		85	85			
Partition/Door	0	0	0	0	0	0	0	0.00	Infil		0	0			
Floor	0	0	0	0	0.00	0	0	0.00	MinStop/Rh		0	0			
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Return		853	853			
Infiltration	0	0	0	0	0	0	0	0.00	Exhaust		85	85			
Sub Total ==>	1,992	0	1,992	8	4,997	27	-3,547	12.11	Rm Exh		0	0			
Internal Loads				Internal Loads							ENGINEERING CKS				
Lights	3,747	937	4,684	18	3,747	20	0	0.00	% OA		10.0	10.0			
People	9,000	0	9,000	35	5,000	27	0	0.00	cfm/ft²		0.93	0.93			
Misc	4,684	0	4,684	18	4,684	25	0	0.00	cfm/ton		396.47				
Sub Total ==>	17,432	937	18,369	71	13,432	73	0	0.00	ft²/ton		425.15				
Ceiling Load	0	0	0	0	0	0	0	0.00	Btu/hr-ft²		28.23	-32.01			
Ventilation Load	0	0	5,559	22	0	0	0	22.02	No. People		20.0	21.9/1000 ft²			
Adj Air Trans Heat	0	0	0	0	0	0	0	0							
Dehumid. Ov Sizing	0	0	0	0	0	0	-19,296	65.87							
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00							
Exhaust Heat	0	-94	-94	0	0	0	0	0.00							
Sup. Fan Heat	0	0	0	0	0	0	0	0.00							
Ret. Fan Heat	0	0	0	0	0	0	0	0.00							
Duct Heat Pkup	0	0	0	0	0	0	0	0.00							
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00							
Supply Air Leakage	0	0	0	0	0	0	0	0.00							
Grand Total ==>	19,423	843	25,826	100.00	18,429	100.00	-22,842	-29,292	100.00						

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass ft² (%)	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F	
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb							
Main Clg	2.2	25.8	18.0	853	77.8	63.9	69.6	55.0	53.7	61.4	Floor	915	Main Htg	-29.3	853	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0
											ExFlr	0	Humidif	0.0	0	0.0	0.0
Total	2.2	25.8									Roof	0	Opt Vent	0.0	0	0.0	0.0
											Wall	217	Total	-29.3			
											Ext Door	0					

Room Checksums

By HENDERSON ENGINEERS

L301 Donor Lobby

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES		
Peaked at Time:		Mo/Hr: 8 / 15		Mo/Hr: 7 / 15		Mo/Hr: Heating Design							
Outside Air:		OADB/WB/HR: 94 / 79 / 129		OADB: 95		OADB: 0							
Space Sens. + Lat.	Plenum Sens. + Lat	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	SADB	Cooling	Heating		
Btu/h	Btu/h	Btu/h		Btu/h		Space Sens	Tot Sens						
Envelope Loads				Envelope Loads							AIRFLOWS		
Skylite Solar	0	0	0	0	0	0	0	0.00	Diffuser	283	283		
Skylite Cond	0	0	0	0	0	0	0	0.00	Terminal	283	283		
Roof Cond	835	0	835	9	885	14	-825	8.50	Main Fan	283	283		
Glass Solar	81	0	81	1	90	1	0	0.00	Sec Fan	0	0		
Glass/Door Cond	82	0	82	1	85	1	-318	3.27	Nom Vent	28	28		
Wall Cond	158	0	158	2	171	3	-248	2.56	AHU Vent	28	28		
Partition/Door	0	0	0	0	0	0	0	0.00	Infil	0	0		
Floor	0	0	0	0	0.00	0	0	0.00	MinStop/Rh	0	0		
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	Return	283	283		
Infiltration	0	0	0	0	0	0	0	0.00	Exhaust	28	28		
Sub Total ==>	1,156	0	1,156	12	1,230	20	-1,390	14.33	Rm Exh	0	0		
Internal Loads				Internal Loads							ENGINEERING CKS		
Lights	1,499	375	1,874	20	1,499	25	0	0.00	% OA	10.0	10.0		
People	2,700	0	2,700	29	1,500	25	0	0.00	cfm/ft²	0.77	0.77		
Misc	1,874	0	1,874	20	1,874	31	0	0.00	cfm/ton	360.28			
Sub Total ==>	6,073	375	6,447	69	4,873	80	0	0.00	ft²/ton	466.67			
Ceiling Load	0	0	0	0	0	0	-6,174	63.65	Btu/hr-ft²	25.71	-26.50		
Ventilation Load	0	0	1,846	20	0	0	0	0.00	No. People	6.0	16.4/1000 ft²		
Adj Air Trans Heat	0	0	0	0	0	0	0	0.00					
Dehumid. Ov Sizing			0	0			0	0.00					
Ov/Undr Sizing	0		0	0	0	0	0	0.00					
Exhaust Heat		-37	-37	0			0	0.00					
Sup. Fan Heat			0	0			0	0.00					
Ret. Fan Heat		0	0	0			0	0.00					
Duct Heat Pkup		0	0	0			0	0.00					
Underflr Sup Ht Pkup			0	0			0	0.00					
Supply Air Leakage		0	0	0			0	0.00					
Grand Total ==>	7,228	337	9,411	100.00	6,103	100.00	-7,564	9.700					

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity		Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb		ft² (%)	MBh	cfm	°F	°F	
Main Clg	0.8	9.4	7.0	283	78.0	64.0	69.6	55.0	52.6	57.2	Floor	366		-9.7	283	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0		0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1		0.0	0	0.0	0.0
											ExFlr	0		0.0	0	0.0	0.0
Total	0.8	9.4									Roof	366	0	0.0	0	0.0	0.0
											Wall	66	11	16	0.0	0	0.0
											Ext Door	0	0	0	-9.7		

Room Checksums

By HENDERSON ENGINEERS

Stairs

COOLING COIL PEAK					CLG SPACE PEAK					HEATING COIL PEAK					TEMPERATURES				
Peaked at Time:		Mo/Hr: 6 / 8			Mo/Hr: 6 / 8		Mo/Hr: Heating Design						Cooling			Heating			
Outside Air:		OADB/WB/HR: 73 / 69 / 101			OADB: 73		OADB: 0						SADB			Ra Plenum			
	Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Return	Fn MtrTD	Fn BldTD	Fn Frict			
	Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)							
Envelope Loads					Envelope Loads										AIRFLOWS				
Skylite Solar	0	0	0	0	0	0	Skylite Solar	0	0	0.00			Diffuser	2,192	2,192				
Skylite Cond	0	0	0	0	0	0	Skylite Cond	0	0	0.00			Terminal	2,192	2,192				
Roof Cond	16	0	16	0	16	0	Roof Cond	-451	-451	0.60			Main Fan	2,192	2,192				
Glass Solar	47,559	0	47,559	90	47,559	100	Glass Solar	0	0	0.00			Sec Fan	0	0				
Glass/Door Cond	-1,164	0	-1,164	-2	-1,164	-2	Glass/Door Cond	-22,379	-22,379	29.74			Nom Vent	219	219				
Wall Cond	552	0	552	1	552	1	Wall Cond	-625	-625	0.83			AHU Vent	219	219				
Partition/Door	0	0	0	0	0	0	Partition/Door	0	0	0.00			Infil	0	0				
Floor	0	0	0	0	0.00	0	Floor	0	0	0.00			MinStop/Rh	0	0				
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00	0.00			Return	2,192	2,192				
Infiltration	0	0	0	0	0	0	Infiltration	0	0	0.00			Exhaust	219	219				
Sub Total ==>	46,963	0	46,963	89	46,963	99	Sub Total ==>	-23,455	-23,455	31.17			Rm Exh	0	0				
Internal Loads					Internal Loads										ENGINEERING CKS				
Lights	382	96	478	1	382	1	Lights	0	0	0.00			% OA	10.0	10.0				
People	0	0	0	0	0	0	People	0	0	0.00			cfm/ft²	10.96	10.96				
Misc	0	0	0	0	0	0	Misc	0	0	0.00			cfm/ton	499.38					
Sub Total ==>	382	96	478	1	382	1	Sub Total ==>	0	0	0.00			ft²/ton	45.56					
Ceiling Load	0	0	0	0	0	0	Ceiling Load	0	0	0.00			Btu/hr-ft²	263.38	-376.27				
Ventilation Load	0	0	5,246	10	0	0	Ventilation Load	0	-16,571	22.02			No. People	0.0	0.0/1000 ft²				
Adj Air Trans Heat	0	0	0	0	0	0	Adj Air Trans Heat	0	0	0									
Dehumid. Ov Sizing	0	0	0	0	0	0	Ov/Undr Sizing	-35,229	-35,229	46.81									
Ov/Undr Sizing	0	0	0	0	0	0	Exhaust Heat	0	0	0.00									
Exhaust Heat	-10	-10	0	0	0	0	OA Preheat Diff.	0	0	0.00									
Sup. Fan Heat	0	0	0	0	0	0	RA Preheat Diff.	0	0	0.00									
Ret. Fan Heat	0	0	0	0	0	0	Additional Reheat	0	0	0.00									
Duct Heat Pkup	0	0	0	0	0	0	System Plenum Heat	0	0	0.00									
Underflr Sup Ht Pkup	0	0	0	0	0	0	Underflr Sup Ht Pkup	0	0	0.00									
Supply Air Leakage	0	0	0	0	0	0	Supply Air Leakage	0	0	0.00									
Grand Total ==>	47,345	86	52,677	100.00	47,345	100.00	Grand Total ==>	-58,684	-75,255	100.00									

COOLING COIL SELECTION										AREAS			HEATING COIL SELECTION				
	Total Capacity	Sens Cap.	Coil Airflow	Enter DB/WB/HR			Leave DB/WB/HR			Gross Total	Glass		Capacity	Coil Airflow	Ent	Lvg	
	ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	ft²	(%)	MBh	cfm	°F	°F	
Main Clg	4.4	52.7	47.0	2,192	74.9	62.3	66.8	55.0	54.1	63.0	Floor	200	Main Htg	-75.3	2,192	63.0	94.8
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Part	0	Aux Htg	0.0	0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	Int Door	1	Preheat	0.0	0	0.0	0.0
											ExFlr	0	Humidif	0.0	0	0.0	0.0
Total	4.4	52.7									Roof	200	Opt Vent	0.0	0	0.0	0.0
											Wall	880	Total	-75.3			
											Ext Door	0					

Room Checksums

By HENDERSON ENGINEERS

V101 Vestibule

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK				TEMPERATURES																							
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design		Mo/Hr: Heating Design		Mo/Hr: Heating Design		Cooling	Heating																						
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0		OADB: 0		OADB: 0		SADB	0.0	125.0																					
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Ra Plenum	0.0	66.0																					
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)	Return	0.0	70.0																					
Envelope Loads				Envelope Loads								Fn MtrTD	0.0	0.0																					
Skylite Solar	0	0	0	0	0	Skylite Solar	0	0.00				Fn BldTD	0.0	0.0																					
Skylite Cond	0	0	0	0	0	Skylite Cond	0	0.00				Fn Frict	0.0	0.0																					
Roof Cond	0	0	0	0	0	Roof Cond	0	0.00				AIRFLOWS																							
Glass Solar	0	0	0	0	0	Glass Solar	0	0.00							Cooling	Heating																			
Glass/Door Cond	0	0	0	0	0	Glass/Door Cond	-3,024	90.30							Diffuser	0	56																		
Wall Cond	0	0	0	0	0	Wall Cond	-197	11.14							Terminal	0	56																		
Partition/Door	0	0	0	0	0	Partition/Door	0	0.00							Main Fan	0	56																		
Floor	0	0	0	0	0	Floor	0	0.00							Sec Fan	0	0																		
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	Adjacent Floor	0.00	0.00							Nom Vent	0	0																		
Infiltration	0	0	0	0	0	Infiltration	0	0.00							AHU Vent	0	0																		
<i>Sub Total ==></i>	0	0	0	0	0	<i>Sub Total ==></i>	-3,221	101.44							Infil	0	0																		
Internal Loads				Internal Loads											MinStop/Rh	0	0																		
Lights	0	0	0	0	0	Lights	0	0.00							Return	0	56																		
People	0	0	0	0	0	People	0	0.00							Exhaust	0	0																		
Misc	0	0	0	0	0	Misc	0	0.00							Rm Exh	0	0																		
<i>Sub Total ==></i>	0	0	0	0	0	<i>Sub Total ==></i>	0	0.00							Auxiliary	0	0																		
Ceiling Load				Ceiling Load											Leakage Dwn	0	0																		
Ventilation Load	0	0	0	0	0	Ventilation Load	-128	0.00				Leakage Ups	0	0																					
Adj Air Trans Heat	0	0	0	0	0	Adj Air Trans Heat	0	0				ENGINEERING CKS																							
Dehumid. Ov Sizing	0	0	0	0	0	Ov/Undr Sizing	0	0.00							Cooling	Heating																			
Ov/Undr Sizing	0	0	0	0	0	Exhaust Heat	0	0.00							% OA	0.0	0.0																		
Exhaust Heat	0	0	0	0	0	OA Preheat Diff.	0	0.00							cfm/ft²	0.00	0.56																		
Sup. Fan Heat	0	0	0	0	0	RA Preheat Diff.	0	0.00							cfm/ton	0.00																			
Ret. Fan Heat	0	0	0	0	0	Additional Reheat	0	0.00							ft²/ton	0.00																			
Duct Heat Pkup	0	0	0	0	0	System Plenum Heat	48	-1.44							Btu/hr-ft²	0.00	-33.49																		
Underflr Sup Ht Pkup	0	0	0	0	0	Underflr Sup Ht Pkup	0	0.00							No. People	0.0	0.0/1000 ft²																		
Supply Air Leakage	0	0	0	0	0	Supply Air Leakage	0	0.00							COOLING COIL SELECTION																				
<i>Grand Total ==></i>	0	0	0	100.00	0	<i>Grand Total ==></i>	-3,349	100.00										Total Capacity	Sens Cap.		Coil Airflow		Enter DB/WB/HR		Leave DB/WB/HR										
COOLING COIL SELECTION				AREAS				HEATING COIL SELECTION										ton	MBh	MBh	cfm	°F	°F	gr/lb	°F	°F	gr/lb	Gross Total	Glass	Capacity	Coil Airflow	Ent	Lvg		
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							Floor	100									Floor	100						
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							Part	0									Part	0						
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0							Int Door	1									Int Door	1						
<i>Total</i>	0.0	0.0																ExFlr	0									ExFlr	0						
												Roof	0	0				0								Roof	0	0	0						
												Wall	186	100				54								Wall	186	100	54						
												Ext Door	0	0				0								Ext Door	0	0	0						
												Total		-3.4												Total		-3.4							

Room Checksums

By HENDERSON ENGINEERS

V301 Vestibule

COOLING COIL PEAK				CLG SPACE PEAK				HEATING COIL PEAK			TEMPERATURES					
Peaked at Time:		Mo/Hr: 0 / 0		Mo/Hr: 0 / 0		Mo/Hr: Heating Design					Cooling			Heating		
Outside Air:		OADB/WB/HR: 0 / 0 / 0		OADB: 0		OADB: 0					SADB			Ra Plenum		
Space Sens. + Lat.	Plenum Sens. + Lat.	Net Total	Percent Of Total (%)	Space Sensible	Percent Of Total (%)	Space Peak	Coil Peak	Percent Of Total	Space Sens	Tot Sens	Percent Of Total	Return	Ret/OA	Fn MtrTD	Fn BldTD	Fn Frict
Btu/h	Btu/h	Btu/h	(%)	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	(%)	Btu/h	Btu/h	Btu/h	Btu/h	Btu/h
Envelope Loads				Envelope Loads												
Skylite Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Skylite Cond	0	0	0	0	0	0	0	0.00	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Roof Cond	0	0	0	0	0	0	-212	8.62	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Glass Solar	0	0	0	0	0	0	0	0.00	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Glass/Door Cond	0	0	0	0	0	-2,177	-2,177	88.42	-2,177	-2,177	88.42	0.0	0.0	0.0	0.0	0.0
Wall Cond	0	0	0	0	0	-157	-161	6.52	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Partition/Door	0	0	0	0	0	0	0	0.00	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Floor	0	0	0	0.00	0	0	0	0.00	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Adjacent Floor	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.0	0.0	0.0	0.0	0.0
Infiltration	0	0	0	0	0	0	0	0.00	0	0	0.00	0.0	0.0	0.0	0.0	0.0
<i>Sub Total ==></i>	0	0	0	0	0	-2,334	-2,550	103.56	0	0	0.00	0.0	0.0	0.0	0.0	0.0
Internal Loads				Internal Loads												
Lights	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
People	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Misc	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
<i>Sub Total ==></i>	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Ceiling Load	0	0	0	0	0	-128	0	0.00	0	0	0.00	0	0	0	0	0
Ventilation Load	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Adj Air Trans Heat	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Dehumid. Ov Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Ov/Undr Sizing	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Exhaust Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Sup. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Ret. Fan Heat	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Duct Heat Pkup	0	0	0	0	0	0	88	-3.56	0	0	0.00	0	0	0	0	0
Underflr Sup Ht Pkup	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Supply Air Leakage	0	0	0	0	0	0	0	0.00	0	0	0.00	0	0	0	0	0
Grand Total ==>	0	0	0	100.00	0	100.00	-2,463	-2,463	100.00	0	0	0.0	0.0	0.0	0.0	0.0

AIRFLOWS		
	Cooling	Heating
Diffuser	0	41
Terminal	0	41
Main Fan	0	41
Sec Fan	0	0
Nom Vent	0	0
AHU Vent	0	0
Infil	0	0
MinStop/Rh	0	0
Return	0	41
Exhaust	0	0
Rm Exh	0	0
Auxiliary	0	0
Leakage Dwn	0	0
Leakage Ups	0	0

ENGINEERING CKS		
	Cooling	Heating
% OA	0.0	0.0
cfm/ft²	0.00	0.41
cfm/ton	0.00	
ft²/ton	0.00	
Btu/hr-ft²	0.00	-24.63
No. People	0.0	0.0/1000 ft²

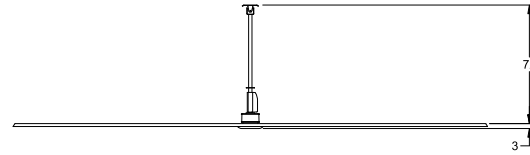
COOLING COIL SELECTION										
	Total Capacity		Sens Cap. MBh	Coil Airflow cfm	Enter DB/WB/HR			Leave DB/WB/HR		
	ton	MBh			°F	°F	gr/lb	°F	°F	gr/lb
Main Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Aux Clg	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Opt Vent	0.0	0.0	0.0	0	0.0	0.0	0.0	0.0	0.0	0.0
Total	0.0	0.0								

AREAS			
	Gross Total	Glass	
		ft²	(%)
Floor	100		
Part	0		
Int Door	1		
ExFlr	0		
Roof	100	0	0
Wall	108	72	67
Ext Door	0	0	0

HEATING COIL SELECTION				
	Capacity MBh	Coil Airflow cfm	Ent °F	Lvg °F
Aux Htg	0.0	0	0.0	0.0
Preheat	0.0	0	0.0	0.0
Humidif	0.0	0	0.0	0.0
Opt Vent	0.0	0	0.0	0.0
Total	-2.5			

Model: DS-6-24-170HV

High Volume, Low Speed Ceiling Fan



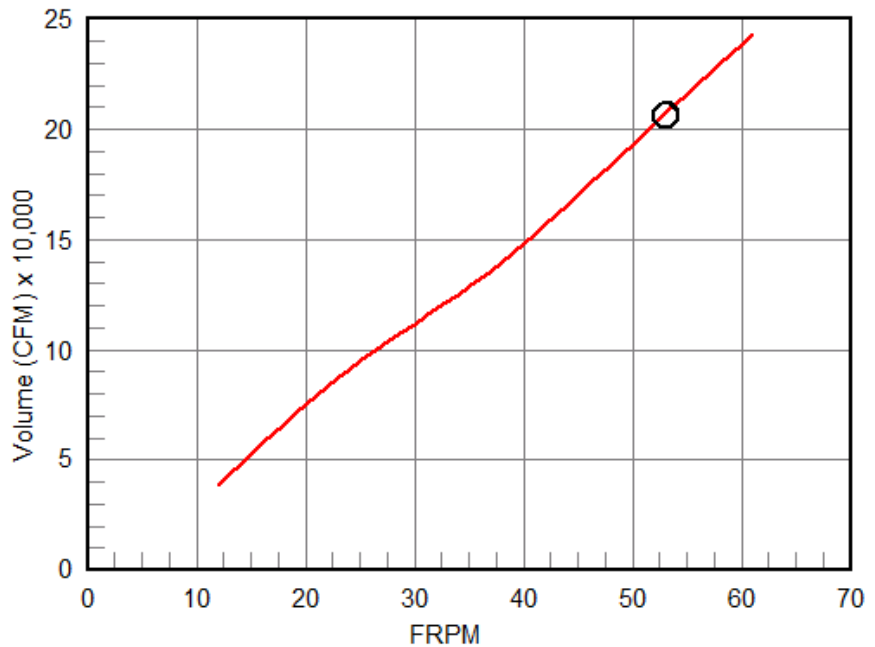
Dimensional	
Impeller Diameter (ft)	24
Impeller Diameter (in.)	288
Quantity	8
Weight w/o Acc's (lb)	119
Weight w/ Acc's (lb)	264


Installation Clearances	
Minimum Fan Spacing (ft)	72
Clearance to Wall (ft)	36
Blade Tip Clearance (ft)	3
Vertical Blade Clearance (ft)	3
Standby Blade Deflection (in.)	3.7

Performance Per Fan	
*Tested Direction of Operation	Forward
Actual Volume (CFM)	206,733
Coverage Area (ft ²)	9,750
Max Coverage Area (ft ²)	9,750
Avg. Air Speed (ft/min)	340
Max Avg. Air Speed (ft/min)	392
Fan RPM	53
Max Fan RPM	61
**Integrated Efficiency (CFM/W)	249
Total Sound Pressure (dBA)	47

Fan Operation	
Direction of Operation Capability	Forward or Reverse
Communication Protocol	Modbus RTU

Motor	
Size (W)	1,100
Voltage/Cycle/Phase	460/60/3
Enclosure	IP54
Max Motor RPM	61
***System FLA (Amps)	3.5
**Standby Power (W)	11
**Input Power (W)	1,016



 Operating point
Fan curve

Notes:

All dimensions shown are in units of in. (unless specified otherwise)

Dimensions shown may vary with fan speed. Consult installation manual for clearance requirements.
dBA – A weighted sound pressure level measured 5 ft off the ground at 20 ft from the center of the fan – dBA levels are not licensed by AMCA International

*Cataloged performance data tested using forward direction of operation per 10 CFR Part 430.

**Based on 208/60/3 testing per 10 CFR 430

***FLA is based on worst case system voltage and phase combination



Model: DS-6-24-170HV

High Volume, Low Speed Ceiling Fan

Standard Construction Features:

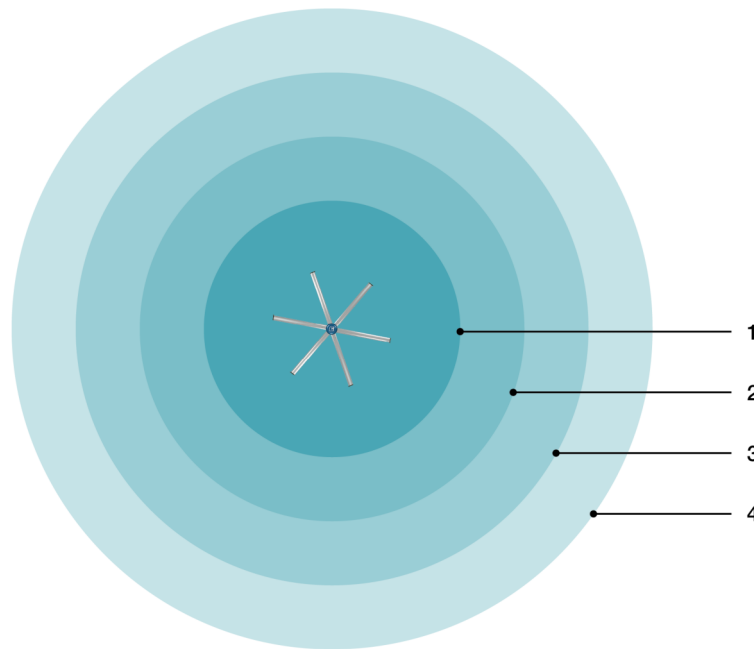
Heavy duty frame with protective finish - Extruded aluminum airfoils - High efficiency direct drive motor designed for either forward or reverse operation - Factory mounted and wired variable frequency drive - Factory installed plug and play wiring - Universal ceiling mount - Heavy duty safety restraint cable - Airfoil and fan hub retaining systems - AMCA certified for Circulating Fan Performance

Selected Options & Accessories:

6 Blade, Extruded Aluminum Airfoil Kit
Mill Finish, No Color
Aluminum Winglet; Hi-Pro Polyester Finish, Flat Black (044) Color
I-Beam Mounting Kit; Hi-Pro Polyester Finish, Flat Black (044) Color
6 ft Drop Length; Hi-Pro Polyester Finish, Flat Black (044) Color
Hub Plate and Impeller Hub; Hi-Pro Polyester Finish, Flat Black (044) Color
No Hub Plate Decal
Power Wiring Pigtail, Internal, General, 3 ft of Flexible Power Cord from Unit, Unstripped Wire
Plug-and-Play Network Communication Wiring Pigtail, Internal, Terminated with Shielded CAT-5e Splitter (RJ45 Ports)
200 ft of Shielded, Twisted Pair (STP) CAT-5e Control Cable
Fire Alarm Wiring Pigtail, Internal, 6 ft from Unit, Terminated with Crimp Connector
Low-Voltage (24VDC/VAC or 115VAC), Normally Closed Electromechanical Fire Alarm Relay
Braided Galvanized Steel Safety Cable, 14 ft from Unit
Braided Galvanized Steel Guy Wires, 20 ft from Unit
Cable Clamp Hardware for Safety Cable and Guy Wires
Switch, NEMA-3R, Toggle, Shipped with Unit
Electrical Warranty: 1 Yr (Standard)
Mechanical Warranty: 10 Yrs (Standard)

Model: DS-6-24-170HV
High Volume, Low Speed Ceiling Fan

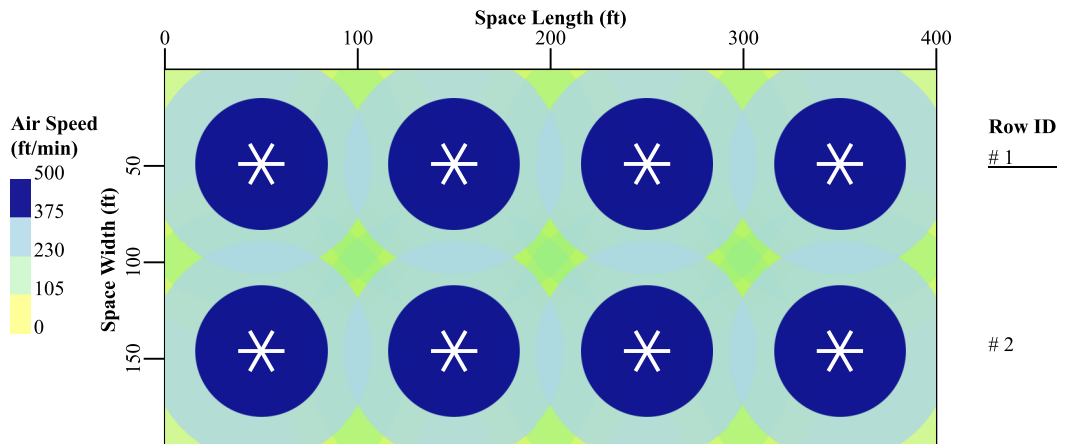
Fan Coverage Data



	Fan Speed (RPM)	Zone 1 375+ FPM Air Speed Radius (ft)	Zone 2 230+ FPM Air Speed Radius (ft)	Zone 3 105+ FPM Air Speed Radius (ft)	Zone 4 <105 FPM Air Speed Radius (ft)	Recommended Coverage Radius Per Fan (ft)
Selected	53	34	57	77	93	56
Maximum	61	42	62	79	94	87

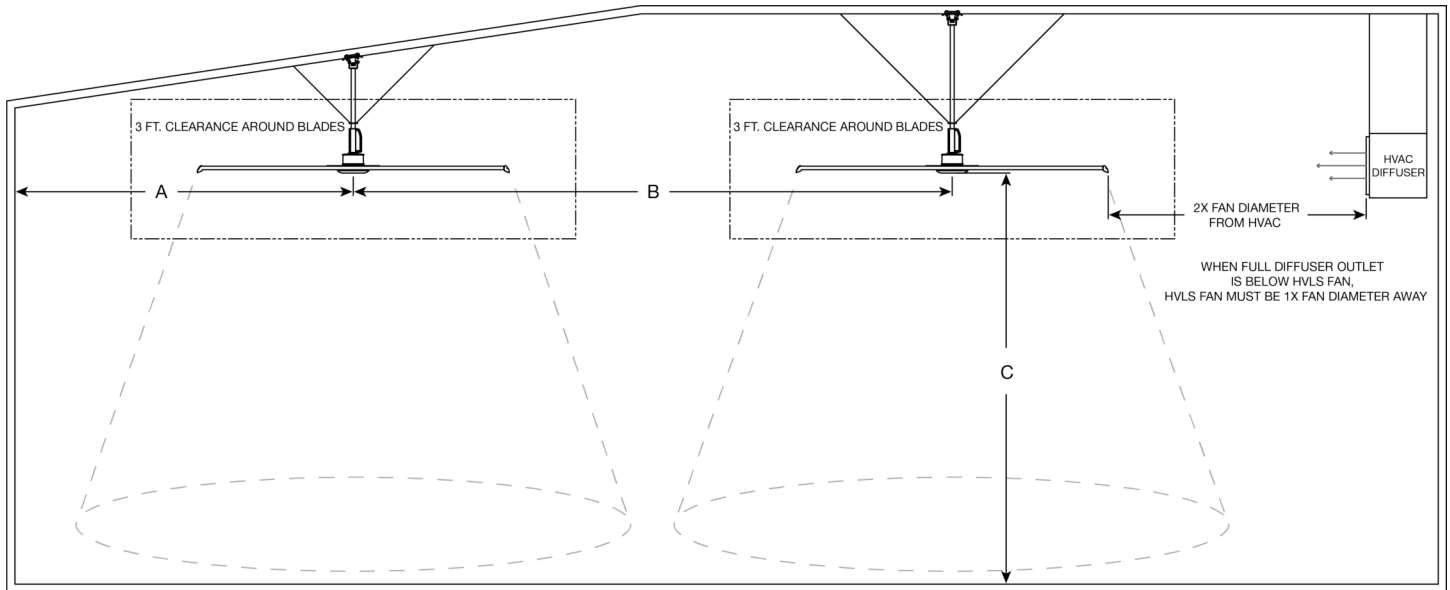
Model: DS-6-24-170HV
High Volume, Low Speed Ceiling Fan

Recommended Layout



Model: DS-6-24-170HV
High Volume, Low Speed Ceiling Fan

Fan Spacing & Clearances

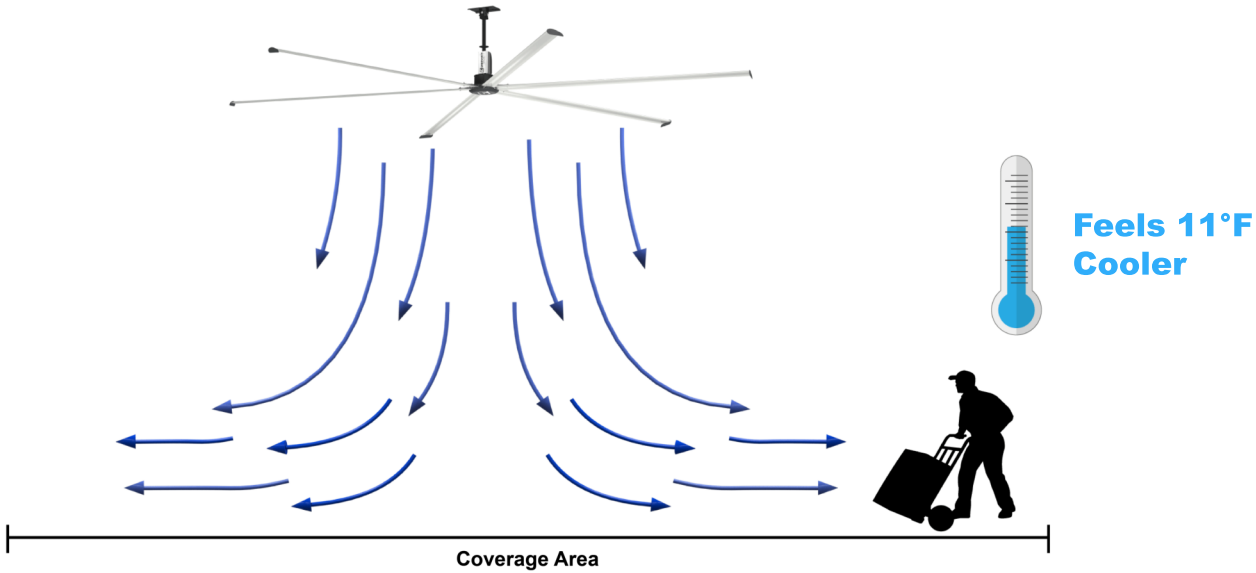


	A - Clearance to Wall (ft)	B - Fan Spacing (ft)	C - Clearance to Floor (ft)
Minimum	36	72	10

Additional Requirements

- For NFPA 13 compliance in buildings equipped with sprinklers:
 - Fan must be centered approximately between four adjacent sprinklers
 - Vertical clearance from fan to sprinkler deflector must be a minimum of 3 ft (36 in.)
 - Fan must be interlocked to shut down immediately upon a waterflow alarm from the building's fire alarm system
 - Interlock with building's fire alarm system shall be in accordance with the requirements of NFPA 72
- Avoid installing fan directly below a light source to prevent a strobing effect that can be caused by fan rotation

Perceived Cooling Effect



Perceived Cooling Effect Based on ASHRAE 55-2017

Coverage Area Per Fan (ft ²)	Operative Temp. (F)	Relative Humidity (%)	Metabolic Rate	Clothing Level	Avg. Air Speed (ft/min)	Perceived Cooling Effect (F)
9,750	77	60	1.7 Walking	0.57 Pants, Short Sleeves	340	11

Model: DS-6-24-170HV

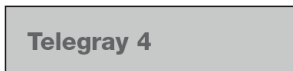
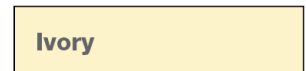
Finish Selection

Selected Frame Finish	
Finish Type	Hi-Pro Polyester
Mount Finish Color	Flat Black (044)
Downtube Finish Color	Flat Black (044)
Hub/Hub Plate Finish Color	Flat Black (044)
Winglet Finish Color	Flat Black (044)



Selected Airfoil Finish	
Finish Type	Mill
Finish Color	None

Available Finish Options (Additional Charges May Apply):

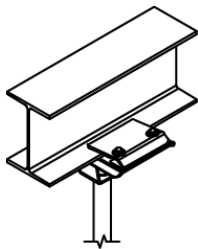


*Color is for reference only and is not to be used for final color matching. Wood grain finishes available on airfoils only. Anodized finishes not shown.

Model: DS-6-24-170HV
High Volume, Low Speed Ceiling Fan

Mechanical Installation Requirements

Selected Mounting Kit: I-Beam



⚠ IMPORTANT: HVLS fans must be mounted to building structure as shown in one of the mounting details on this page. Other mounting methods are not acceptable unless approved by Structural Engineer of Record (SEOR). For complete installation instructions, refer to the installation, operation and maintenance manual (IOM).

⚠ IMPORTANT: Failure to install the fan's safety retention cable and guy wires (if provided) will result in voiding of the fan warranty.

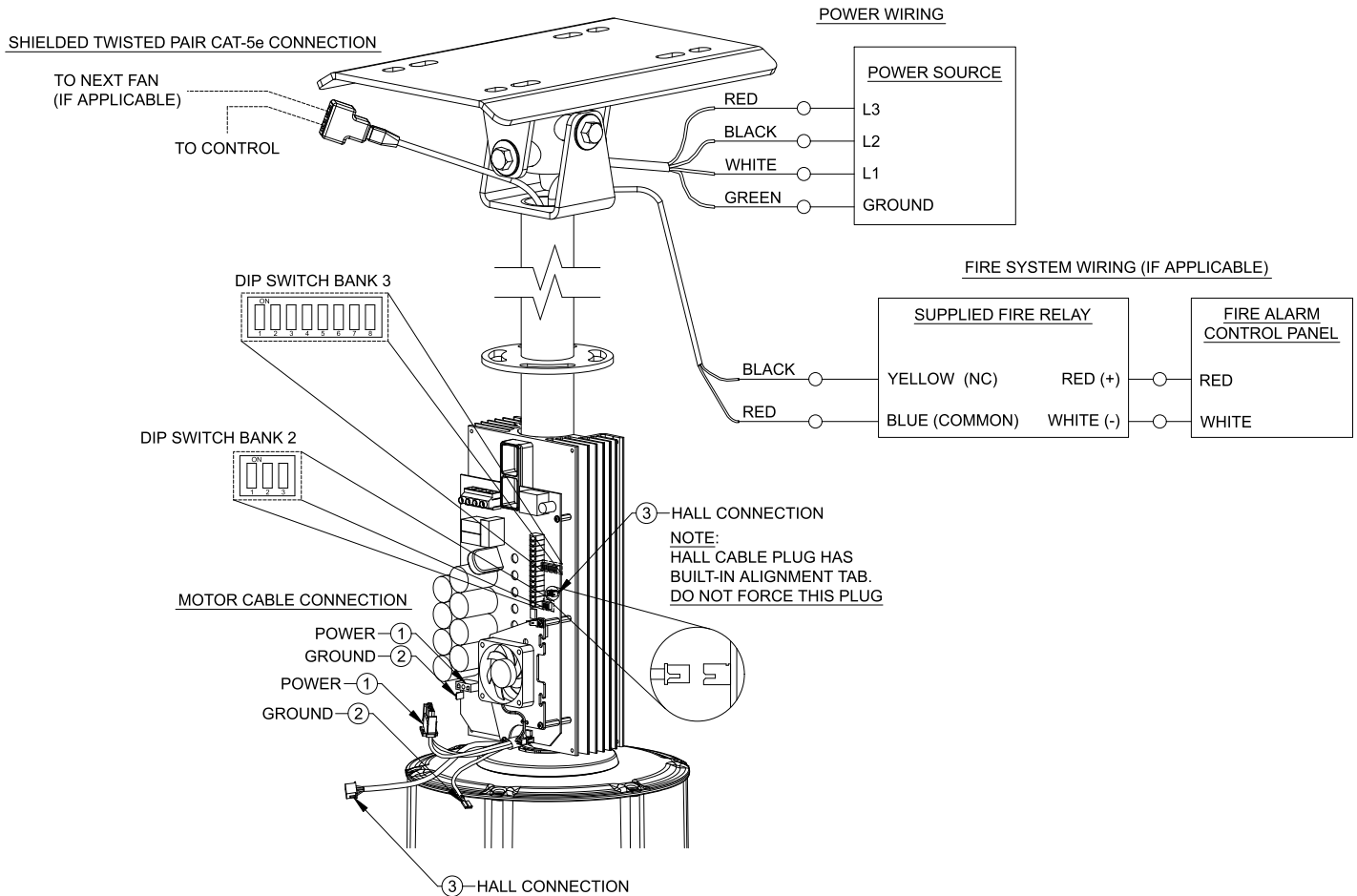
Available Mounting Kits (Additional Charges May Apply):

<p>UNISTRUT</p>	<p>Z-PURLIN</p>
<p>STEEL TRUSS</p>	<p>WOOD BEAM</p>

Model: DS-6-24-170HV
High Volume, Low Speed Ceiling Fan

Electrical Installation Requirements

⚠ IMPORTANT: HVLS fans must be installed with the supplied CAT-5e communication cable or shielded, twisted pair (STP) CAT-5e (by others) that complies with the following specifications. Cable must be twisted pair, shielded 26 ga. CAT-5e cable with a drain wire and must be compliant with ISO 11801. Cable must use shielded RJ45 connectors with a soldered drain and wiring configuration must follow EIA/TIA T568B wiring pinout. Individual CAT-5e cable lengths must not exceed 200 ft. in order to prevent network communication issues.



NOTE: If networking multiple HVLS fans to run using a single control source, additional wiring and network modification may be required. Please refer to the fans's installation, operation and maintenance manual (IOM)

Model: DS-6-24-170HV
 High Volume, Low Speed Ceiling Fan

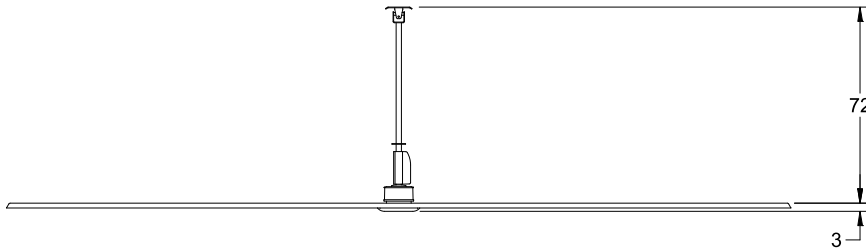
HVLS Fan Compliance

Department of Energy (DOE) 10 CFR Part 430 Compliance		
DOE Min. Efficiency (CFM/W)	Calculated Efficiency (CFM/W)	Compliance
232	249	Yes

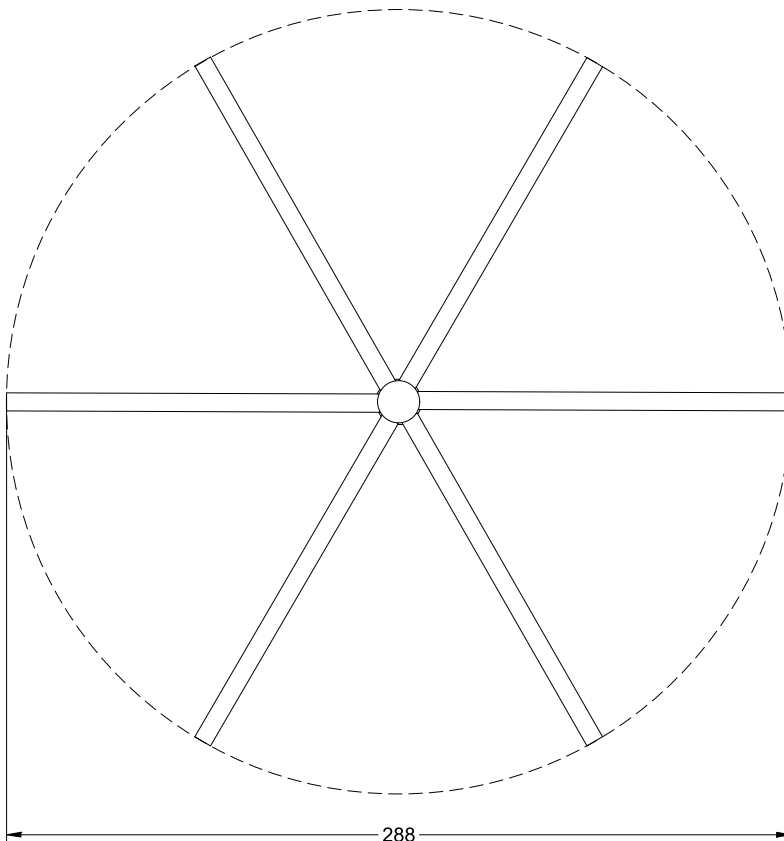
ASHRAE 55-2017 Compliance									
Operative Temp. (F)	Relative Humidity (%)	Metabolic Rate	Clothing Level	Avg. Air Speed (ft/min)	Perceived Cooling Effect (F)	Acceptable Predicted Mean Vote (PMV)	Calculated Predicted Mean Vote (PMV)	Thermal Sensation	Compliance
77	60	1.7 Walking	0.57 Pants, Short Sleeves	340	11	$-0.5 \leq PMV \leq 0.5$	-0.32	Neutral	Yes

Assembly Drawing

Type: High Volume, Low Speed Ceiling Fan



SIDE VIEW



BOTTOM VIEW

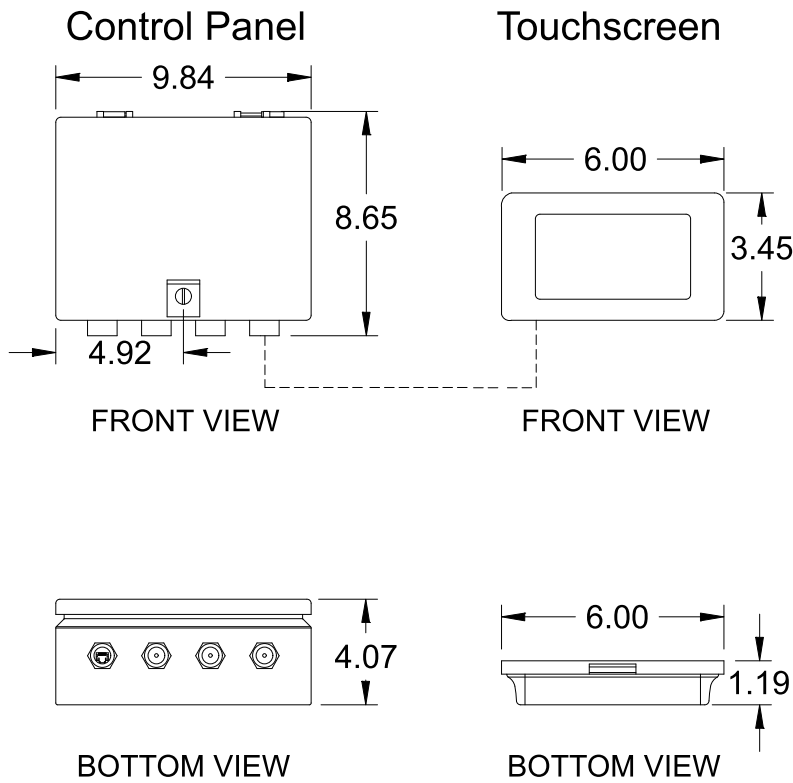
Notes: All dimensions shown are in units of in..

HVLS Fan Controls

Standard Construction Features:

HVLS fan controls are designed for use with Greenheck's high volume, low speed (HVLS) ceiling fan products. Each control is configured for communication with one or multiple HVLS fans via the included RJ45 connector.

- Control Type: Adv. Touchscreen
- Control Quantity: 1
- Fans Per Control: 10
- Installation Kit: Surface Mounted
- Control Enclosure: Touchscreen interface with IP30 enclosure and remotely-mounted control panel with IP65 enclosure
- Power Supply: Includes 115V power adapter for control panel; requires 115V power receptacle (by others)
Touchscreen interface powered by included communication cable
- Communications: Integrated BACnet MSTP to Modbus RTU Translation for Communication with HVLS Fan(s)
Includes 50 ft of Shielded Communication Cable Between Touchscreen Interface and Control Panel
- Fan Operation: Capable of Operating Up to 10 HVLS Fans with Any Combination of Models and Sizes
Fans Can Operate in Groups or Individually with Unique Speed Settings and Directions of Rotation

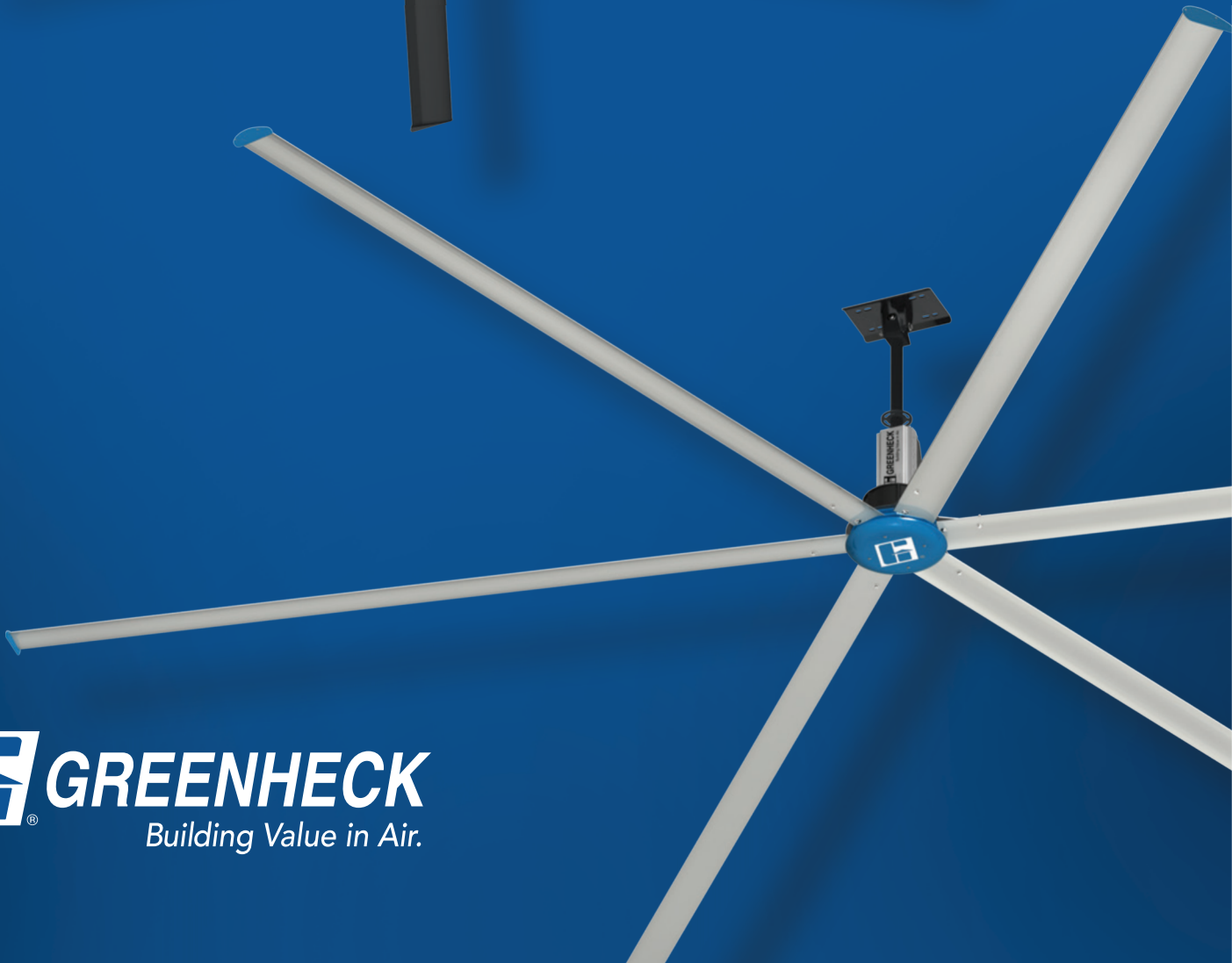
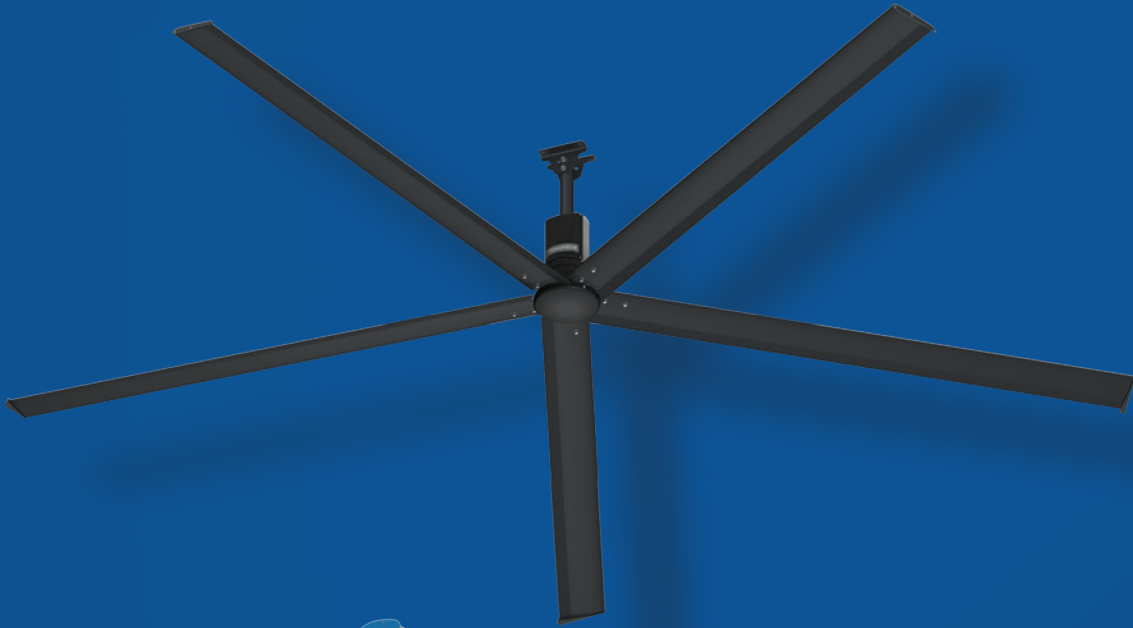


Notes: All dimensions shown are in units of in.

Disclaimer: This color chart is for reference only and is not to be used for final color matching. Shades may vary due to the color and resolution of your computer screen and/or your particular color printer output. Greenheck is not responsible or liable for color matches made with online color chart.

HVLS FANS

Finishes & Colors



 **GREENHECK**
Building Value in Air.



For Mount, Downtube, Hub Plate, Airfoil Blades and Winglets*



Safety Orange



Safety Yellow



Signal Violet



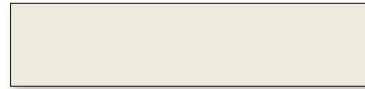
Utility Red



Signal Blue



Equipment Green



Bone White



Ivory



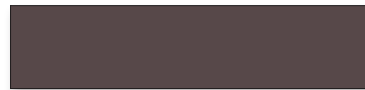
Telegray 4



Concrete Gray



Hampton Brown



Medium Bronze



Flat Black



Custom Color Match

**All colors are for reference only and not to be used for final color matching.*

Hi-Pro Polyester Finishes



Model DS-3

- Mount, Downtube, Airfoil Blades Utility Red
- Hub Plate and Winglets Flat Black

Woodgrain Finishes



Model DC-5
• Downtube, Hub Plate and Winglets Flat Black
• Airfoil Blades Cinnamon Cherry

For Airfoil Blades Only*



Cinnamon Cherry



Golden Knotty Pine



Natural Cherry



Dark Oak



Honey Knotty Pine

**All colors are for reference only and not to be used for final color matching.*

Anodize Finishes

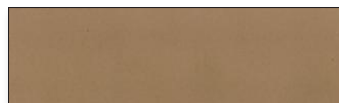


- Model DS-6**
- Mount, Downtube, Hub Plate and Winglets Flat Black
 - Airfoil Blades Champagne Anodize

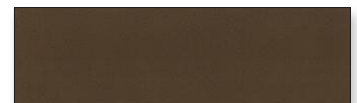
For Airfoil Blades Only*



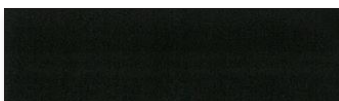
Clear Anodize



Champagne Anodize



Medium Bronze Anodize



Black Anodize

**All colors are for reference only and not to be used for final color matching.*

Configure the five features shown with custom colors to blend-in or stand-out in any facility.

1 Mount

Hi-Pro Polyester

2 Downtube

Hi-Pro Polyester

3 Hub Plate

Hi-Pro Polyester

4 Winglet

Hi-Pro Polyester

5 Airfoil Blades

*Hi-Pro Polyester,
Woodgrain or Anodize*



P.O. Box 410 | Schofield, WI 54476-0410 USA
Phone 715.359.6171 | Fax 715.355.2399 | greenheck.com

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2018 IPC FIXTURE LOADING

FIXTURE TYPE	QTY	D.F.U. (EA)	TOTAL D.F.U.	HOT S.F.U. (EA)	COLD S.F.U. (EA)	COMBINED S.F.U. (EA)	TOTAL S.F.U. (HOT)	TOTAL S.F.U. (COLD)	TOTAL SERVICE S.F.U.
BATHROOM GROUP (1.6 GPF FLUSH TANK)		5.0	0.0	1.50	2.70	3.60	0	0	0.0
BATHROOM GROUP (3.5 GPF FLUSH TANK)		6.0	0.0	3.00	6.00	8.00	0	0	0.0
BATHTUB (PRIVATE)		2.0	0.0	1.00	1.00	1.40	0	0	0.0
BIDET		1.0	0.0	1.50	1.50	2.00	0	0	0.0
PRIVATE CLOTHES WASHER RESIDENTIAL		2.0	0.0	1.00	1.00	1.40	0	0	0.0
PUBLIC CLOTHES WASHER RESIDENTIAL		3.0	0.0	3.00	3.00	4.00	0	0	0.0
CLINICAL SERVICE SINK		6.0	0.0	1.50	8.00	8.00	0	0	0.0
DISHWASHER (RESIDENTIAL)	1	2.0	2.0	1.40	0.00	1.40	1.4	0	1.4
DRINKING FOUNTAIN	2	0.5	1.0	0.00	0.25	0.25	0	0.5	0.5
PRIVATE SINK (BAR, KITCHEN OR BREAKROOM)		2.0	0.0	1.00	1.00	1.40	0	0	0.0
PUBLIC SINK (KITCHEN OR BREAKROOM)		2.0	0.0	3.00	3.00	4.00	0	0	0.0
SINK (FLUSHING RIM)		6.0	0.0	3.00	3.00	4.00	0	0	0.0
SINK (WASH FOUNTAIN PER HEAD)	1	2.0	2.0	1.00	1.00	1.40	1	1	1.4
PRIVATE LAVATORY		1.0	0.0	0.50	0.50	0.70	0	0	0.0
PUBLIC LAVATORY	13	1.0	13.0	1.50	1.50	2.00	19.5	19.5	26.0
SERVICE SINK (MOP BASIN)	2	3.0	6.0	2.25	2.25	3.00	4.5	4.5	6.0
PRIVATE LAUNDRY TUB		2.0	0.0	2.00	2.00	3.00	0	0	0.0
FLOOR DRAIN		2.0	0.0	0.00	0.00	0.00	0	0	0.0
SHOWER (PUBLIC - EACH HEAD)		2.0	0.0	3.00	3.00	4.00	0	0	0.0
SHOWER (PRIVATE- ONE HEAD)		2.0	0.0	1.00	1.00	1.40	0	0	0.0
URINAL (1.0 GPF)	9	2.0	18.0	0.00	5.00	5.00	0	45	45.0
URINAL (0.125 GPF)		2.0	0.0	0.00	2.00	2.00	0	0	0.0
URINAL (WATERLESS)		0.5	0.0	0.00	0.00	0.00	0	0	0.0
WALL HYDRANT -EXTERIOR	7	0.0	0.0	0.00	5.00	5.00	0	35	35.0
WALL HYDRANT - NON-FREEZE INTERIOR	12	0.0	0.0	0.00	5.00	5.00	0	60	60.0
PRIVATE / PUBLIC WC (1.6 GPF FLUSH TANK)		4.0	0.0	0.00	2.00	2.00	0	0	0.0
PRIVATE WATER CLOSET (1.6 GPF FLUSH TANK)		3.0	0.0	0.00	2.20	2.20	0	0	0.0
PUBLIC WATER CLOSET (1.6 GPF FLUSH TANK)		4.0	0.0	0.00	5.00	5.00	0	0	0.0
PRIVATE WATER CLOSET (1.6 GPF FLUSH VALVE)		3.0	0.0	0.00	6.00	6.00	0	0	0.0
PUBLIC WATER CLOSET (1.6 GPF FLUSH VALVE)	18	4.0	72.0	0.00	10.00	10.00	0	180	180.0
PUBLIC WATER CLOSET (3.5 GPF FLUSH VALVE)		6.0	0.0	0.00	10.00	10.00	0	0	0.0
MISC. CONTINUOUS FLOW (GPM)		0.13	0.0	0.00	0.13	0.13	0	0	0.0
SPECIALTY KITCHEN EQUIP.									
COMMERCIAL WASHER EXTRACTOR		6.0	0.0	7.50	7.50	10.00	0	0	0.0
DISPOSER (2" TRAP)		3.0	0.0	0.00	2.00	2.00	0	0	0.0
DISPOSER (3" TRAP)		5.0	0.0	0.00	2.00	2.00	0	0	0.0
PRE-SCRAPPER		2.0	0.0	1.50	1.50	2.00	0	0	0.0
SINK (BAR) (1-1/2" IW)		2.0	0.0	1.50	1.50	2.00	0	0	0.0
SINK (DUMP) (1-1/2" IW)		2.0	0.0	1.50	1.50	2.00	0	0	0.0
SINK (HAND) (1-1/2" IW)		2.0	0.0	1.50	1.50	2.00	0	0	0.0
SINK (PREP / VEGGIE) (2" IW)		3.0	0.0	1.50	1.50	2.00	0	0	0.0
SINK (2 COMPARTMENT) (2" IW)		3.0	0.0	1.50	1.50	2.00	0	0	0.0
SINK (3 COMPARTMENT) (2" IW)		3.0	0.0	3.00	3.00	4.00	0	0	0.0
DISHWASHER (RESTAURANT) (2" IW)		3.0	0.0	2.00	0.00	2.00	0	0	0.0
ICE MACHINE (3/4" IW)	2	0.5	1.0	0.00	1.00	1.00	0	2	2.0
COFFEE MAKER (3/4" IW)		0.5	0.0	0.00	0.50	0.50	0	0	0.0
TEA MAKER (3/4" IW)		0.5	0.0	0.00	0.50	0.50	0	0	0.0
CAPPUCCINO MACHINE (3/4" IW)		0.5	0.0	0.00	0.50	0.50	0	0	0.0
KETTLE (2" IW)		3.0	0.0	1.50	1.50	2.00	0	0	0.0
CARBONATOR		0.5	0.0	0.00	0.50	0.50	0	0	0.0
HOT FOOD TABLE (3/4" IW)		0.5	0.0	0.75	0.75	1.00	0	0	0.0
DIPPER WELL (3/4" IW)		0.5	0.0	0.00	0.75	0.75	0	0	0.0
TOTAL UNITS:	67		115.0				26.4	347.5	357.3

PLUMBING FIXTURES AND EQUIPMENT

University of Missouri
Indoor Practice Facility
Columbia, Missouri

HEI #2050004521

Plumbing fixtures selected are preliminary basis of design
and may be revised to accommodate future requirements.

100% Construction Documents

June 22, 2021



Job Name _____
 Job Location _____
 Engineer _____
 Approval _____

Contractor _____
 Approval _____
 Contractor's P.O. No. _____
 Representative _____

LEAD FREE*

Series LF719 Double Check Valve Assemblies

Sizes: 1/2" – 2" (15 – 50mm)

Series LF719 Double Check Valve Assemblies are designed to protect drinking water supplies from dangerous cross-connections in accordance with national plumbing codes and water authority requirements.

This series may be used in only those cross-connections identified by local inspection authorities as non-health hazard applications. Check with local authority having jurisdiction regarding vertical orientation, frequency of testing or other installation requirements. The LF719 features Lead Free* construction to comply with Lead Free* installation requirements. Series LF719 meets the requirements of ASSE Std. 1015 and AWWA Std. C510.

Features

- Manufactured from Lead Free* cast copper silicon alloy
- Separate access, top entry check valve design
- Reversible seat disc rubber, extends check valve life
- Chloramine resistant elastomers
- Replaceable seats and seat discs
- Compact design
- Top mounted screwdriver slotted ball valve test cocks
- Low pressure drop
- 1/2" – 1" (15 – 25mm) have Tee handles
- No special tools required for servicing
- Plastic on plastic check guiding reduces potential binding due to mineral deposits

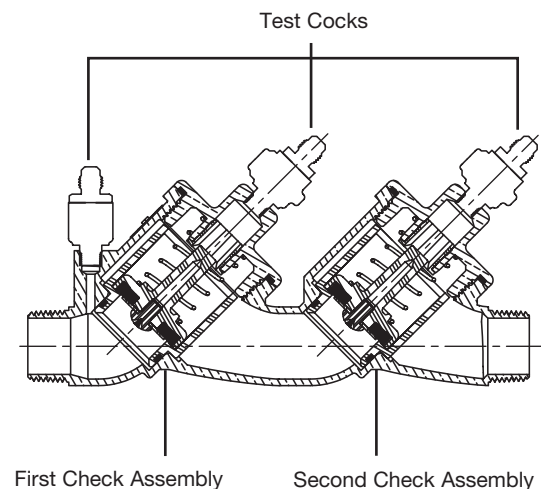
Specifications

Series LF719 Double Check Valve Assembly shall be installed at each noted location. Provide assembly with integral shutoff valves that conform to ASSE 1015 and AWWA C510. The assembly shall have top entry access points for each check assembly, screw driver slotted test cocks and require the use of no special tools for servicing. All wetted rubber parts shall be manufactured from silicone or chloramine resistant EPDM rubber. The Lead Free* Double Check Valve Assemblies shall comply with state codes and standards, where applicable, requiring reduced lead content. All valve seats and seat discs shall be replaceable. Seat discs shall be reversible to extend check valve life. Check valve guiding shall be plastic to plastic. The assembly shall be a Watts Series LF719.

Watts product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.



LF719QT



**Now Available
WattsBox Insulated Enclosures.**

For more information, refer to literature ES-WB.

NOTICE

Inquire with governing authorities for local installation requirements

NOTICE

The information contained herein is not intended to replace the full product installation and safety information available or the experience of a trained product installer. You are required to thoroughly read all installation instructions and product safety information before beginning the installation of this product.

***The wetted surface of this product contacted by consumable water contains less than 0.25% of lead by weight.**

WATTS®

Available Models

Suffix:

- S – bronze strainer
- QT – quarter-turn ball valves

Pressure-Temperature

Operating Pressure: 175psi (12.1 bar)

Operating Temperature Range: 33°F – 180°F (0.5°C – 82°C)

Materials

- Body: Lead Free* cast copper silicon alloy
- Elastomers: Chloramine resistant silicone and EPDM
- Check Seats: PPO
- Disc Holders: PPO

Standards

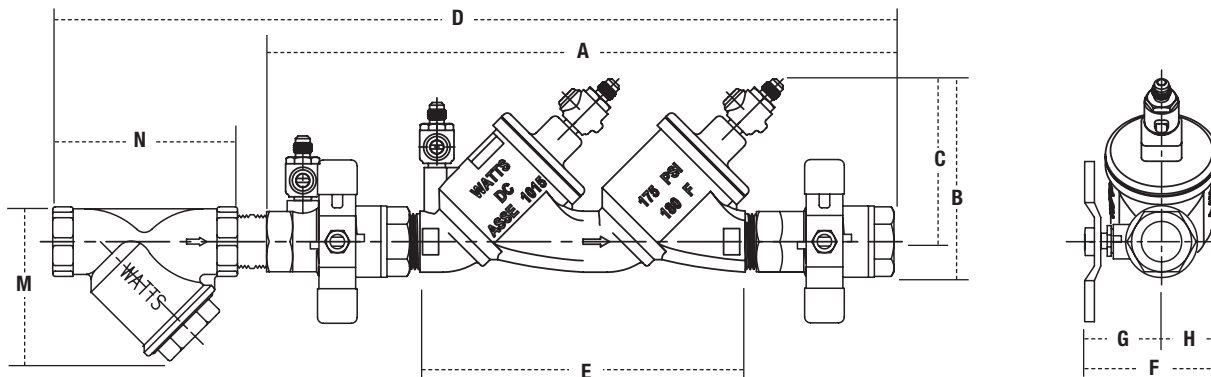
AWWA Std C510 compliant

Approvals



Approved by the Foundation for Cross-Connection Control and Hydraulic Research at the University of Southern California

Dimensions/Weights

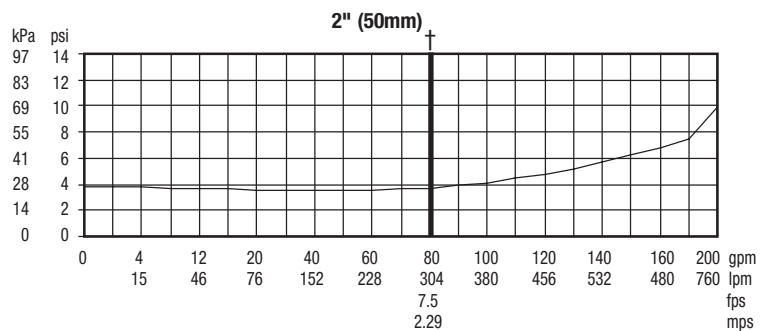
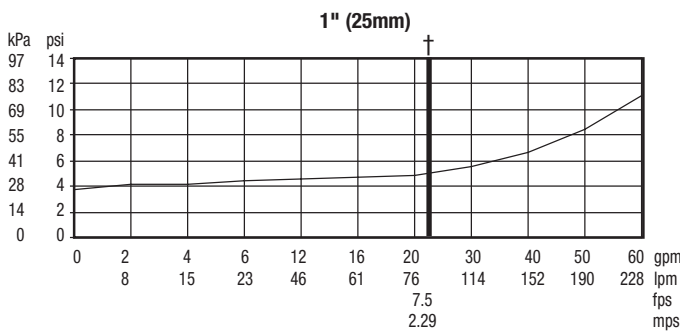
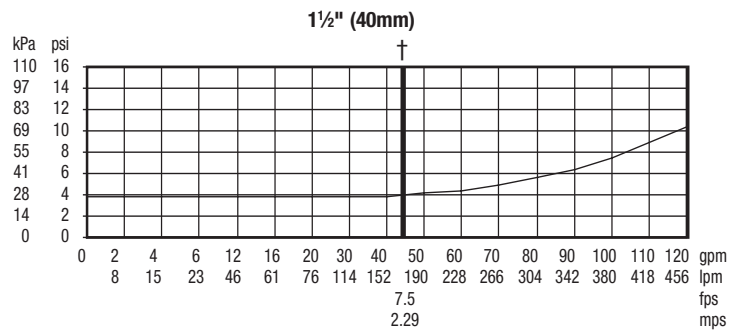
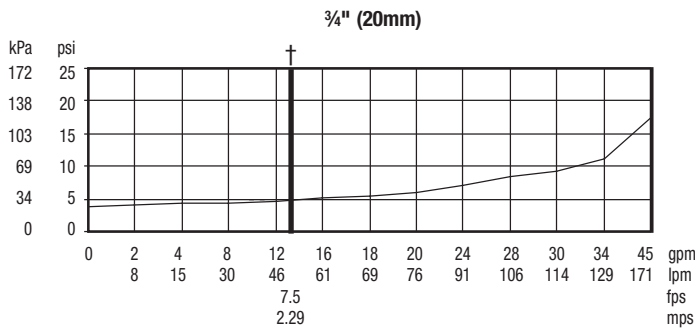
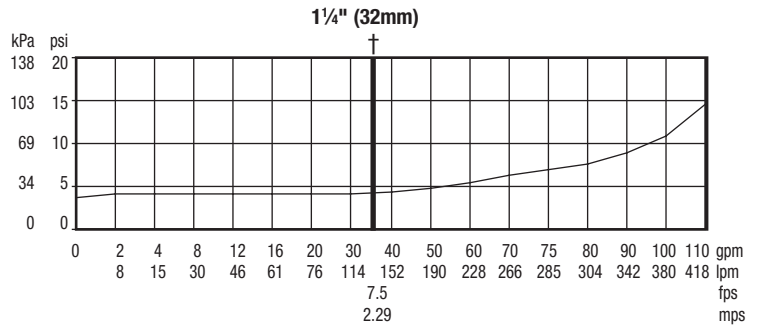
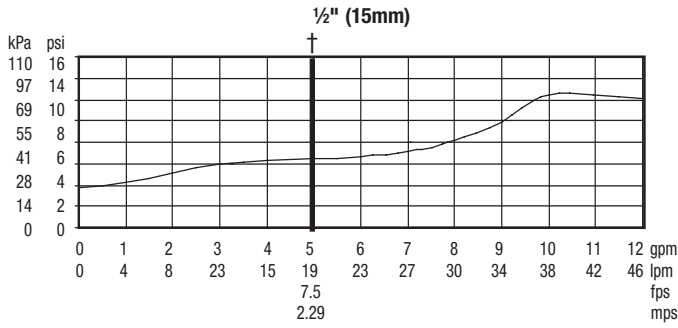
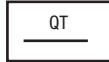


LF719QT, LF719QT-S

SIZE (DN)		DIMENSIONS										STRAINER		WEIGHT											
in.	mm	A	B	C	D	E(LF)	F	G	H	M	N	719QT	719QT-S												
in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.	lbs.	kgs.										
1/2	15	9 ⁹ / ₁₆	242	3 ¹¹ / ₁₆	94	2 ¹⁵ / ₁₆	73	12 ⁹ / ₁₆	318	5 ¹³ / ₁₆	147	2 ⁷ / ₁₆	62	1 ¹¹ / ₁₆	43	3/4	19	1 ³ / ₈	35	2 ³ / ₄	70	2.8	1.3	3.8	1.7
3/4	20	12 ¹ / ₈	307	4 ¹ / ₄	108	3 ¹ / ₂	88	15 ⁷ / ₁₆	393	7 ¹¹ / ₁₆	195	3 ¹ / ₈	79	2 ¹ / ₁₆	52	1 ¹ / ₁₆	27	1 ⁵ / ₈	41	3 ³ / ₁₆	81	4.7	2.1	6.4	2.9
1	25	14 ¹³ / ₁₆	376	4 ⁹ / ₁₆	116	3 ⁷ / ₈	98	19 ¹ / ₂	495	9 ⁵ / ₈	244	3 ³ / ₄	95	2 ⁷ / ₁₆	62	1 ⁵ / ₁₆	33	2 ¹ / ₈	54	3 ³ / ₄	95	7.4	3.4	9.4	4.3
1 1/4	32	18 ¹⁵ / ₁₆	480	6 ¹ / ₈	156	5 ¹ / ₈	129	24 ¹ / ₁₆	610	11 ¹¹ / ₁₆	297	4 ¹ / ₄	108	2 ⁵ / ₈	67	1 ⁵ / ₈	41	2 ¹ / ₂	64	4 ⁷ / ₁₆	113	14.0	6.3	18.0	8.1
1 1/2	40	18 ¹⁵ / ₁₆	480	6 ¹ / ₈	156	5 ¹ / ₈	129	25 ¹ / ₄	640	11 ¹¹ / ₁₆	297	4 ³ / ₄	121	3 ¹ / ₈	79	1 ⁵ / ₈	41	3	76	4 ⁷ / ₈	124	16.1	7.3	19.9	9.0
2	50	21 ³ / ₁₆	538	7 ¹ / ₁₆	179	5 ⁵ / ₈	142	28 ¹⁵ / ₁₆	735	13 ³ / ₈	340	5 ³ / ₈	137	3 ⁷ / ₁₆	87	1 ¹⁵ / ₁₆	49	3 ⁹ / ₁₆	90	5 ¹⁵ / ₁₆	151	25.7	11.6	33.4	15.2

Capacities

† Typical maximum flow rate (7.5 feet/sec.)



USA: T: (978) 689-6066 • F: (978) 975-8350 • Watts.com
 Canada: T: (905) 332-4090 • F: (905) 332-7068 • Watts.ca
 Latin America: T: (52) 81-1001-8600 • Watts.com

J
DRAWING NUMBER S1770
SIZE A
SCALE: NONE
DATE: 2-25-85
APPROVED BY: JD
CHECKED BY: JD
DRAWN BY: CR
FIGURE NUMBER 1770

WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA
DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

SMITH® JAY R. SMITH MFG. CO.®
MEMBER OF MORRIS GROUP INTERNATIONAL
POST OFFICE BOX 3237
MONTGOMERY, ALABAMA 36109-0237 (USA)
TEL: 334-277-8520 FAX: 334-272-7396 www.jrsmith.com

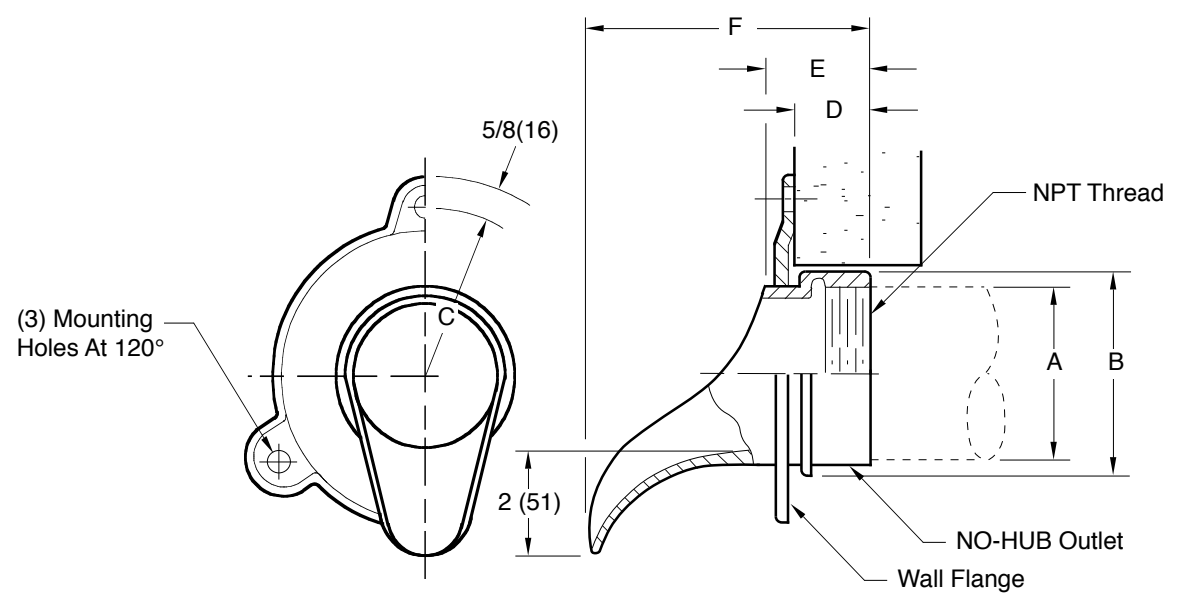


LOCATION
DSN

ROOF ACCESSORY

DOWNSPOUT NOZZLE

FUNCTION: Used as a parapet overflow or at the base of a wall where a concealed leader discharges rainwater to ground. Nozzle design diverts water away from building, eliminating wall stains. Wall flange covers rough opening and serves as anchor.



NOTE: For ADA Compliant See Fig. 1770-ADA

- Fig. 1770T.....Threaded Outlet
- Fig. 1770Y.....NO-HUB Outlet 02(50), 03(75), 04(100) and 06(150)

	*				*				*		
A=PIPE	02(50)	03(75)	04(100)	05(125)	06T(150)	06Y(150)	08(200)	10(255)	12(305)		
B=DIA	2 3/4 (70)	4 (100)	5 (125)	6 (150)	7 1/4 (185)	7 1/4 (185)	9 1/4 (235)	11 1/8 (283)	13 1/4 (335)		
C=RAD	2 3/4 (70)	3 1/2 (89)	3 7/8 (98)	4 3/8 (111)	5 (125)	5 (125)	5 7/8 (149)	7 1/4 (185)	8 (205)		
D	1 3/8 (35)	1 3/8 (35)	1 3/8 (35)	1 3/8 (35)	1 3/8 (35)	1 13/16 (46)	1 5/8 (41)	1 3/4 (44)	2 (51)		
E	2 1/16 (52)	2 1/16 (52)	2 1/16 (52)	2 1/16 (52)	2 1/16 (52)	2 1/2 (64)	2 3/8 (60)	2 3/4 (70)	2 15/16 (75)		
F	5 5/8 (143)	5 5/8 (143)	5 5/8 (143)	5 5/8 (143)	5 5/8 (143)	6 1/4 (160)	5 15/16 (149)	5 3/8 (138)	7 9/16 (192)		

REGULARLY FURNISHED:
Cast Bronze Nozzle and Flange.

- VARIATIONS:**
- Bird Screen -BS
 - * NO-HUB Adaptor (specify Fig. 2646Y)
[5"(125), 8"(200), 10"(255) and 12"(305) only]

- OPTIONAL MATERIALS:**
- Nickel Bronze -NB
 - Polished Bronze -PB
 - Chrome Plated -CP

NOTE: Dimensions shown in parentheses are in millimeters.

J	10-18-18	Added Note ADA Compliant	TBW	CL	WEIGHT POUNDS	VOLUME CUBIC FEET	FIGURE NUMBER 1770
H	5-26-16	Rev. Optional Materials	TBW	TK			
G	01/14/11	Added NO-HUB Outlet	JJ	TK			
F	6-16-05	Revised Table	RN	CL			
REV.	DATE	DESCRIPTION	BY	CKD. BY			



**general
rubber**

800-233-6294

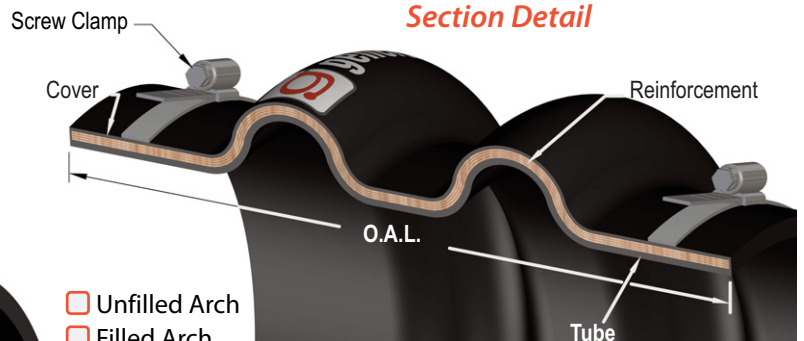
Customer: _____ Date: _____

Job/Project: _____

Ref/Tag: _____

Style 8102 Rubber Slip-On Sleeve

Sizes 1 1/2" [DN40] - 12" [DN300] | 8102-0000-3.16


 Unfilled Arch

 Filled Arch
 (reduce movements by 50%,
 increase spring rates by 400%)


	Pure Gum	Neoprene	Butyl	Nitrile (Buna-N)	EPDM	Viton® (FKM)
Tube	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Cover	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Tire Cord:	° F [° C]	° F [° C]	° F [° C]	° F [° C]	° F [° C]	° F [° C]
<input type="checkbox"/> Polyester	180 [82]	225 [107]	250 [121]	210 [99]	250 [121]	250 [121]
<input type="checkbox"/> Kevlar®	180 [82]	225 [107]	300 [149]	210 [99]	350 [177]	400 [204]

Maximum Temperature rating based on lowest temperature material selected. EPDM or Butyl w/Polyester Tire Cord rated 300°F (149°C) for Air Service up to 25 psig (1.7 barg)

Bill of Materials

ITEM	MATERIAL	FINISH
Screw Clamps	Stainless Steel	Plain
Textile Reinforcement	Tire Cord	RFL Coating

Operational Parameters (customer specified)

Quantity	<input type="text"/>	Size ID (DN)	<input type="text"/>	O.A.L.	<input type="text"/>
		Pressure	<input type="text"/>	Vacuum	<input type="text"/>

SIZE			MOVEMENT (non-concurrent)			PRESSURE	
Size ID in [mm]	Actual ID in [mm]	Over-All Length O.A.L. in [mm]	Comp. in [mm]	Ext. in [mm]	Lateral in [mm]	Pressure psig [barg]	Vacuum in-Hg [barg]
1 1/2 [40]	1 15/16 [49]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	90 [6.2]	15 [-0.5]
2 [50]	2 3/8 [60]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	90 [6.2]	15 [-0.5]
2 1/2 [65]	2 7/8 [73]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	90 [6.2]	15 [-0.5]
3 [80]	3 1/2 [89]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	90 [6.2]	15 [-0.5]
4 [100]	4 1/2 [114]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	90 [6.2]	15 [-0.5]
5 [125]	5 9/16 [141]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	50 [3.4]	15 [-0.5]
6 [150]	6 5/8 [168]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	50 [3.4]	15 [-0.5]
8 [200]	8 5/8 [219]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	35 [2.4]	15 [-0.5]
10 [250]	10 3/4 [273]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	35 [2.4]	15 [-0.5]
12 [300]	12 3/4 [324]	12 [305]	3 1/2 [89]	1 1/2 [38]	1 1/2 [38]	35 [2.4]	15 [-0.5]

Available in split-wrap, multiple arches, custom offsets and face-to-face dimensions, sizes not shown and reducing arrangements.

Contact General Rubber Corporation for full product specifications, Warnings and installation instructions.

System Includes: Pump, Switch, and Alarm



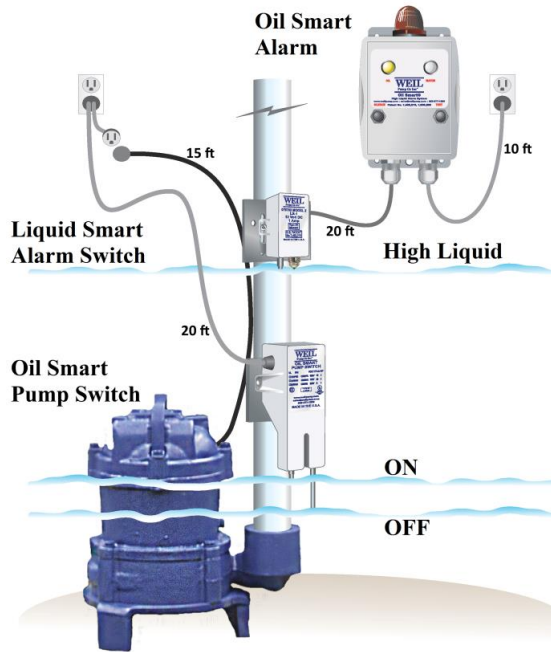
Heavy duty pump, control, and alarm system for commercial and industrial elevator sump applications. Pump clear and grey water with solids to 1/2 Inch. Will not pump oil.

Pump

- Case – Cast Iron
- Impeller – Cast Iron
- Strainer – 304 Stainless Steel
- Stainless Steel Hardware

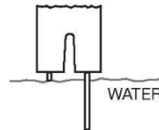
Motor

- Single Seal
 - Carbon against Ceramic
- **Air-Filled Hermetically Sealed Shaft – Stainless Steel Series 300**
- Motor Shell – Cast Iron
- Insulation – Class F
- Ball Bearings – 2 – Double Sealed
- Power Cord Length – 15 ft with 3 conductor grounded plug
- Single-Phase Motor:
 - 1750 RPM, 60 Hz, 115 Volts
 - Automatic reset thermal and overload protection
 - Capacitors and start relay in motor



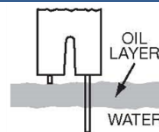
Normal Condition (Water Only)

The short sensor probe turns the pump “on” and the long sensor probe turns the pump “off”. When the short sensor is in contact with water, the pump will continue to cycle “on and off” until the short sensor detects oil



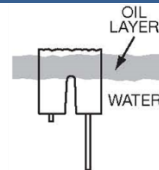
Oil Present Condition

The pump will not cycle if oil is in contact with the short sensor.



High Water (Oil Present Condition)

If additional water enters the basin it will cause the oil layer to rise above the short sensor, resulting in the pump cycling



Disch. Size	2
Disch. Type	NPT
Solids Max.	1/2 Inch
Mounting Style	Floor

Oil Smart Pump Switch

The Oil Smart Switch pumps water, not hydrocarbons. The switch provides a 4-1/2 inch on/off differential range, and identifies whether oil or water is present. 20 ft cord and plug. Use in applications including:

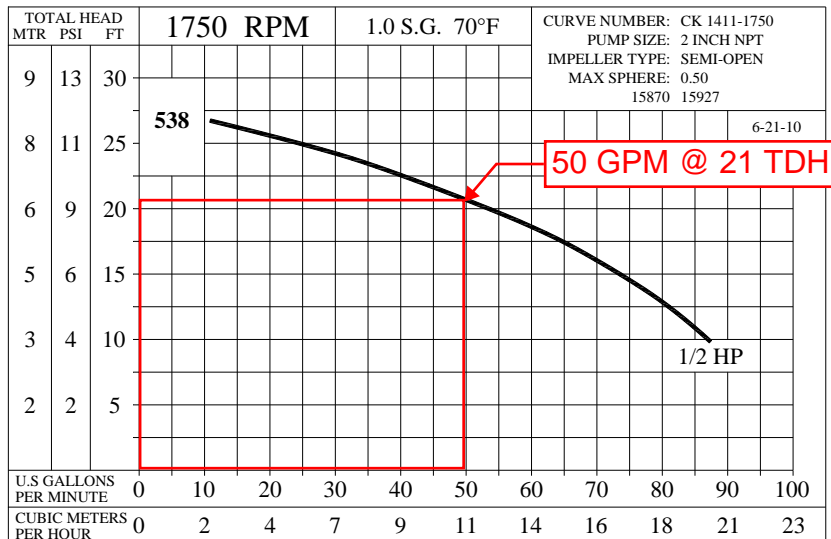
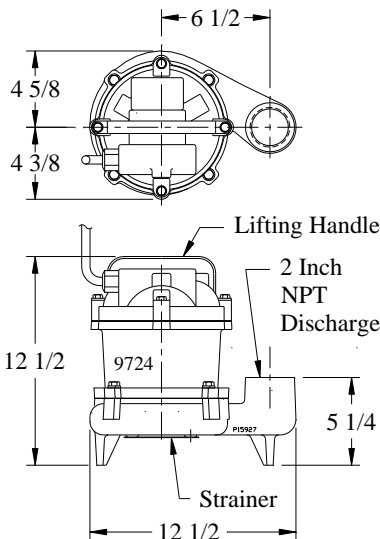
- Elevators
- Transformer oil contaminant areas
- Underground utility vaults
- Marine

Oil Smart Alarm & Switch

The Oil Smart Alarm differentiates and indicates whether oil or water is present at high level.

Includes:

- Alarm dome light
- 85db Horn
- Silence and test buttons
- Isolated contacts for all conditions
- 10ft cord and plug – 115 Volt
- Differentiating switch with 20ft cord



PRODUCT SPECIFICATIONS

Elkay ezH2O[®] Bottle Filling Station with Bi-Level Integral SwirlFlo[®] Fountain, Refrigerated Non-Filtered Refrigerated Stainless. Chilling Capacity of 8.0 GPH (gallons per hour) of 50° F drinking water, based on 80° F inlet water and 90° F ambient, per ASHRAE 18 testing. Features shall include Antimicrobial, Green Ticker[™], Hands Free, Laminar Flow, Real Drain. Furnished with Flexi-Guard[®] Safety Bubbler. Electronic Bottle Filler Sensor with Mechanical Front Bubbler Button activation. Product shall be Wall Mount (Inwall Frame/Plate), for Indoor applications, serving 2 station(s). Unit shall be certified to UL 399 and CAN/CSA C22.2 No. 120. Unit shall be lead-free design which is certified to NSF/ANSI 61 & 372 (lead free) and meets Federal and State low-lead requirements.



Special Features:	Antimicrobial, Green Ticker [™] , Hands Free, Laminar Flow, Real Drain
Finish:	Stainless Steel
Power:	115V/60Hz
Bubbler Style:	Flexi-Guard [®] Safety Bubbler
Activation by:	Electronic Bottle Filler Sensor with Mechanical Front Bubbler Button
Mounting Type:	Wall Mount (Inwall Frame/Plate)
Chilling Capacity*:	8.0 GPH
Full Load Amps	1
Rated Watts:	370
Dimensions (L x W x H):	38-1/2" x 19" x 55-1/16"
Approx. Shipping Weight:	170 lbs.
Installation Location:	Indoor
No. of Stations Served:	2

*Based on 80° F inlet water & 90° F ambient air temp for 50° F chilled drinking water.

Special Note: Non-filtered model

- Mechanically-Activated bubbler continues to supply water in event of service disruptions.
- Green Ticker: Informs user of number of 20 oz. plastic water bottles saved from waste.
- Laminar flow provides clean fill with minimal splash.
- Silver Ion Antimicrobial protection on key plastic components to inhibit the growth of mold and mildew.
- Real Drain System eliminates standing water.

COOLING SYSTEM

- Compressor: Hermetically-sealed, reciprocating type, single phase. Sealed-in lifetime lubrication.
- Condenser: Fan cooled, copper tube with aluminum fins. Fan motor is permanently lubricated.
- Cooling Unit: Combination tube-tank type. Continuous copper tubing with is fully insulated with EPS foam that

PART: _____ QTY: _____
 PROJECT: _____
 CONTACT: _____
 DATE: _____
 NOTES: _____
 APPROVAL: _____

AMERICAN PRIDE. A LIFETIME TRADITION. Like your family, the Elkay family has values and traditions that endure. For almost a century, Elkay has been a family-owned and operated company, providing thousands of jobs that support our families and communities.



Included with Product: Fountain with Integral Bottle Filling Station (ERPBD28WSC), Mounting Frame (MFWS210), Chiller (ECH8)

▼ Ships in multiple boxes.

PRODUCT COMPLIANCE

- ADA & ICC A117.1
- ASME A112.19.3/CSA B45.4
- Buy American Act
- CAN/CSA C22.2 No. 120
- GreenSpec[®]
- NSF/ANSI 61 & 372 (lead free)
- UL 399



Complies with ADA & ICC A117.1 accessibility requirements when installed according to the requirements outlined in these standards. Installation may require additional components and/or construction features to be fully compliant. Consult the local Authority Having Jurisdiction if necessary.

- [Installation Instructions \(PDF\) - 1000003097](#)
- [Installation Instructions \(PDF\) - 0000001030](#)
- [Installation Instructions \(PDF\) - 0000001027](#)

5 Year Limited Warranty on the refrigeration system of the unit. Electrical components and water system are warranted for 12 months from date of installation. **Warranty pertains to drinking water applications only. Non-drinking water applications are not covered under warranty.**

[Warranty \(PDF\)](#)

In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

meets UL requirements for self-extinguishing material.

- Refrigerant Control: Refrigerant R-134a is controlled by accurately calibrated capillary tube.
- Temperature Control: Easily accessible enclosed adjustable thermostat is factory preset. Requires no adjustment other than for altitude requirements.

OPTIONAL ACCESSORIES

EWF3000 - Elkay WaterSentry Plus Filter System Kit (Bottle Fillers)
LKAPR1 - Elkay Cane Apron for SwirlFlo Gray
ACCESS12X38-5 - Accessory - Stainless Steel Access Panel for Bi-Level Architectural Fountains

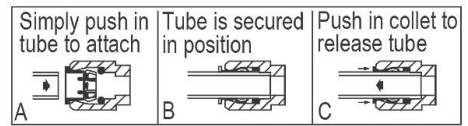
In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

IMPORTANT! INSTALLER PLEASE NOTE:

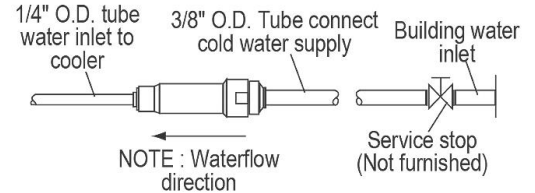
The grounding of electrical equipment such as telephone, computers, etc., to water lines is a common procedure. This grounding may be in the building or may occur away from the building. This grounding can cause electrical feedback into a water cooler, creating an electrolysis which causes a metallic taste or causes an increase in the metal content of the water. This condition is avoidable by using the proper materials as indicated below. The drain fittings which are provided by the installer should also be plastic to electrically isolate the cooler from the building plumbing system.

These products are designed to operate on 20 psi to 105 psi supply line pressure. Simultaneous operation of both bubblers on a bi-level unit may not be possible depending on water supply pressure. If simultaneous operation is desired, please ensure a minimum of 50 psi supply.

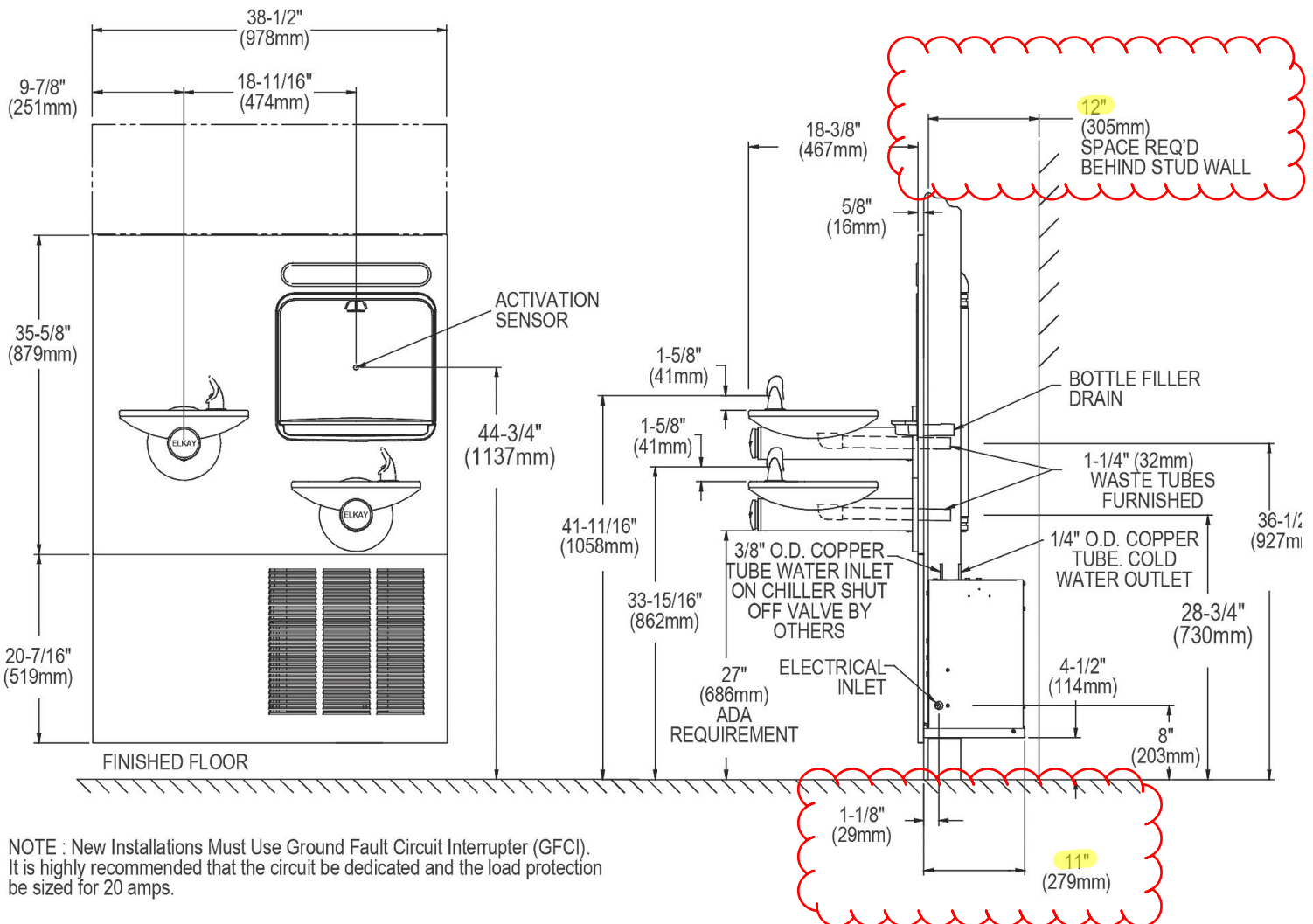
OPERATION OF QUICK CONNECT FITTINGS



Pushing tube in before pulling it out helps to release tube



BOTTLE FILLER SPECIFICATIONS



NOTE : New Installations Must Use Ground Fault Circuit Interrupter (GFCI). It is highly recommended that the circuit be dedicated and the load protection be sized for 20 amps.

In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

WALL OPENING

IMPORTANT: It is necessary to create a wall opening 37-1/2" W x 52-1/8" H and 4-1/2" above the floor line.

ELECTRICAL DATA

Junction box for a (3) wire 10AMP branch circuit. Standard 120 Volt, 60 HZ, single phase.
Electrical outlet, three (3) conductor grounded. Locate withing safe reach of power cord.

MOUNTING FRAME MFWS210

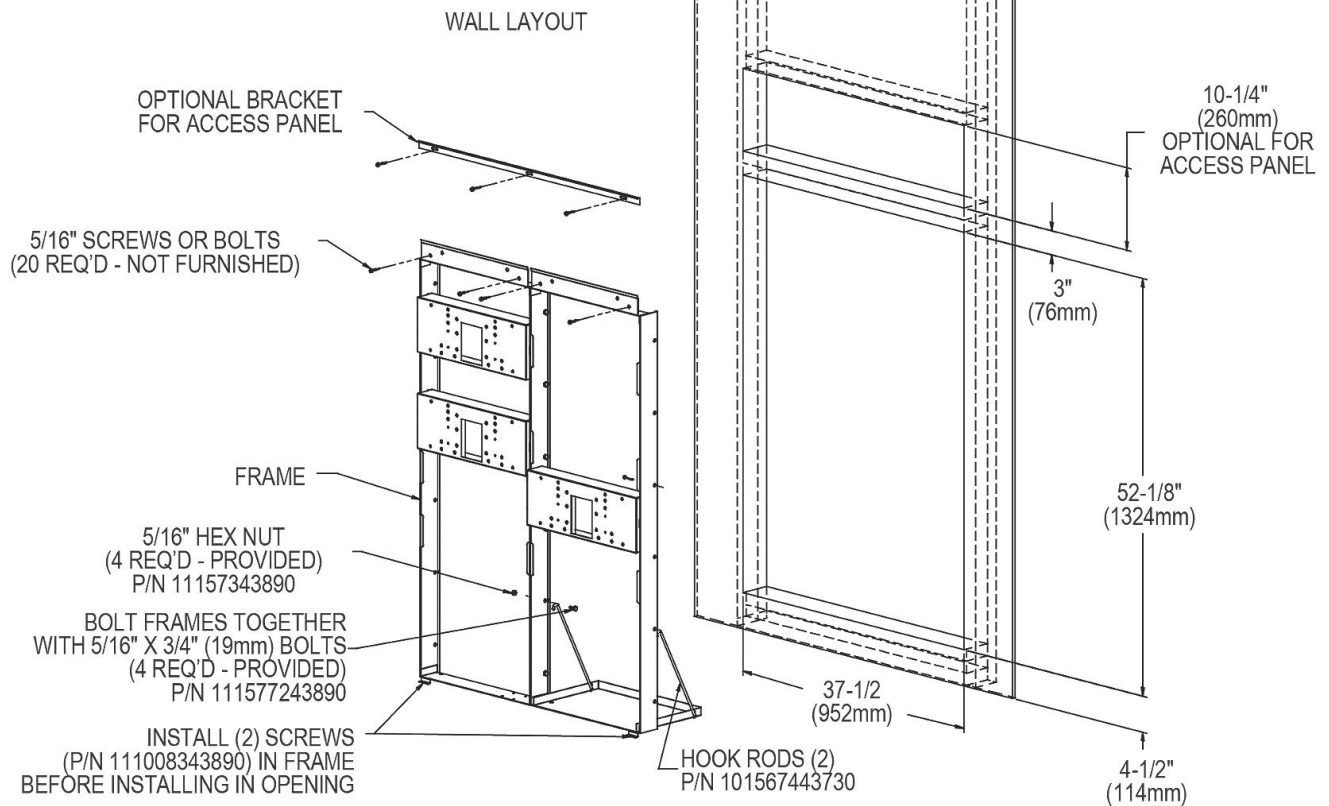
INSTALLER NOTE

This drinking fountain is furnished with a bubbler and valve including all connecting fittings which are manufactured of completely lead free material. Shut off valve (not furnished) to accept 3/8" O.D. unplated copper tube.

MOUNTING INSTRUCTIONS

Refer to rough-in for location of plumbing and electrical sources. The support frame is to be installed first. Hang upper panel to hanger on frame. Fountains are to be attached to panel and wall frame. Water service lines, waste lines and electrical are assembled as required. Perform a final check for leaks and correct functions of fountains and chiller. (For details see the installation instructions.)

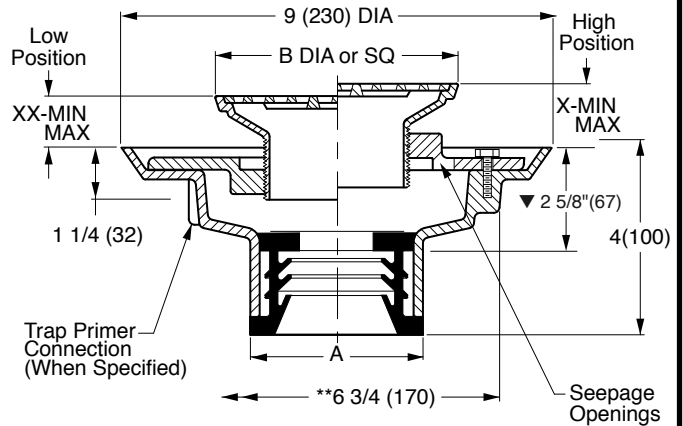
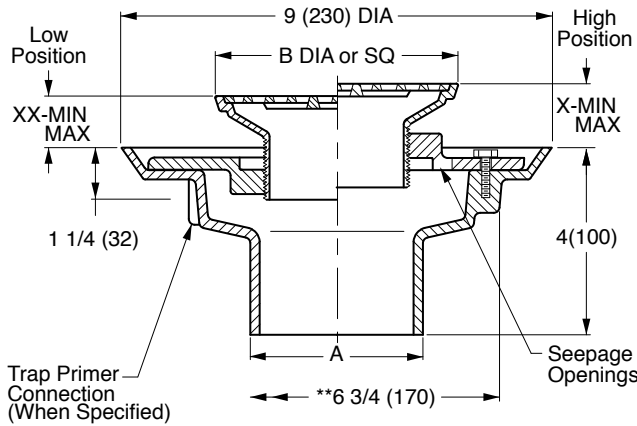
Installation requires trap to be installed in wall. Trap and service stop not included.



In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

FLOOR OR SHOWER DRAINS WITH ADJUSTABLE STRAINER HEADS

FUNCTION: General service floor drain for use in showers, toilets, kitchens and other finished areas where foot traffic is expected. The round top strainer head is used for all types of poured finished floors. The square top is particularly adaptable to floors that are finished in material of square or straight line pattern. Reversible flashing collar permits adjustment of the strainer to meet finished floor level.



A (Pipe Size) = 02(50), 03(75), 04(100), 05(125) or 06(150)

NO-HUB OUTLET

- Fig. 2005Y.....(A) ROUND TOP
- Fig. 2005Y.....(B) SQUARE TOP

SPEEDI-SET OUTLET

- Fig. 2005L.....(A) ROUND TOP
- Fig. 2005L.....(B) SQUARE TOP

Outlet Size	Nickel Bronze Strainer Head
▲ 02(50)	05(125) DIA or SQ
▲ 03(75)	06(150) DIA or SQ
▲ 04(100)	08(205) DIA or SQ

Strainer Size B DIA or SQ	*Collar In High Position X		*Collar In Low Position XX		Free Area SQ IN (SQ CM)	
	MIN	MAX	MIN	MAX	ROUND	SQUARE
05 (125)	1 1/4(32)	2 1/4(57)	3/4(19)	1 5/8(41)	7(45)	6.5(42)
06 (150)	1 1/4(32)	2 1/4(57)	3/4(19)	1 5/8(41)	9(58)	12.5(81)
07 (180)	1 1/4(32)	2 1/4(57)	7/8(22)	1 7/8(48)	14(90)	11(71)
08 (205)	1 1/2(38)	2 1/2(64)	1(25)	1 7/8(48)	17(110)	14(90)
*09 (230)	1 1/2(38)	2 3/8(60)	1(25)	1 7/8(48)	18(116)	16(103)
*10 (255)	1 1/2(38)	2 3/8(60)	1(25)	1 7/8(48)	23(48)	16(103)

- ▼ This dimension to internal stop of speedi-set gasket.
- Add 3/8"(10) to all min/max dimensions for round strainers.
- * Collar is reversible to obtain extreme high and low strainer positions.
- ** Not available for 5"(125) size strainer.
- ** MIN 6 3/4"(170) hole required for core drilled application.

REGULARLY FURNISHED:

Duco Cast Iron Body with Flashing Collar and Adjustable Strainer Head as Indicated by Suffix Letter Selected.

VARIATIONS:

- Flapper Type Backwater Valve -V
- Hinged Grate -H
- L Speedi-Set Service Weight 2(50), 3(75) & 4"(100) only
- LXH Speedi-Set Extra Heavy 2(50), 3(75) & 4"(100) only
- Sediment Bucket -B
- Trap Primer Connection -P050 1/2" (13) & -P075 3/4" (19)
- Vandal Proof Screws -U
- Wide Flanged Strainer (Specify Fig. DX2005)
- T Threaded Outlet
- Heelproof Grate -HP -AHP (Round) or -BHP (Square)
- Quad Close Trap Seal (Specify Fig. 2692)

OPTIONAL MATERIALS:

- Bronze Body -BB
- Chrome Plated Strainer -CP
- Galvanized Cast Iron Body -G
- Nickel Bronze Strainer -NB
- Polished Bronze Strainer -PB
- Stainless Steel (Specify Fig. 9700-A)

NOTE: Dimensions shown in parentheses are in millimeters.

- ▲ Meets ASME Standard A112.6.3-2001 02(50), 03(75) or 04"(100) sizes only.

SEE PM0457 FOR OPTIONAL STRAINER HEADS.

DRAWING NUMBER S2005

SIZE A

SCALE: NONE

DATE: 5-17-85

APPROVED BY: TD

CHECKED BY: TD

DRAWN BY: PJ

2005

FIGURE NUMBER

R	6-10-15	Revised Variations Rev. Dwg., Var. Revised Variations Addition to Variations	TBW	CL	WEIGHT POUNDS	VOLUME CUBIC FEET	FIGURE NUMBER
Q	11-18-11		TBW	CR			
P	11-20-09		RN	BW			
N	12/18/08		JJ	BW			
REV.	DATE	DESCRIPTION	BY	CKD. BY			

2005

WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA

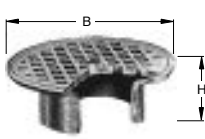
DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

OPTIONAL STRAINER HEADS

G
 DRAWING NUMBER PM0457 SH 1 of 2
 SIZE A
 SCALE NONE
 DATE: 5-17-85
 APPROVED BY: TD
 CHECKED BY: TD
 DRAWN BY: PJ
 2010 SERIES OPTIONAL STRAINER HEADS
 FIGURE NUMBER

ASSUME NO RESPONSIBILITY OR USE OF SUPERSEDED OR VOID DATA
 DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

ROUND STRAINER



MATERIALS:
 Chrome Plated -CP
 Polished Bronze -PB
 Nickel Bronze -NB

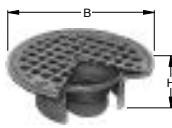
VARIATIONS:
 •Hinged Grate (Specify Suffix -AH)
 Sediment Bucket -B
 Vandal Proof Screws -U

B DIA	05 (125)	06 (150)	07 (180)	08 (205)	09 (230)	10 (255)
H	2 (51)	2 (51)	2 1/4 (57)	2 1/2 (64)	2 1/2 (64)	2 3/4 (70)
X MIN	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)	1 1/2 (38)	1 1/2 (38)
X MAX	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	2 1/2 (64)	2 3/4 (70)

Specify Type, Size & Finish eg: A05NB
 *Not available for 05" (125) size

SUFFIX -A

FLAPPER TYPE BACKWATER VALVE



FUNCTION: Provides backwater protection at point where protection is needed.

MATERIALS:
 Chrome Plated -CP
 Polished Bronze -PB
 Nickel Bronze -NB

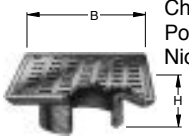
VARIATIONS:
 •Hinged Grate (Specify Suffix -AH)
 Vandal Proof Screws -U

B DIA	05 (125)	06 (150)	07 (180)	08 (205)
H	2 (51)	2 (51)	2 1/4 (57)	2 1/2 (64)
X MIN	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)
X MAX	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)

Specify Type, Size & Finish eg: AV05NB
 *Not available for 05" (125) size

SUFFIX -AV

SQUARE STRAINER



MATERIALS:
 Chrome Plated -CP
 Polished Bronze -PB
 Nickel Bronze -NB

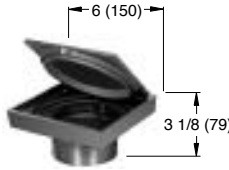
VARIATIONS:
 Flapper Type Backwater Valve (Specify Suffix -BV) 05 (125), 06 (150), 07 (180) or 08" (205) sizes only
 •Hinged Grate (Specify Suffix -BH)
 Sediment Bucket -B
 Vandal Proof Screws -U

B DIA	05 (125)	06 (150)	07 (180)	08 (205)	09 (230)	10 (255)
H	2 (51)	2 (51)	2 1/4 (57)	2 1/2 (64)	2 1/4 (57)	2 1/4 (57)
X MIN	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)	1 1/2 (38)	1 1/2 (38)
X MAX	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	2 1/4 (57)	2 3/8 (60)

Specify Type, Size & Finish eg: B05NB
 *Not available for 05" (125) size

SUFFIX -B

STRAINER HEAD w/SQUARE HINGED COVER



MATERIALS:
 Chrome Plated -CP
 Polished Bronze -PB
 Nickel Bronze -NB

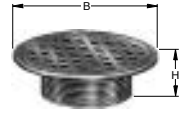
VARIATIONS:
 Gasketed Water Tight Cover -GC
 Secured Cover -SC
 Secondary Strainer Grate -SG

Specify Type, Size & Finish eg: BSNB

SUFFIX -BS

REINFORCED ROUND STRAINER

FUNCTION: Used in finished floors where light wheeled loads are anticipated.



MATERIALS:
 Chrome Plated -CP
 Polished Bronze -PB
 Nickel Bronze -NB

VARIATIONS:
 Flapper Type Backwater Valve (Specify Suffix -CV)
 Sediment Bucket -B
 Vandal Proof Screws -U


B DIA	05 (125)	06 (150)	08 (205)	10 (255)
H	2 (51)	2 (51)	2 1/2 (64)	2 3/4 (70)
MIN	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)	1 7/8 (48)
MAX	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	2 3/4 (70)

Specify Type, Size & Finish eg: C06NB

SUFFIX -C

REINFORCED TRACTOR STRAINER

FUNCTION: Used in finished floors where medium weight wheeled loads are anticipated and loose set non-tilt tractor grate is desired.



MATERIALS:
 Cast Iron -CI
 Chrome Plated -CP
 Polished Bronze -PB
 Nickel Bronze -NB

VARIATIONS:
 Flapper Type Backwater Valve (Specify Suffix -DV or -EV)
 Sediment Bucket -B
 Vandal Proof Screws -U

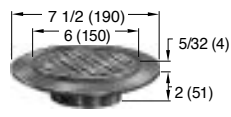
SUFFIX	B DIA	H	X	
-D	07 (180)	3 1/4 (83)	2 5/8 (67)	3 1/2 (89)
-E	09 (230)	3 1/2 (89)	2 3/4 (70)	3 1/2 (89)

Specify Type, Size & Finish eg: D09PB
 E09PB

SUFFIX -D-E

TILE FLANGE

FUNCTION: Provides integral flange set 5/32" (4) below rim to receive floor covering. Flange may have option of tapped holes for securing pan and gasket.



MATERIALS:
 Chrome Plated -CP
 Polished Bronze -PB
 Nickel Bronze -NB

VARIATIONS:
 Flapper Type Backwater Valve (Specify Suffix -FV)
 Holes in Flange -SH
 Sediment Bucket -B
 Vandal Proof Screws -U

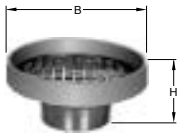
X	
MIN	MAX
1 1/4 (32)	2 1/8 (54)

Specify Type, Size & Finish eg: F06NB

SUFFIX -F

ADJUSTABLE STRAINER HEAD

FUNCTION: Used in a non-traffic area when a funnel type strainer head is required and space does not allow use of the 3500 series funnel. The extended rim allows use as an anti-flood and anti-splash drip pan.



VARIATIONS:
 Flapper Type Backwater Valve (Specify Suffix -F37V or F38V)

MATERIALS:
 Cast Iron -CI
 Chrome Plated -CP
 Galvanized Cast Iron -G
 Polished Bronze -PB
 Nickel Bronze -NB

SUFFIX	-F37	-F38
B DIA	07 (180)	09 (230)
H	3 1/4 (83)	3 1/2 (89)
X MIN	2 5/8 (67)	2 3/4 (70)
X MAX	3 1/2 (89)	3 1/2 (89)

Specify Type, Size & Finish eg: F37NB F38CP

SUFFIX -F37-F38

REV.	DATE	DESCRIPTION	BY	CKD. BY	FIGURE NUMBER 2010 SERIES OPTIONAL STRAINER HEADS 1 of 2
	10-4-01	Revised Suffix-BS	RN	CL	
	8-24-99	Revised	TBW		
	6-11-99	Revised Tables	CMD	BS	
	11-4-97	Added Nickel Bronze	EMB	BS	

NOTE: Dimensions shown in parentheses are in millimeters.

OPTIONAL STRAINER HEADS

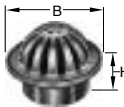

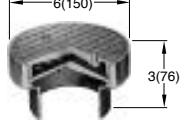
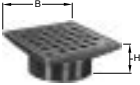

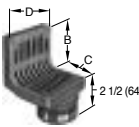
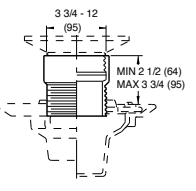
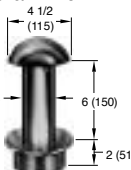
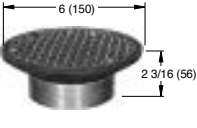
DRAWING NUMBER PM0457 SH 2 of 2	SIZE A	SCALE NONE																																																																											
<p>LOW DOME STRAINER</p> <p>FUNCTION: Used in gutters and recessed areas where excessive debris build-up is expected. Dome insures drainage even when partly covered.</p> <p>MATERIALS: Chrome Plated -CP Polished Bronze -PB Nickel Bronze -NB</p> <p>VARIATIONS: Flapper Type Backwater Valve (Specify Suffix -GV) Sediment Bucket -B Vandal Proof Screws -U</p>  <table border="1" style="font-size: small;"> <tr><td>B DIA</td><td>05 (125)</td><td>06 (150)</td><td>08 (205)</td></tr> <tr><td>H</td><td>2 (51)</td><td>2 (51)</td><td>2 1/2 (64)</td></tr> <tr><td>MIN</td><td>1 1/4 (32)</td><td>1 1/4 (32)</td><td>1 1/2 (38)</td></tr> <tr><td>MAX</td><td>2 1/4 (57)</td><td>2 1/4 (57)</td><td>2 1/2 (64)</td></tr> </table> <p>SUFFIX -G Specify Type, Size & Finish eg: G08PB</p>	B DIA	05 (125)	06 (150)	08 (205)	H	2 (51)	2 (51)	2 1/2 (64)	MIN	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)	MAX	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	<p>SOLID HINGED COVER</p> <p>FUNCTION: Used in areas where intermittent drain use is required. Solid cover prevents intrusion of chips, saw-dust, etc., which are swept up before cover is opened for washdown. The secondary strainer prevents debris from entering the waste line.</p> <p>MATERIALS: Cast Iron -CI Chrome Plated -CP Polished Bronze -PB Nickel Bronze -NB</p> <p>VARIATIONS: Flapper Type Backwater Valve (Specify Suffix -GV) Vandal Proof Screws -U</p>  <table border="1" style="font-size: small;"> <tr><td>B DIA</td><td>05 (125)</td><td>06 (150)</td><td>07 (180)</td><td>08 (205)</td></tr> <tr><td>H</td><td>2 (51)</td><td>2 (51)</td><td>2 1/4 (57)</td><td>2 1/2 (64)</td></tr> <tr><td>X MIN</td><td>1 1/4 (32)</td><td>1 1/4 (32)</td><td>1 1/4 (32)</td><td>1 1/2 (38)</td></tr> <tr><td>X MAX</td><td>2 1/4 (57)</td><td>2 1/4 (57)</td><td>2 1/4 (57)</td><td>2 1/2 (64)</td></tr> </table> <p>SUFFIX -H Specify Type, Size & Finish eg: H05CP</p>	B DIA	05 (125)	06 (150)	07 (180)	08 (205)	H	2 (51)	2 (51)	2 1/4 (57)	2 1/2 (64)	X MIN	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)	X MAX	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	<p>SPANNER WRENCH COVER</p> <p>FUNCTION: Solid gas tight, vandal proof, threaded cover for areas where intermittent drain use is required.</p> <p>MATERIALS: Chrome Plated -CP Polished Bronze -PB Nickel Bronze -NB</p> <p>VARIATIONS: Flapper Type Backwater Valve (Specify Suffix -JV) Sediment Bucket -B</p>  <table border="1" style="font-size: small;"> <tr><td colspan="2">X</td></tr> <tr><td>MIN</td><td>MAX</td></tr> <tr><td>2 (51)</td><td>3 (76)</td></tr> </table> <p>SUFFIX -J Specify Type, Size & Finish eg: J06NB</p>	X		MIN	MAX	2 (51)	3 (76)																																	
B DIA	05 (125)	06 (150)	08 (205)																																																																										
H	2 (51)	2 (51)	2 1/2 (64)																																																																										
MIN	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)																																																																										
MAX	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)																																																																										
B DIA	05 (125)	06 (150)	07 (180)	08 (205)																																																																									
H	2 (51)	2 (51)	2 1/4 (57)	2 1/2 (64)																																																																									
X MIN	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)																																																																									
X MAX	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)																																																																									
X																																																																													
MIN	MAX																																																																												
2 (51)	3 (76)																																																																												
<p>REINFORCED SQUARE STRAINER</p> <p>FUNCTION: Used in finished floors where some light wheeled traffic is anticipated.</p> <p>MATERIALS: Chrome Plated -CP Polished Bronze -PB Nickel Bronze -NB</p> <p>VARIATIONS: Flapper Type Backwater Valve (Specify Suffix -KV) Sediment Bucket -B Vandal Proof Screws -U</p>  <table border="1" style="font-size: small;"> <tr><td>B SQ</td><td>05 (125)</td><td>06 (150)</td><td>07 (180)</td><td>08 (205)</td></tr> <tr><td>H</td><td>2 (51)</td><td>2 (51)</td><td>2 1/4 (57)</td><td>2 1/2 (64)</td></tr> <tr><td>X MIN</td><td>1 1/4 (32)</td><td>1 1/4 (32)</td><td>1 1/4 (32)</td><td>1 1/2 (38)</td></tr> <tr><td>X MAX</td><td>2 1/4 (57)</td><td>2 1/4 (57)</td><td>2 1/4 (57)</td><td>2 1/2 (64)</td></tr> </table> <p>SUFFIX -K Specify Type, Size & Finish eg: K07CP</p>	B SQ	05 (125)	06 (150)	07 (180)	08 (205)	H	2 (51)	2 (51)	2 1/4 (57)	2 1/2 (64)	X MIN	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)	X MAX	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)	<p>RECTANGULAR STRAINER</p> <p>FUNCTION: Used in finished floors where light wheeled loads and or heavy foot traffic are anticipated.</p> <p>MATERIALS: Chrome Plated -CP Polished Bronze -PB Nickel Bronze -NB</p> <p>VARIATIONS: Sediment Bucket -B Vandal Proof Screws -U</p>  <table border="1" style="font-size: small;"> <tr><td>SUFFIX</td><td>L</td><td>M</td><td>N</td><td>P</td><td>R</td><td>T</td></tr> <tr><td>B x B'</td><td>4 1/2 (115)</td><td>4 1/2 (115)</td><td>5 (125)</td><td>5 (125)</td><td>6 (150)</td><td>6 (150)</td></tr> <tr><td>H</td><td>2 1/4 (57)</td><td>2 1/2 (64)</td><td>2 1/4 (57)</td><td>3 (76)</td><td>2 1/4 (57)</td><td>3 (76)</td></tr> <tr><td>X MIN</td><td>1 3/8 (35)</td><td>1 7/8 (49)</td><td>1 3/8 (35)</td><td>2 1/8 (54)</td><td>1 3/8 (35)</td><td>2 1/4 (57)</td></tr> <tr><td>X MAX</td><td>2 3/8 (60)</td><td>2 3/4 (70)</td><td>2 3/8 (60)</td><td>3 (76)</td><td>2 3/8 (60)</td><td>3 1/8 (79)</td></tr> </table> <p>SUFFIX -L-M-N-P-R-T Specify Type, Size & Finish eg: LNB</p>	SUFFIX	L	M	N	P	R	T	B x B'	4 1/2 (115)	4 1/2 (115)	5 (125)	5 (125)	6 (150)	6 (150)	H	2 1/4 (57)	2 1/2 (64)	2 1/4 (57)	3 (76)	2 1/4 (57)	3 (76)	X MIN	1 3/8 (35)	1 7/8 (49)	1 3/8 (35)	2 1/8 (54)	1 3/8 (35)	2 1/4 (57)	X MAX	2 3/8 (60)	2 3/4 (70)	2 3/8 (60)	3 (76)	2 3/8 (60)	3 1/8 (79)	<p>ANGLE STRAINER</p> <p>FUNCTION: Shower room drain set at wall and floor junction. Vertical grate openings prevent drain stoppage should flat surface become covered.</p> <p>MATERIALS: Cast Iron -CI Chrome Plated -CP Polished Bronze -PB Nickel Bronze -NB</p> <p>VARIATIONS: Vandal Proof Screws -U</p>  <table border="1" style="font-size: small;"> <tr><td>SUFFIX</td><td>B</td><td>C</td><td>D</td><td>X</td></tr> <tr><td></td><td></td><td></td><td></td><td>MIN MAX</td></tr> <tr><td>-V</td><td>3 1/2 (89)</td><td>3 1/2 (89)</td><td>4 1/2 (115)</td><td>1 5/8 (41) 2 5/8 (67)</td></tr> <tr><td>-W</td><td>6 3/4 (170)</td><td>6 3/4 (170)</td><td>6 1/2 (165)</td><td>1 5/8 (41) 2 5/8 (67)</td></tr> </table> <p>SUFFIX -V -W Specify Type, Size & Finish eg: VPB, WNB</p>	SUFFIX	B	C	D	X					MIN MAX	-V	3 1/2 (89)	3 1/2 (89)	4 1/2 (115)	1 5/8 (41) 2 5/8 (67)	-W	6 3/4 (170)	6 3/4 (170)	6 1/2 (165)	1 5/8 (41) 2 5/8 (67)
B SQ	05 (125)	06 (150)	07 (180)	08 (205)																																																																									
H	2 (51)	2 (51)	2 1/4 (57)	2 1/2 (64)																																																																									
X MIN	1 1/4 (32)	1 1/4 (32)	1 1/4 (32)	1 1/2 (38)																																																																									
X MAX	2 1/4 (57)	2 1/4 (57)	2 1/4 (57)	2 1/2 (64)																																																																									
SUFFIX	L	M	N	P	R	T																																																																							
B x B'	4 1/2 (115)	4 1/2 (115)	5 (125)	5 (125)	6 (150)	6 (150)																																																																							
H	2 1/4 (57)	2 1/2 (64)	2 1/4 (57)	3 (76)	2 1/4 (57)	3 (76)																																																																							
X MIN	1 3/8 (35)	1 7/8 (49)	1 3/8 (35)	2 1/8 (54)	1 3/8 (35)	2 1/4 (57)																																																																							
X MAX	2 3/8 (60)	2 3/4 (70)	2 3/8 (60)	3 (76)	2 3/8 (60)	3 1/8 (79)																																																																							
SUFFIX	B	C	D	X																																																																									
				MIN MAX																																																																									
-V	3 1/2 (89)	3 1/2 (89)	4 1/2 (115)	1 5/8 (41) 2 5/8 (67)																																																																									
-W	6 3/4 (170)	6 3/4 (170)	6 1/2 (165)	1 5/8 (41) 2 5/8 (67)																																																																									
<p>EXTENSION ADAPTOR</p> <p>FUNCTION: Used when a strainer head must be raised to accommodate deeper floor fill.</p> <p>REGULARLY FURNISHED: Duco Cast Iron -CI</p> <p>MATERIALS: Cast Bronze -CB Galvanized Cast Iron -G</p>  <p>NOTE: Extension can be stacked for increased maximum adjustment.</p> <p>SUFFIX -X</p>	<p>OVERFLOW WITH STANDPIPE</p> <p>FUNCTION: Used as overflow drain in decorative pools, fish ponds or similar areas. Dome prevents floating objects from entering drain line.</p> <p>MATERIALS: Chrome Plated -CP Nickel Bronze -NB Polished Bronze -PB</p> <p>VARIATIONS: Less Dome -LD Standpipe Height other than 6" (150) (Specify Height)</p>  <table border="1" style="font-size: small;"> <tr><td>SUFFIX</td><td>A</td><td>X</td></tr> <tr><td></td><td>SIZE</td><td>MIN MAX</td></tr> <tr><td>-Y</td><td>2 (51)</td><td>3/4 (19) 2 1/8 (54)</td></tr> <tr><td>-Z</td><td>3 (76)</td><td>3/4 (19) 2 1/8 (54)</td></tr> </table> <p>SUFFIX -Y-Z Specify Type, Size & Finish eg: YCP, ZCP</p>	SUFFIX	A	X		SIZE	MIN MAX	-Y	2 (51)	3/4 (19) 2 1/8 (54)	-Z	3 (76)	3/4 (19) 2 1/8 (54)	<p>HEAVY DUTY ADJUSTABLE</p> <p>FUNCTION: Used in finished floors where light wheeled loads and or heavy foot traffic are anticipated.</p> <p>MATERIALS: Polished Bronze -PB Rough Bronze -RB Nickel Bronze -NB</p> <p>VARIATIONS: Flapper Type Backwater Valve (Specify Suffix -69V) Sediment Bucket -B Vandal Proof Screws -U</p>  <p>SUFFIX -69 eg: A06NB-69</p>																																																															
SUFFIX	A	X																																																																											
	SIZE	MIN MAX																																																																											
-Y	2 (51)	3/4 (19) 2 1/8 (54)																																																																											
-Z	3 (76)	3/4 (19) 2 1/8 (54)																																																																											

FIGURE NUMBER	J H G F E	1-17-12 8-24-99 6-11-99 1-22-99 11-4-97	Rev. Variations of Suffix -J Revised Revised Tables T Strainer was S Strainer Added Nickel Bronze	TBW TBW CMD TBW EMB	AM BS BS BS	FIGURE NUMBER 2010 SERIES OPTIONAL STRAINER HEADS 2 of 2
REV.	DATE	DESCRIPTION		BY	CKD. BY	

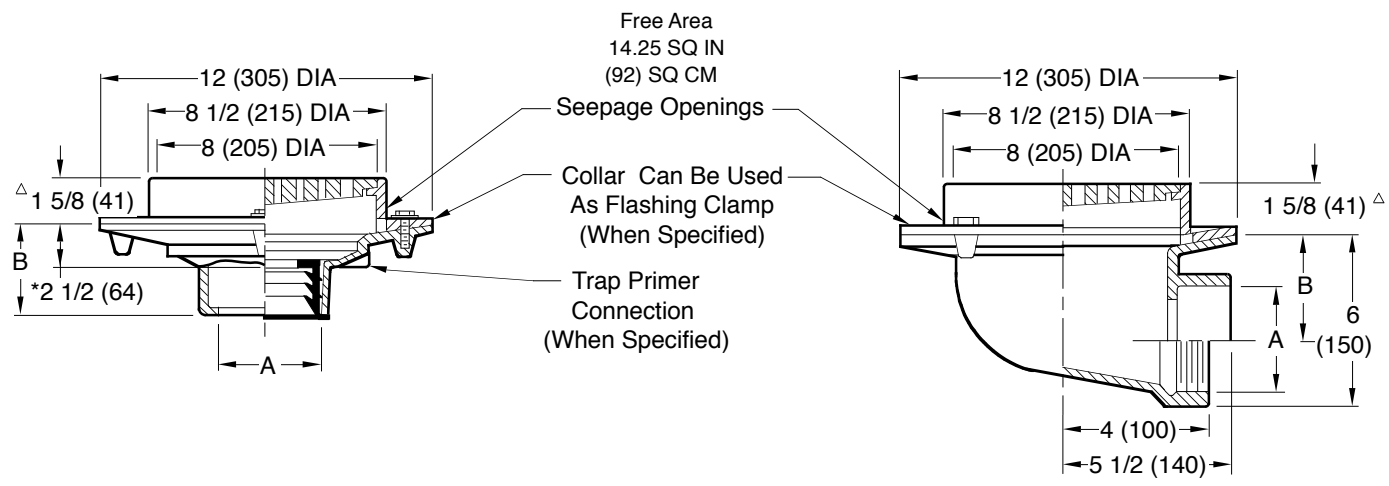
NOTE: Dimensions shown in parentheses are in millimeters.

FLOOR DRAINS

WITH 8 1/2" (215) ROUND TOPS

MEDIUM DUTY DRAINS

FUNCTION: Used in moderate traffic areas where waste water contains no sediment or debris and floor construction requires shallow drain body. Body flange and flashing collar serve as anchor in on-grade locations and as flashing clamp when installed in waterproof floors.



** Fig. 2110C ... CAULK OUTLET
 Fig. 2110Y ... NO-HUB OUTLET

Fig. 2115C ... CAULK OUTLET
 Fig. 2115T ... THREADED OUTLET

A SIZE	02 (50)	03 (75)	04 (100)	06 (150)
B	3 3/4 (95) for Caulk, NO-HUB, and Speedi-Set, 2 (51) for Threaded		3 3/4 (95) NO-HUB Only	

A SIZE	02 (50)	03 (75)	04 (100)
B	4 1/4 (110)	3 3/4 (95)	3 1/4 (83)

REGULARLY FURNISHED:
 Duco Cast Iron Body and Flashing Collar with Cast Iron Bar Grate.

- VARIATIONS:**
- Closure Plug -XP (Fig. 2110 only)
 - Deflector Grate -DG
 - Dome Grate -D
 - Flat Bottom Strainer -FBS (Fig. 2110 only)
 - L Speedi-Set Service Weight (Fig. 2110 only)
 - LXH Speedi-Set Extra Heavy (Fig. 2110 only)
 - NO-HUB Adaptor (Specify Fig. 2646Y) (Fig. 2115 only)
 - Sediment Bucket -B
 - Square Top -S
 - Trap Primer Connection -P050 1/2" (13) & -P075 3/4" (19)
 - Vandal Proof Grate -U
 - Wide Flange Deck Drain (Specify Fig. DX2565)
 - T Threaded Outlet
 - Quad Close Trap Seal (Specify Fig. 2692) (Fig. 2110 Only)

- OPTIONAL MATERIALS:**
- Ductile Iron Grate -M
 - Galvanized Cast Iron -G
 - Nickel Bronze Top -NB
 - Polished Bronze Top -PB
 - Stainless Steel (Specify Fig. 9710)

△ Add 3/16" (5) when bronze top is specified.

*This dimension to internal stop of Speedi-Set gasket.

**Meets U.S. Gov't Spec. per WW-P-541-b, Type 220, 02 (50) and 03" (75) sizes only. *

See Fig. 2130 for 04" (100) size.

Meets ANSI Spec A112.6.3-2001
 02(50), 03(75) or 04"(100) sizes only.

*Not available on Fig. 2110T threaded outlet drain.

NOTE: Dimensions shown in parentheses are in millimeters.

DRAWING NUMBER S2110
 SIZE A
 SCALE: NONE
 DATE: 5-17-85
 APPROVED BY: TD
 CHECKED BY: TD
 DRAWN BY: PJ
 FIGURE NUMBER 2110, 2115

WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA
 DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

REV.	DATE	DESCRIPTION	BY	CKD. BY	WEIGHT POUNDS	VOLUME CUBIC FEET	FIGURE NUMBER
J	6-10-15	Revised Variations	TBW	CL			2110, 2115
H	4-25-14	Revised MM	TBW	CL			
G	11/17/05	Revised 2110 A-Size Table	JJ	CL			
F	05/10/05	Revised ANSI note	JJ	AM			

N



JAY R. SMITH MFG. CO.
 MEMBER OF MORRIS GROUP INTERNATIONAL
 POST OFFICE BOX 3237
 MONTGOMERY, ALABAMA 36109-0237 (USA)
 TEL: 334-277-8520 FAX: 334-272-7396 www.jrsmith.com



LOCATION

FD3

DRAWING NUMBER
S2240

SIZE
A

SCALE:
NONE

DATE:
6-19-85

APPROVED BY:
TD

CHECKED BY:
TD

DRAWN BY:
CM

2240, 2245

FIGURE NUMBER

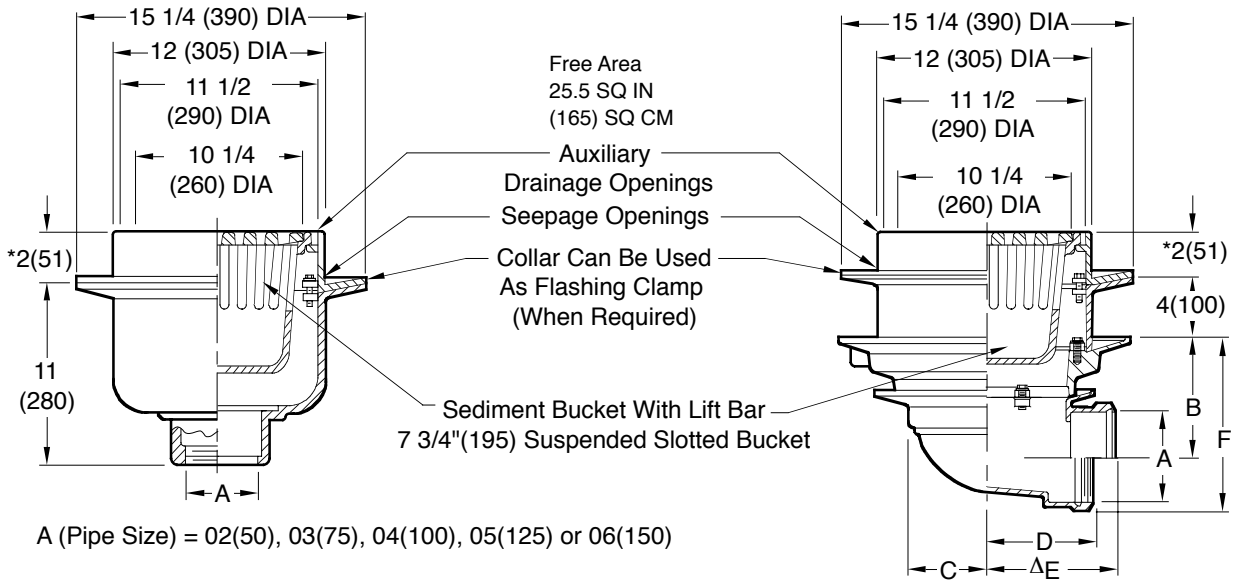
WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA

FLOOR DRAINS

WITH 12"(305) ROUND TOPS DEEP BODY - SEDIMENT BUCKET

MEDIUM DUTY DRAINS - "SAFE-SET" BUCKET

FUNCTION: For general use where water contains solids and debris that must be intercepted. Large deep body and bucket are adaptable to areas where heavy flow and considerable debris are anticipated. "Safe-Set" design insures bucket replacement after cleaning since top grate cannot be inserted unless bucket is in place.



A (Pipe Size) = 02(50), 03(75), 04(100), 05(125) or 06(150)

- Fig. 2240C . . .CAULK OUTLET
- Fig. 2240T . . .THREADED OUTLET
- Fig. 2240Y . . . NO-HUB OUTLET

- Fig. 2245C . . .CAULK OUTLET
- Fig. 2245T . . .THREADED OUTLET
- Fig. 2245Y . . . NO-HUB OUTLET

REGULARLY FURNISHED:

Duco Cast Iron Body and Flashing Collar with Cast Iron Grate and Slotted Sediment Bucket.

VARIATIONS:

- Hinged Grate -H
- Solid Free Standing Bucket -B (Specify Fig. 2241)
- Square Top -S
- Trap Primer Connection -P050 1/2"(13) & -P075 3/4"(19)(Fig.2240 only)
- Vandal Proof Grate -U
- L Speedi-Set Service Weight 02(50), 03(75) & 04"(100) sizes only (Fig. 2240 only)
- LXH Speedi-Set Extra Heavy 02(50), 03(75) & 04"(100) sizes only (Fig. 2240 only)
- Quad Close Trap Seal (Specify Fig. 2692) (Fig. 2240 Only)

OPTIONAL MATERIALS:

- Galvanized Cast Iron -G
- Nickel Bronze Top -NB
- Polished Bronze Top -PB

NOTE: 02(50), 03(75), & 04"(100) sizes require a transition collar (as shown in above illustration) which fits between the body & collar. 05(125) & 06"(150) sizes do not require transition collar.

Δ02(50), 03(75) & 04"(100) sizes only. The "E" dimension is 9(230) for NO-HUB outlets.

*Add 5/16" (8) when bronze top is specified

*Add 7/8" (22) when hinged top is specified

**Hinged grate not available in safe-set design. Full grate is provided with a suspended bucket.

NOTE: Dimensions shown in parentheses are in millimeters.

A SIZE	02 (50)	03 (75)	04 (100)	05 (125)	06 (150)
B	6 7/8 (175)	6 3/8 (162)	5 7/8 (149)	5 (125)	4 1/2 (115)
C	4 3/4 (120)	4 3/4 (120)	4 3/4 (120)	6 1/4 (160)	6 1/4 (160)
D	6 (150)	6 (150)	6 (150)	6 5/8 (168)	6 7/8 (175)
ΔE	7 1/4 (185)	7 1/2 (190)	7 3/4 (195)	7 3/4 (195)	7 3/4 (195)
F	8 5/8 (219)	8 3/4 (220)	8 3/4 (220)	8 1/2 (215)	8 1/2 (215)

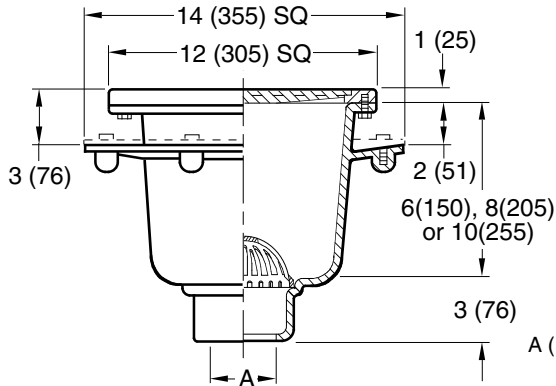
REV.	DATE	DESCRIPTION	BY	CKD. BY	WEIGHT POUNDS	VOLUME CUBIC FEET	FIGURE NUMBER
							2240, 2245

SANI-CEPTOR® ACID RESISTANT COATED FLOOR & INDIRECT WASTE DRAINS

SQUARE NICKEL BRONZE TOP

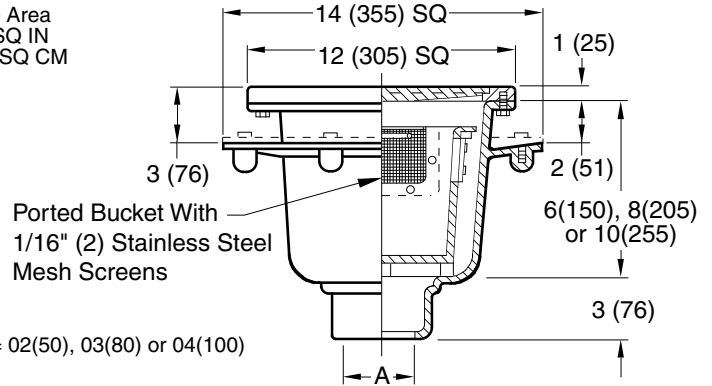
12" (305) TOP - DAIRY DRAINS FOR QUARRY TILE FLOORS

FUNCTION: Used in creameries, dairies, breweries and other locations which utilize a quarry tile floor requiring a 3" (76) flange to top dimension. The ported sediment bucket catches all solids yet provides ample drainage.



WITH DOME BOTTOM STRAINER

Free Area
 42 SQ IN
 (271) SQ CM



WITH SEDIMENT BUCKET

- 6"(150) deep 8"(205) deep 10"(255) deep **CAULK OUTLET** 6"(150) deep **8"(205) deep** 10"(255) deep
- Fig... 3110C ... 3120C ... 3130C ... Fig... 3111C ... 3121C ... 3131C
- Fig... 3110Y ... 3120Y ... 3130Y ... Fig... 3111Y ... 3121Y ... 3131Y

FEATURES, OPTIONS & ORDERING INFORMATION

REGULARLY FURNISHED: Cast Iron Flanged Receptor with Seepage Holes, Acid Resistant Coated Interior, Nickel Bronze Rim and Secured Grate. Aluminum Dome Bottom Strainer or **Sediment Bucket** as Indicated by Figure Number.

- OPTIONAL MATERIALS:**
- All Duco Cast Iron Receptor -CI
 - All Galvanized Receptor -G

- VARIATIONS:**
- Aluminum Flat Bottom Strainer -FBS
 - Aluminum Slotted Sediment Bucket -ASB (in place of ported bucket)
 - Flashing Clamp -C
 - Less Flange (Specify Fig. 3115,3125,3135,3116,3126,3136)

- Polished Aluminum Dome Bottom Strainer -PDBS
- Solid Bottom Ported Sediment Bucket with Stainless Steel Mesh Screens -SBP
- Vandal Proof Grate -U
- L Speedi-set Service Weight 02(50), 03(80) & 04"(100) sizes only
- LXH Speedi-Set Extra Heavy 02(50), 03(80) & 04"(100) sizes only

NOTE: Dimensions shown in parentheses are in millimeters.

SUFFIX NUMBER SQUARE RIM

DESCRIPTION

<input type="checkbox"/>	-10	Less NB Rim and Grate
<input type="checkbox"/>	-11	Less Grate w/NB Rim
<input type="checkbox"/>	-12	With NB Rim and 1/2 Grate
<input type="checkbox"/>	-13	With NB Rim and 3/4 Grate
<input type="checkbox"/>	-14	With NB Rim and Grate with 2 1/2" (64) SQ Center Hole
<input type="checkbox"/>	-15	With NB Rim and Aluminum Recessed Grate
<input type="checkbox"/>	-19	With NB Rim and Hinged Grate
<input type="checkbox"/>	-21	With NB Rim and Grate with 4" (100) DIA NB Funnel
<input type="checkbox"/>	-22	With NB Rim and Grate with 6" (150) DIA NB Funnel
<input type="checkbox"/>	-25	With NB Rim and Grate with 8 1/4(210) x 3 1/4(83) x 4 1/2"(115) High Oval NB Funnel
<input type="checkbox"/>	-26	With NB Rim and Grate with 6(150) x 2 1/2(64) x 1"(25) High Oval NB Funnel
<input type="checkbox"/>	-41	With NB Rim and Solid Cover
<input type="checkbox"/>	-42	With NB Rim and 1/2 Solid Cover
<input type="checkbox"/>	-43	With NB Rim and 3/4 Solid Cover
<input type="checkbox"/>	-44	With NB Rim and Solid Cover with 2 1/2" (64) DIA Center Hole
<input type="checkbox"/>	-69	With NB Rim and XH Stainless Steel Secured Grate

H	04/10/02	Rev. S.S. Mesh Size	JJ	CL	WEIGHT POUNDS	VOLUME CUBIC FEET	FIGURE NUMBER 3110-3131 SERIES
F	03/14/02	Corrected Dim. Location	JJ	AM			
REV.	DATE	DESCRIPTION	BY	CKD. BY			

DRAWING NUMBER **S3110**
 SIZE **A**
 SCALE: **NONE**
 DATE: **9-19-85**
 APPROVED BY: **SJM**
 CHECKED BY: **JD**
 DRAWN BY: **PJ**
3110-3131 SERIES
 DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE
 WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA

GOVERNOR STANDARD MODEL



2 PSIG

STANDARD MODEL

Inlet Pressure Range: 3" W.C. to 2 PSIG

MAIN FEATURES

ANSI Z21.80A-2012 / CSA 6.22A-2012(R2016) Class I for outlet pressures up to 14" W.C. Certified

Integral Vent Limiter

External Vent Limiter – no vent line required**

Positive 100% bubble tight lockup

Inlet and Outlet test ports 500 to 1 Turndown

Filter included in all models

SPECIFICATIONS

Suitable for use with Natural Gas,

LPG, and other non-corrosive, clean gas

Inlet Pressure: 3" W.C. to 2 PSIG CSA approved

Max. Inlet 7.25 PSIG for non-CSA applications

Outlet pressure: 2" W.C. to 14" W.C. and up to 4.25 PSIG for non-CSA applications

Temperature range: -40°F to 150°F

Connections: ½" thru 4"

Maximum Emergency Inlet Exposure Pressure: 80 PSIG

Suitable for Indoor or Outdoor Installation***

VENT SIZE

1/4" NPT 1/2" – 1"

1/2" NPT 1 1/4" – 4"

OUTLET SPRING RANGE

Green 2" W.C. to 5.1" W.C.*

Red 2.75" W.C. to 7.87" W.C.*

White 4" W.C. to 11.8" W.C.*

Black 6" W.C. to 14" W.C.*

Yellow 9.8" W.C. to 27.5" W.C.*

Violet 23.6" W.C. to 59" W.C. or 0.85 to 2.13

PSIG * Orange 55" W.C. to 118" W.C. or 2 to 4.26 PSIG

* Spring is CSA outlet pressure certified

** As Approved by Local Codes and Standards

*** Brass vent limiter must be removed for outdoor installation

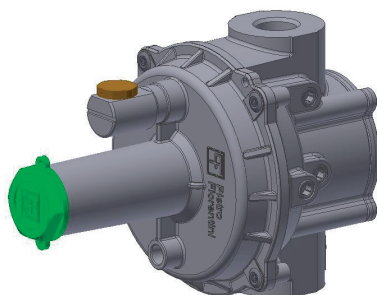
TECHNICAL DATA

Capacity in cfm for .60 Specific gravity gas with filter (capacity without filter in brackets)

	Outlet Pessue Set Point	Operating Inlet Pressure			
		14" W.C.	1 PSIG	2 PSIG	
GPR1	31051 1/2"	8" W.C.	386 (360)	552 (649)	785 (923)
		11" W.C.	218 (256)	511 (601)	785 (923)
	31052 3/4"	8" W.C.	369 (450)	665 (812)	946 (1154)
		11" W.C.	363 (321)	616 (751)	946 (1154)
	31053 1"	8" W.C.	495 (585)	893 (1,055)	1270 (1154)
		11" W.C.	353 (417)	825 (977)	1270 (1154)
31150 1/2" High Capacity	8" W.C.	610 (855)	1097 (1,543)	1558 (2193)	
	11" W.C.	433 (609)	10,14 (1,428)	1558 (2193)	
31151 3/4" High Capacity	8" W.C.	714 (1,080)	1284 (1,949)	1824 (2771)	
	11" W.C.	507 (770)	1187 (1,803)	1824 (2771)	
31152 1" High Capacity	8" W.C.	903 (1,283)	1625 (2,314)	2309 (3290)	
	11" W.C.	642 (914)	1503 (2,142)	2309 (3290)	
GPR2	31153 1 1/4"	8" W.C.	2,071(3,062)	3,735 (5,522)	5311 (7851)
		11" W.C.	1,476 (2,183)	3,457 (5,110)	5311 (7851)
	31154 1 1/2"	8" W.C.	2,567 (3,197)	4,629 (5,766)	6581 (8197)
		11" W.C.	1,829 (2,279)	4,284 (5,336)	6581 (8197)
	31155 2"	8" W.C.	5,179 (5,854)	9,339 (10,557)	13278 (15009)
		11" W.C.	3,691(4,173)	8,643 (9,336)	13278 (15009)
	31156/F 2 1/2"	8" W.C.	6,530 (7,431)	11,775 (13,999)	16741(19051)
		11" W.C.	4,655 (5,297)	10,898 (12,401)	16741(19051)
	31157/F 3"	8" W.C.	7,205 (9,007)	12,993 (16,242)	18473 (23092)
		11" W.C.	12,025 (6,240)	12,025 (15,032)	18473 (23092)
	31158/F 4"	8" W.C.	12,835 (15,762)	23,245 (28,424)	32906 (40411)
		11" W.C.	9,149 (11,236)	21,420 (26,306)	32906 (40411)

Tab.3

For additional sizing, visit www.gasinside.com www.GasInside.com • 888.618.8787





HB

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Fax (800) 362-1463
www.PRIER.com

Anti-Siphon Angle Sill Faucets & Hose Bibbs

C-155 C-157 **C-158** C-255 C-257 C-258 Styles

Application



Features

Prier Anti-Siphon Angle Sill Faucets are designed for areas that require water service with an anti-siphon backflow check valve connection, but are not subject to freezing temperatures. Typical installations include outdoor connections in mild climates or any indoor installation for residential, commercial, institutional and industrial applications. An optional valve box is available in either satin nickel or brass finish.

- Heavy Pattern Cast Brass Construction with Solid Cast Brass Mounting Flange
- Optional Heavy Patterned Casted Brass Valve Box in Satin Nickel or Brass finish
- Satin Nickel Plated or Polished Chrome Body
- Stainless Steel Seat Washer Screw & Handle Screw
- Powder Coated Non-Ferrous Metal Handle or Operating Key on Loose Key Vandalproof Sill Faucets
- Full Circle ACME Threads on Stem Assembly with Standard 1/4" L Size Seat Washer
- Lock Shield Cap
- AFG Teflon with Graphite Packing
- Vacuum Breaker Backflow Check Valve Approved under ASSE 1011 and CSA B64.2



Ordering



C-158NP.75

C-155NP.50

C-155BX1

Operator

- 1-Handle
- 2-Loose Key
- 3-Handle & Key

Inlet Type
 5-FPT Inlet
 7-SWT Inlet
 8-NPT Inlet

Finish
 NP-Satin Nickel Plated
 CP-Polished Chrome Plated

Inlet Size
 50-1/2"
 75-3/4"

Box Finish

- 1-Satin Nickel Plated
- 2-Rough Brass

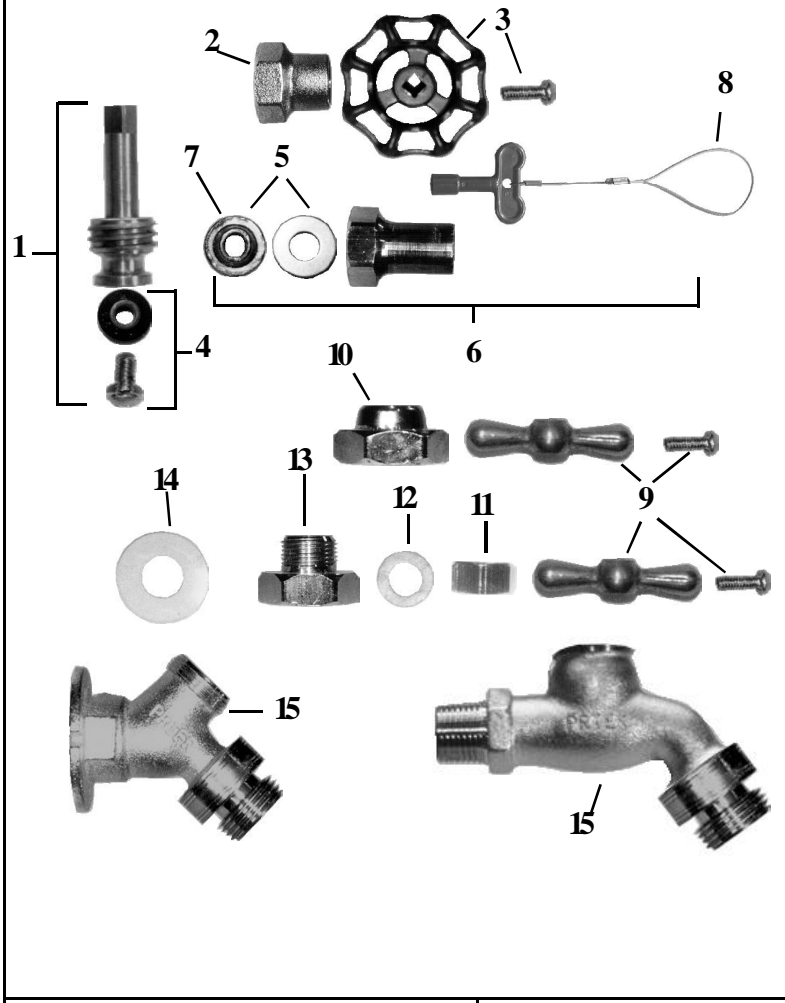




4515 East 139th Street
 Grandview, MO 64030
 800-362-9055
 Fax 800-362-1463

C-155/158/255/258

Parts for Anti-Siphon Angle Sill Faucets & Hose Bibbs



ID	Part No.	Description
1	231-0001	Stem Assy for 155/255/158
1	231-0002	Stem Assy for 158ST
2	300-1008	Valve Stem Cap for 155/157
3	C-134KT-805	Handle & Screw Kit
4	C-135KT-802	Seat Washer Kit 1/4" L Bev.
5	C-134KT-803	Stem Packing Kit
6	C-134KT-804	Loose Key Conversion Kit
7	390-1001	Packing Only
8	C-108KT-808	Loose Key on Lanyard
9	C-138KT-801	T-Handle Kit for C-158
10	310-1012	Packing Nut for C-158
11	310-0006	Stuffing Box for C-158ST
12	393-0001	Stuffing Box packing
13	310-0005	Packing Nut for C-158ST
14	390-0001	Packing for C-158ST
15 _a	320-0003	Brass VB Washer
15 _b	300-0026	Hose Piece for VB
15 _c	324-0001	Spring for VB
15 _d	337-0001	Stop/Release Pin for VB
15 _e	346-0002	Rubber Washer for VB
15	C-434KT-806	Complete VB Assembly

Model C-155/157

NP-Satin Nickel
 CP-Polished Chrome

1/2" FPT Inlet
 3/4" FPT Inlet

Model C-155BX

BX1 Satin Nickel
 BX2 Rough Brass

Model C-158

NP-Satin Chrome
 1/2" MPT Inlet
 3/4" MPT Inlet
 Stuffing Box Packing (ST)

Model C-255/7

NP-Satin Nickel
 CP-Polished Chrome

1/2" FPT Inlet
 3/4" FPT Inlet

Model C-258

NP-Satin Chrome
 1/2" MPT Inlet
 3/4" MPT Inlet

LavAdvantage™

Thermostatic Heater Ideal for Handwashing and Other Fixed or Variable Flow Applications

Specifications

Tankless Electric Water Heater

Applications

- Handwashing
- Kitchen, bar, utility sinks
- Fixed or variable flow
- Ideal for multiple sensor or metering faucets
- Eyewash fountains (EE models - 90°F max)
- Sanitation (S models - 180°F)

Performance Features

- Self-diagnostics with intelligent controls actively protect heater in installed environment
- SafeStart™ technology engages upon start-up to help avoid dry-fire occurrence
- Industry's lowest activation with 0.2 GPM turn on flow
- Digital LED display with accessible user interface communicates system status and heater operation feedback
- Silent operation on all models except for SPEX012240T
- Mounts in any orientation for a flexible installation
- Compact size fits almost anywhere; suitable for ADA compliant facilities
- Only one input line, hot or cold, needed for an easy installation
- Designed to deliver hot water to a single pipe faucet, mixing valves or mixing faucets
- Integral 3/8" compression fittings; no soldering or sweat connections required
- No T&P relief valve needed (check local codes); Ready to go, right out-of-the-box
- Save water and time by installing unit at the point-of-use
- Control system activates heater only on demand
- High temperature limit switch enables safe operation
- Active energy management with power modulation allows for thermostatic accuracy
- 5-year limited warranty on leaks, 1-year on parts

Product Specifications

Dimensions:	10.75" x 5.25" x 3"
Weight:	4 lb
Cover:	ABS-UL rated 94 5VA
Color:	White
Adj. Temperature Range:	70°F-140°F*
Min. Dynamic Operating Pressure:	30 PSI
Max. Dynamic Operating Pressure:	150 PSI
Element:	Replaceable Nichrome cartridge insert
Fittings:	3/8" compression fittings
UL listed file number:	E86887

U.S. Patent #'s: 4,762,980 and 4,960,976

Special Design Service

Inquiries for units for unique applications are welcome.
Call our Technical Service department at **1-800-543-6163**.

IWH



Tested and certified by the Water Quality Association against NSF/ANSI 372 for lead free compliance.



Note: For optimum performance, mounting location should be located within 2 feet of fixture.

Suggested Specification

Tankless water heater shall be an Eemax LavAdvantage model number SPEX_____.

Unit shall have ABS-UL 94 5VA rated cover. Unit shall have 0.2 GPM turn on. Unit shall allow mounting in any direction. Element shall be replaceable cartridge insert. Unit shall have replaceable filter in the inlet connector. Element shall be iron free, Nickel Chrome material. Tankless water heater to utilize complex algorithm, actively managing power application to real time system demand. Integrated flow meter, along with inlet and outlet temperature sensors provide data which allows the unit to instantly adapt to variations in input parameters. Heater shall be fitted with 3/8" compression fittings to eliminate need for soldering. Maximum operating pressure of 150 PSI. Accessible diagnostic features to include error/fault display. Hot water storage tanks prohibited. Unit shall be Eemax or approved equal.

Tankless water heater user interface must have the following capabilities:

- Selectable display including Celsius /Fahrenheit, setpoint, flow rate, inlet temperature outlet temperature, power factor
- Capable of displaying flow rate in gallons per minute & liters per minute
- Diagnostic features to include error/fault display
- Control board must maintain error/fault history of 5 events

Specification options to be included with SPEX models:

- ___ **EE** Emergency Eyewash. Meets ANSI tepid water requirements. Factory set to 90°F. Max temp. 90°F.
- ___ **ML** Multiple Lavatory. Factory set to 110°F. Max temp. 110°F
- ___ **S** Sanitation. Factory set to 120°F. Max temp. 180°F.
- ___ **N4** NEMA 4 steel cabinet with powder coat finish
- ___ **N4X** NEMA 4 stainless steel, corrosion-resistant cabinet

*Special settings available, see specification options

ProSeries XTP™

Thermostatic Water Heater for Commercial and Industrial Applications

Specifications

Tankless Electric Water Heater

Applications

- Booster (up to 180°F)
- Recirculation loop*
- Washdown processes
- Commercial kitchens / utility sinks
- Kitchen, wet bar, utility sinks
- Mop sinks
- Dishwasher
- Handwashing (variable and fixed-flow)

Performance Features

- Adaptive Stability Technology™ assesses the heater condition and shifts unit operation to ensure a consistent and reliable output
- Includes wall mounting bracket allowing for easy, flexible installation, reducing time and labor
- SafeStart™ engages upon start-up to avoid dry-fire occurrence
- 4-line, 20-character LED display delivers an enhanced user experience - display relays system status & operation feedback
- Built to last - constructed of powder-coated galvanized steel, stainless steel heating chambers and sheathed copper heating elements, protecting the heater and minimizing the occurrence of rust and corrosion
- Self-diagnostics with intelligent controls actively protect heater in installed environment
- Flow activation at 0.5 GPM/ 1.89 LPM across product line
- Max flow of 20 GPM
- Fittings suit common plumbing connections (3/4" NPT)
- Temperature stability at +/- 1°F or +/- 0.6°C output
- High temperature limit switch enables safe operation
- Powered by three phase delta, capable of supporting locations serviced by three phase wye or three phase delta power
- Only one input water line, cold or hot, needed for installation
- Factory set to 120°F
- Compact size for flexible installation
- User adjustable turn on flow
- User adjustable temperature settings 60° - 180°F
- Inlet/outlet thermistors for precise temperature control
- Tamper resistant controls (hardware lockout)
- IP25-rated cover prevents water intrusion within the system (water run-off and minimal corrosion)

Optional Features (NEMA cabinet required)

- N4 (powder coated steel), N4X (304SS) N4X6 (316SS) enclosures
- Free standing legs
- Freeze protection for harsh climate, up to -30°F
- Non-fused or fused electrical disconnect
- GFCI
- Explosion proof – C1D2 Compliant, local certification required. Class Z purge and pressurization system provided with pressure switch for alarm controls. For classification other than C1D2 please contact the factory to discuss options.
- Siren and beacon - audible and visual alarm (C1D2 compliant when paired with explosion proof package)
- Display is visible regardless of NEMA cabinet selection

Product Specifications

Min. Operating Pressure:	35 PSI
Max. Operating Pressure:	150 PSI
Optimum Operating Pressure:	60-90 PSI

*In accordance with NEC guidelines, the water heater is designed for a maximum continuous duty cycle of 3 hrs. at 100% power output. After 3 hrs. heater should be powered down for long enough to return heater and electrical infrastructure to ambient temperature.

Information and product specifications contained in this document are subject to change without notice. REV 2020-05



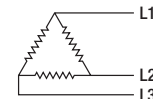
Electrical configuration and requirements

All Eemax three phase units are custom made to order and as such, are non-returnable and non-refundable. Check your electrical supply, making sure all criteria for operating your Eemax water heater are met.

Eemax 480V and 208V Three Phase Units Delta Configuration

Requires: 3 Lives and 1 Ground (earth)

ProSeries XTP is compatible with both delta and wye (Y) electrical configuration requirements. When converting a Y configured unit to a ProSeries XTP delta configured model, the neutral leg is not required.



Special Design Service

- Inquiries for units for unique applications are welcome. Call our Technical Service department at **1-800-543-6163**.
- Custom orders non-refundable

Suggested Specification

Tankless water heater shall be an Eemax model number _____.

Factory installation in a _____ (N4/N4X/N4X6) enclosure.

Enclosure to be fitted with the following features:

_____ FP	Freeze protection (-30°F)
_____ EDS	Non-fused disconnect
_____ FDS	Fused disconnect
_____ EP	Explosion proof (C1D2 compliant)
_____ GFCI	True RMS GFCI with digital display and reset
_____ SK	24" legs for free standing applications
_____ SB	Siren and Beacon
_____ DC	Dry contact
_____ ES	Emergency stop - push button

Tankless water heater must have water connections on the bottom and be constructed with NSF61 listed materials. Unit to accommodate vertical (upright) or horizontal mounting orientations. Heating element to be sheathed, copper cartridge style, designed for field replacement. Tankless water heater to use 4 line, 20 character LED digital display. Display to include selectable Celsius / Fahrenheit, inlet temperature, outlet temperature, and set point temperature. Display to be capable of relaying flow rate in gallons per minute or liters per minute. Diagnostic features to include error and fault code notifications via digital display. Control board to maintain error/fault history. Water heater must be protected by redundant safeties and redundant safeties to include employ integrated flow meter that will ensure accurate turn-on / turn-off flow rate. Unit shall have a 0.5 GPM turn on flow. Water heater shall modulate power to the heating elements to maintain a user-selected output temperature between 60 - 180°F (subject to incoming water temperature). The unit shall be equipped with both computer-controlled and electromechanical auto resetting thermostat switches for high-limited temperature protection. Maximum operating pressure of 150 PSI. The water heater shall be fitted with 3/4" NPT fittings. Heater shall employ technology that engages upon start-up to avoid dry-fire occurrence. Unit shall be Eemax or approved equal.

ProSeries XTP

Thermostatic Water Heater for Commercial and Industrial Applications

Specifications

Tankless Electric Water Heater

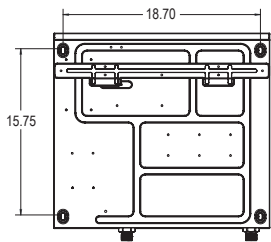
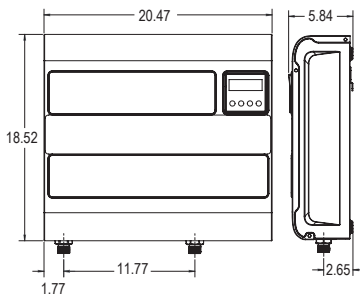
MODEL NUMBER	KW	AMPS PER PHASE	RECOMMENDED WIRE SIZE (90° C/CU)	TURN ON (GPM)	MAX FLOW (GPM)	TEMPERATURE RISE °F										
						1.0 GPM	2.0 GPM	3.0 GPM	4.0 GPM	5.0 GPM	6.0 GPM	7.0 GPM	8.0 GPM	9.0 GPM	10.0 GPM	
VOLTS 208																
C	XTP018208	18	50	8 AWG	0.5	20.0	123°	61°	41°	31°	25°	20°	18°	15°	14°	12°
C	XTP024208	24	67	4 AWG	0.5	20.0	†	82°	55°	41°	33°	27°	23°	20°	18°	16°
C	XTP032208	31.2	87	3 AWG	0.5	20.0	†	107°	71°	53°	43°	36°	30°	27°	24°	21°
VOLTS 480																
C	XTP016480	16	19	12 AWG	0.5	20.5	109°	55°	36°	27°	22°	18°	16°	14°	12°	11°
C	XTP020480	20	24	10 AWG	0.5	20.5	137°	68°	46°	34°	27°	23°	20°	17°	15°	14°
C	XTP024480	24	29	10 AWG	0.5	20.5	†	82°	55°	41°	33°	27°	23°	20°	18°	16°
C	XTP027480	27	33	8 AWG	0.5	20.5	†	92°	61°	46°	37°	31°	26°	23°	20°	18°
C	XTP036480	36	43	8 AWG	0.5	20.5	†	126°	84°	63°	51°	42°	36°	32°	28°	25°
C	XTP048480	48	58	6 AWG	0.5	20.5	†	†	109°	82°	66°	55°	47°	41°	36°	33°
C	XTP054480	54	65	4 AWG	0.5	20.5	†	†	123°	92°	74°	61°	53°	46°	41°	37°

† Temperature electronically limited to factory preset temperature.

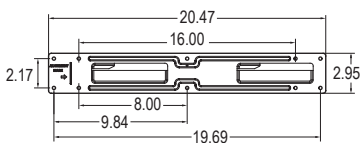
"C" indicates evaluation and compliance to either Underwriters Laboratories (UL) or Intertek (ETL) under CAN/CSA-C22.2 No. 64/No. 88.

Base Model Dimensions

Est. weight 36 lb. Designed for wall mounted installation.



Wall Bracket Dimensions

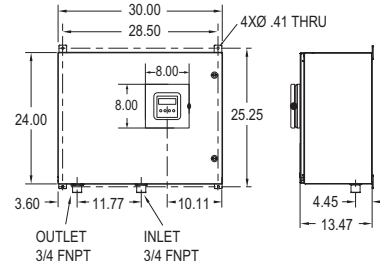


NEMA Cabinet Options

Dimensions: 24"H x 30"W x 13.5"D

- N4** Powder coated steel
- N4X** Corrosion-resistant 304 stainless steel
- N4X6** Corrosion-resistant 316 stainless steel

Est. total weight 130 lb. Designed for wall mounted installation.



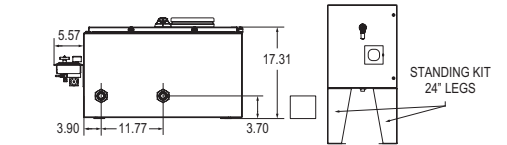
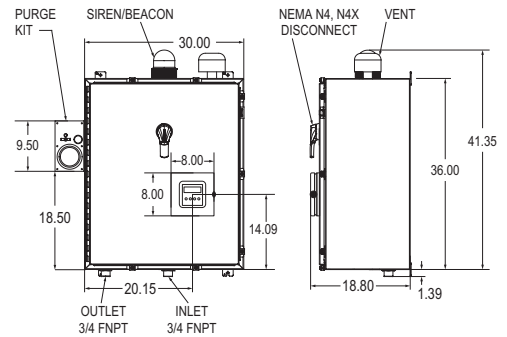
NEMA Cabinet Options and Accessories

Dimensions: 36"H x 30"W x 17.3"D

- N4** Powder coated steel
- N4X** Corrosion-resistant 304 stainless steel
- N4X6** Corrosion-resistant 316 stainless steel

These options require the large cabinet:

- FP** Freeze protection (-30°F)
- EDS** Non-fused disconnect
- FDS** Fused disconnect
- EP** Explosion proof purge kit and vent (C1D2 compliant)
- GFCI** True RMS GFCI with digital display and reset
- SK** 24" legs for free standing applications
- SB** Siren and Beacon
- DC** Dry contact
- ES** Emergency stop - push button

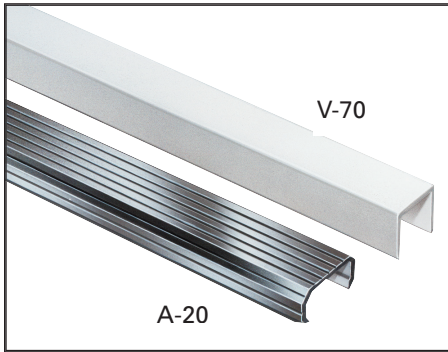


Est. total weight 225 lb, varies based on options. Designed for wall mounted installation. Free standing legs and other options available.

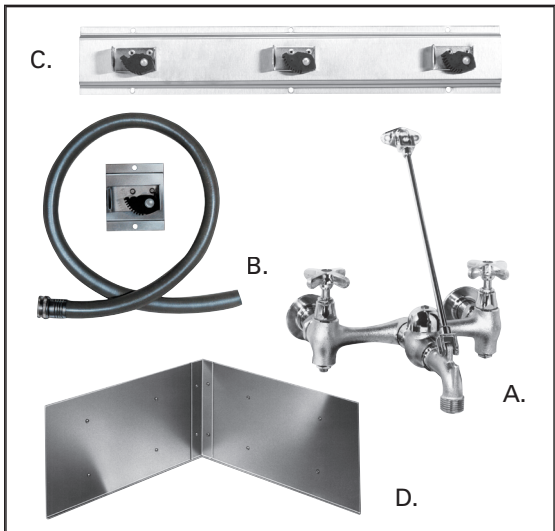
Model No. () Size (), as manufactured by Stern-Williams Co., Inc. Shoulders shall not be less than 8" high inside measurement, and not less than 1-1/4" wide. Drain shall be cast brass with stainless steel strainer cast integral and shall provide for a caulked lead connection not less than 1" deep to a 3" pipe. Receptor composed of pearl grey marble chips and white Portland cement ground smooth, grouted and sealed to resist stains.

An optional anodized extruded aluminum or vinyl bumper guard is offered for exposed sides. Cap to be attached on the job.

STERN
WILLIAMS
MTB®
ARCHITECTURAL
SPECIFICATIONS



MODEL	SIZE	ALUMINUM OR VINYL CAP FOR EXPOSED SIDES		
MTB SQUARE BASIN				
<input type="checkbox"/> MTB-2424	24"x24"x10"	<input type="checkbox"/> CAP ON 1 SIDE	<input type="checkbox"/> CAP ON 2 SIDES	<input type="checkbox"/> CAP ON 3 SIDES
MTB RECTANGULAR BASIN				
<input type="checkbox"/> MTB-3624	36"x24"x10"	<input type="checkbox"/> CAP ON 1 SIDE	<input type="checkbox"/> CAP ON 2 SIDES	<input type="checkbox"/> CAP ON 3 SIDES
A-20	Aluminum bumper guards			
V-70	Vinyl bumper guards			
-SS	Stainless steel caps, cast integral during production			

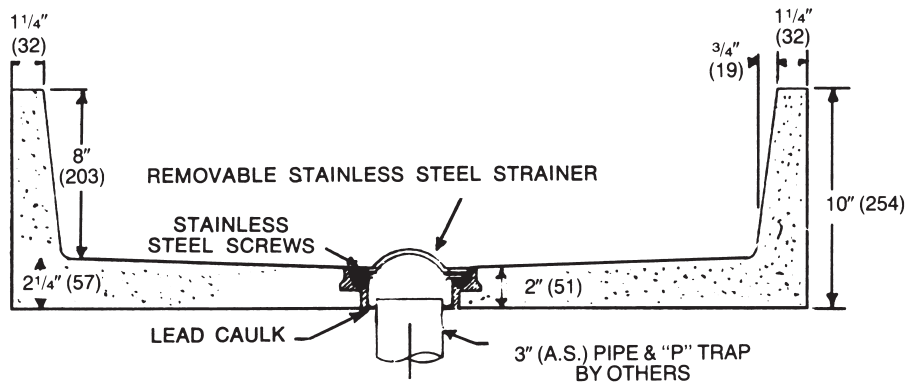


QUALITY OPTIONAL FITTINGS

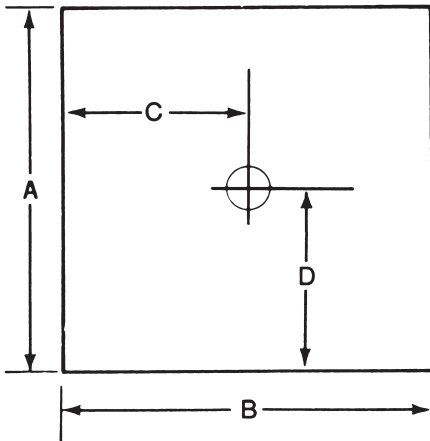
- A. **T-10-VB** Mop-Service sink fitting with vacuum breaker, adjustable top brace, 3/4" hose thread on spout with bucket hook inlets 8" on center, chrome finish.
- T-15 VB** same as above with polished chrome finish.
- B. **T-35** Hose and wall hook. Hose 36" long, with 3/4" chrome couplings. Wall bracket of stainless steel.
- C. **T-40** Stainless Steel Mop Hanger of stainless steel with #4 finish. . . 24" long, with 3 rubber spring loaded grips.
- D. **BP** Splash Catcher Panels of 20 ga. type 304 stainless steel.

JOB ARCHITECT
LOCATION ENGINEER

CROSS SECTION

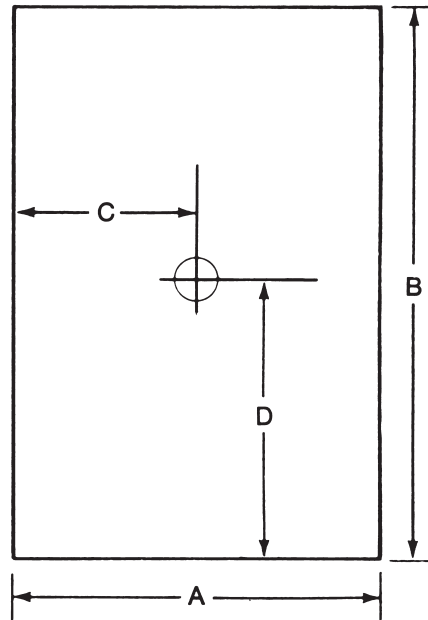


ROUGH-IN



MTB SQUARE BASIN

MODEL	SIZE	A	B	C	D
MTB-2424	Inches 24x24x10	24	24	12	12
MTB-2424	MM 610x610x250	610	610	305	305



MTB RECTANGULAR BASIN

MODEL	SIZE	A	B	C	D
MTB-3624	Inches 36x24x10	24	36	12	18
MTB-3624	MM 915x610x250	610	915	305	457

Note: All dimensions subject to manufacturing variance of plus or minus 1/4" (6 MM).

Washdown & Sill Fittings

387-LEFE27

@ JS

**CHICAGO
FAUCETS**
Geberit Group

Product Type

Inside sill fitting

Features & Specifications

- Full-flow hose thread outlet with inline vacuum breaker
- Vandal Proof 2-1/4" tee handle
- Slow compression operating cartridge, left-hand
- Complies with the requirements of the Buy American Act of 1933.


Performance Specification

- Rated Operating Pressure: 20-125 PSI
- Rated Operating Temperature: 40-140°F

Warranty

- 5-Year Limited Cartridge Warranty
- Lifetime Limited Faucet Warranty
- 1-Year Limited Finish Warranty

Codes & Standards

-  ASME A112.18.1/CSA B125.1

Job Name _____

Item Number _____

Section/Tag _____

Model Specified _____

Architect _____

Engineer _____

Contractor _____

Submitted as Shown Submitted with Variations

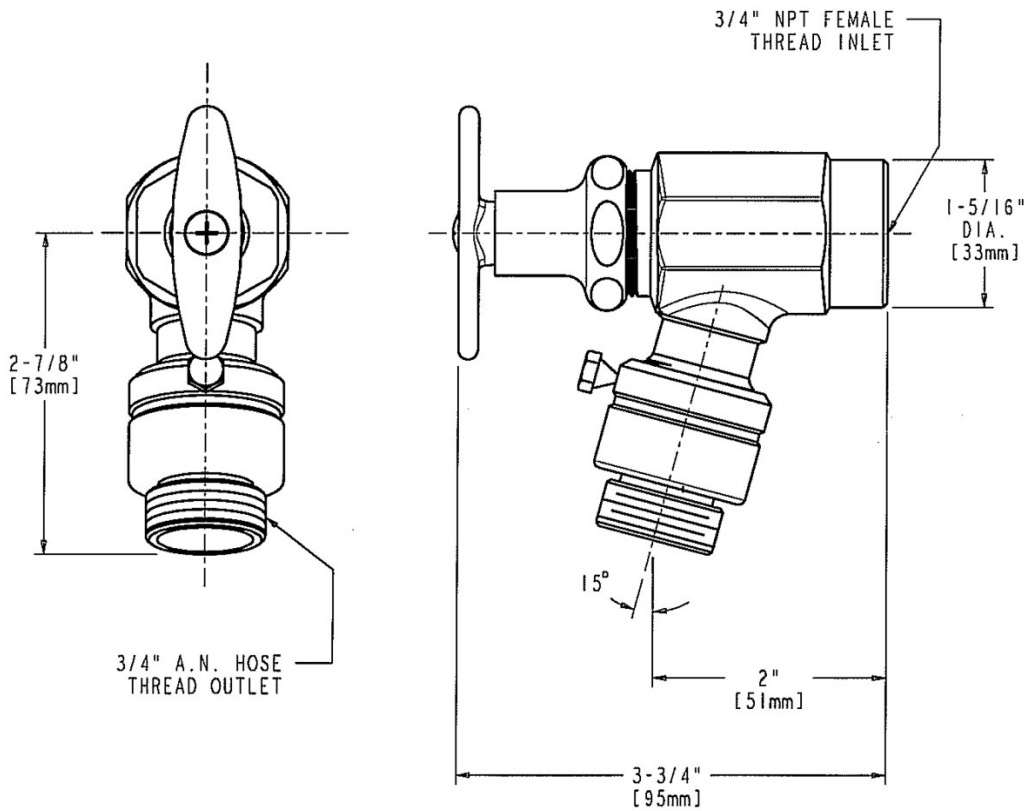
Date _____



2100 South Clearwater Drive
Des Plaines, IL
P: 847/803-5000
F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

Architect/Engineer Specification

Chicago Faucets No. 387-LEFE27, Inside Sill Fitting, wall-mounted, chrome plated. Full-flow, in-line vacuum breaker with hose thread outlet. 2-1/4" metal tee handle with square, tapered broach. Slow compression rebuildable cartridge, opens and closes 360° for fine adjustment, closes with water pressure, features square, tapered stem. 3/4" NPT female thread inlet. Wall flange not included. Hose connection vacuum breakers specially made to permit the attachment of portable hoses to hose thread faucets. Designed to prevent the flow of contaminated water back into the potable water supply, these devices require no plumbing changes, and screw directly onto a sill cock. NOTE: not intended for continuous pressure applications. Mounting hardware included.



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

Chicago Faucets, member of the Geberit Group, is the leading brand of commercial faucets and fittings in the United States, offering a complete range of products for schools, laboratories, hospitals, office buildings, food service, airports and sport facilities. Call 1.800.TECTRUE or 1.847.803.5000 Option 1 for installation or other technical assistance.



DECORUM® 20" x 18" WALL-HUNG LAVATORY WITH EVERCLEAN®

- 20" x 18" vitreous china lavatory with EverClean included
- Available with rear overflow or less overflow
- Recessed self-draining deck with minimal backsplash
- For concealed arm or wall support (wall hanger included)
- ADA and TAS compliant
- Shown with drain grid (sold separately)

- 9024.000EC** No faucet holes
- 9024.001EC** Center hole only (CHO)
- 9024.021EC** CHO with left hand soap dispenser
- 9024.011EC** CHO with right hand soap dispenser
- 9024.901EC** CHO less overflow
- 9024.921EC** CHO with left hand soap dispenser less overflow
- 9024.911EC** CHO with right hand soap dispenser less overflow
- 9024.004EC** 4" centers
- 9024.024EC** 4" centers with left hand soap dispenser
- 9024.014EC** 4" centers with right hand soap dispenser
- 9024.904EC** 4" centers less overflow
- 9024.924EC** 4" centers with left hand soap dispenser less overflow
- 9024.914EC** 4" centers with right hand soap dispenser less overflow
- 9024.008EC** 8" centers
- 9024.908EC** 8" centers less overflow



9024.004EC shown

Nominal Dimensions:

464mm (18-1/4") deep, 508mm (20") wide

Bowl sizes:

354mm (13-15/16") wide, 325mm (12-13/16") front to back, 127mm (5") deep

SEE NEXT PAGE FOR ROUGHING-IN DIMENSIONS

To Be Specified:

- Color: White
- Faucet:
- Faucet Finish:
- Supplies:
- 1-1/4" Trap:

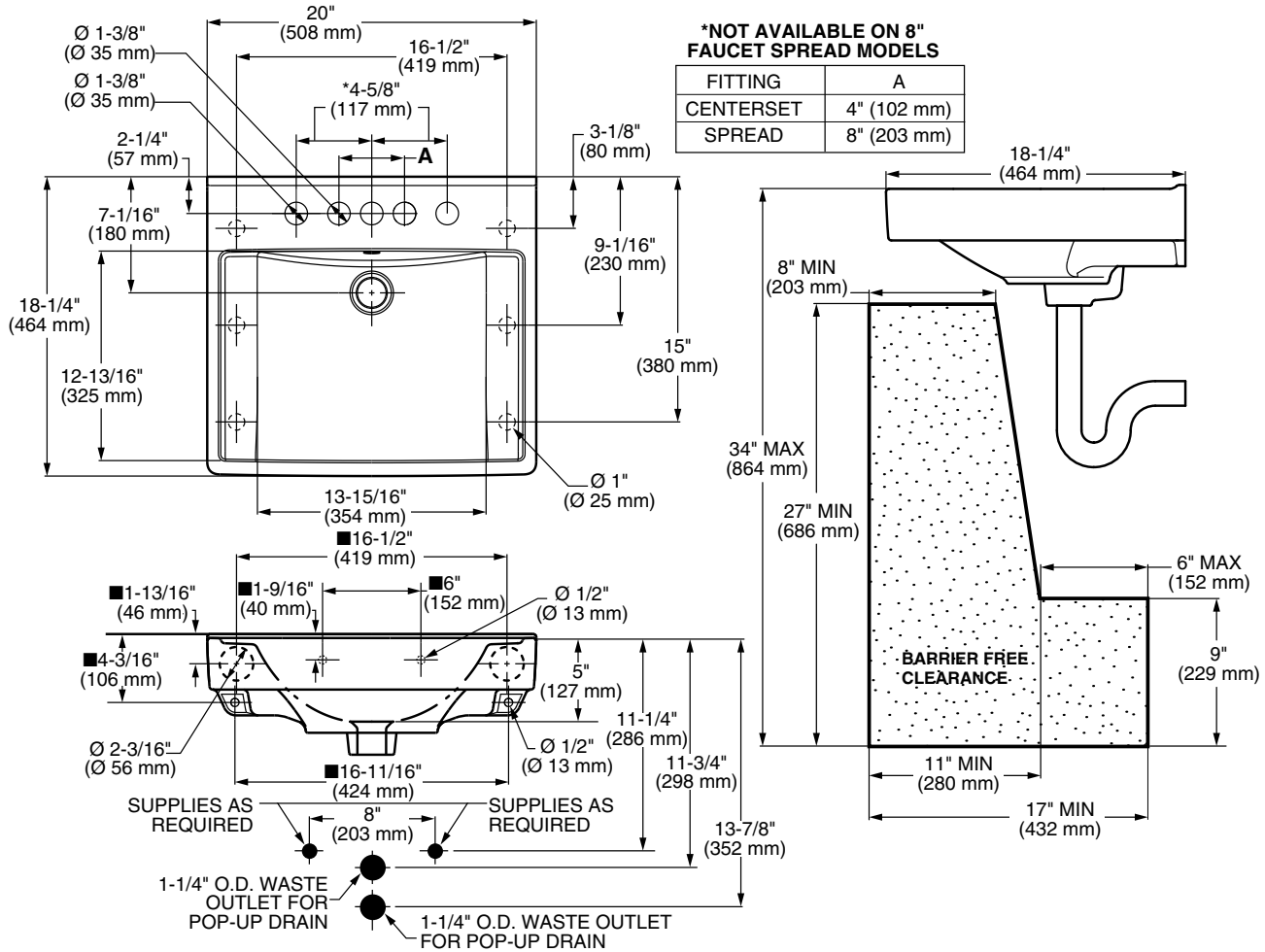
* See faucet section for additional models available

Compliance Certifications - Meets or Exceeds the Following Specifications:

- ASME A112.19.2 for Vitreous China Fixtures



MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND FACILITIES - CHECK LOCAL CODES.
Top of front rim mounted 864mm (34") from finished floor.



NOTES:

- LOOSE KEY ANGLE STOPS, LESS WALL ESCUTCHEONS. SUPPLIES REQUIRED.
- DIMENSIONS SHOWN FOR LOCATION OF SUPPLIES AND "P" TRAP ARE SUGGESTED.
- SUITABLE FOR REINFORCEMENT ONLY, ACTUAL DIMENSIONS MUST BE TAKEN FROM FIXTURE.
- FITTINGS NOT INCLUDED AND MUST BE ORDERED SEPARATELY.
- PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.
- INSTALLATION INSTRUCTIONS SUPPLIED WITH LAVATORY.
- IMPORTANT:** Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

 BARRIER FREE



Model 9024.000EC
No Faucet Holes



Model 9024.001EC
Center Hole Only (CHO)



Model 9024.004EC
4" Centers



Model 9024.008EC
8" Centers



Model 9024.011EC
CHO With Right Hand Soap Dispenser



Model 9024.014EC
4" Centers With Right Hand Soap Dispenser



Model 9024.021EC
CHO With Left Hand Soap Dispenser



Model 9024.024EC
4" Centers With Left Hand Soap Dispenser



Model 9024.901EC
CHO Less Overflow



Model 9024.904EC
4" Centers Less Overflow



Model 9024.908EC
8" Centers Less Overflow



Model 9024.911EC
CHO With Right Hand Soap Dispenser
Less Overflow



Model 9024.914EC
4" Centers With Right Hand Soap Dispenser
Less Overflow



Model 9024.921EC
CHO With Left Hand Soap Dispenser
Less Overflow



Model 9024.924EC
4" Centers With Left Hand Soap Dispenser
Less Overflow

Architectural/Engineering Specification:

Zurn HYDRO-X Power sensor faucets are ideal for high-use applications where **sustainable power**, **durability** and **hands-free operation** are necessary. Self-sustaining hydropower with battery backup for ten years of trouble-free operation, ADA compliant, polished chrome-plated cast brass sensor faucet with infrared proximity sensor for retrofit and new construction. Unit is furnished with a standard 0.5 GPM flow control and mounting hardware.

Zurn Lead Free products (-XL) is the line of durable, high quality brass faucets and fixtures that are designed and manufactured to comply with Section 1417 of the Safe Drinking Water Act (SDWA) which mandates the weighted average lead content of no more than 0.25% of the wetted surface.

Product Features:

- Self-Sustaining Hydropower for 10+ years operation
- Battery Backup
- Line Purge Mode (adjustable)
- Metering Mode (adjustable)
- 30 second Time Out Feature (adjustable)
- Infrared Convergence-Type Proximity Sensor
- Standard Chrome-plated Cast Brass Body
- In-line filter
- Inlet for 1/2" ball riser

Suffix Options:

- ADM Above Deck Mixer
- CP4 Cover Plate 4"[102] Centers
- CP8 Cover Plate 8"[203] Centers
- H4 Wrist Blade handle for ADM
- MV Temperature Mixing Valve
- SH Supply Hoses for Mixing Valve
- TMV-1 Thermostatic Mixing Valve for Single Faucets

Alternate Finishes:

- BN Brushed Nickel

Compliance and Certification:

- Low-Lead Compliant
- ADA Compliant
- ASME A112.18.1/CSA B125.1



*This device is WaterSense labeled when used with the appropriate flow rate and certified for residential and private restrooms.



Aerator Options:

	Flowrate GPM [LpM]	Vandal Resistant	*WaterSense Labeled	Outlet Type
-E	1.5[5.7]	✓	✓	Aerator
-F	0.5[1.9]	✓		Spray (Standard)
-J	1.5[5.7]	✓	✓	Laminar
-K	1.0[3.8]	✓	✓	Laminar
-L	1.0[3.8]	✓	✓	Aerator
-M	0.35[1.3]	✓		Spray
-N	0.5[1.9]	✓		Laminar

Power Supply Choices (Sold Separately):

- ACA 6 VDC Plug-In Power Converter
- HW6 Hardwired Power Converter

Optional Power Supply Accessories:

- CWB Connector Wire for Plug-In Power Converter
- MJ Mini Junction Box

NOTE: For Hardwire applications furnish P6000-HW6 power converter. Order P6000-HW6 power converter separately. The P6000-HW6 and P6000-MJ will power up to 8 sensor faucets. Hydropower assembly excluded on plug-in or hardwired faucet models.

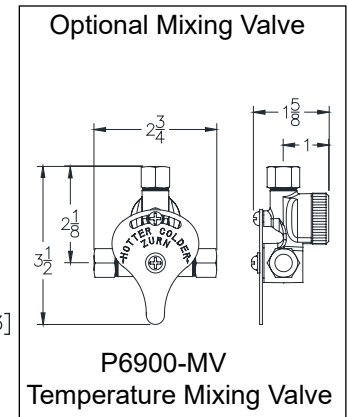
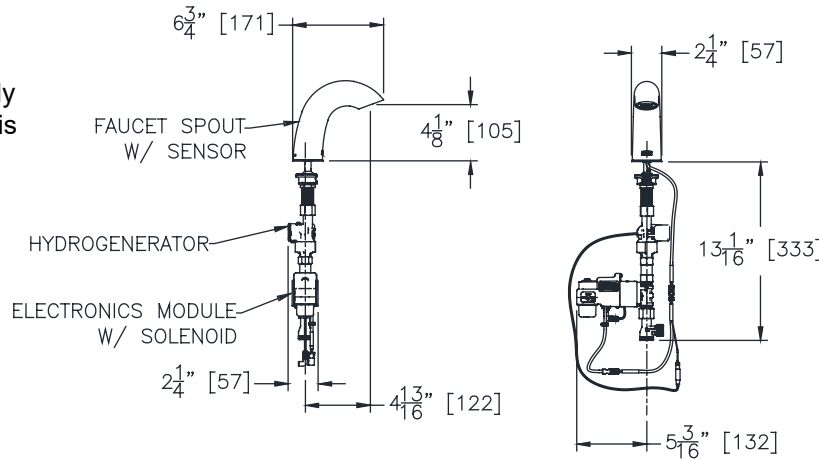
Architectural/Engineering Approval

The information contained in this document is subject to change without notice. Please contact Zurn for most up to date information.

TYPICAL Z6950-XL-S

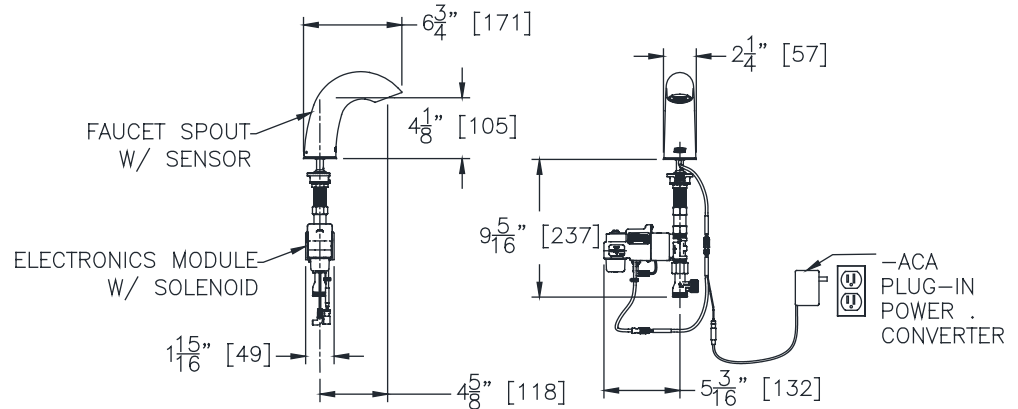
Self Sustaining Battery Powered Faucet

Recommended through hole diameter to properly mount the spout/shank is 1-1/8" to 1-1/4".



TYPICAL Z6950-XL-S-ACA

Plug-In Powered Faucet

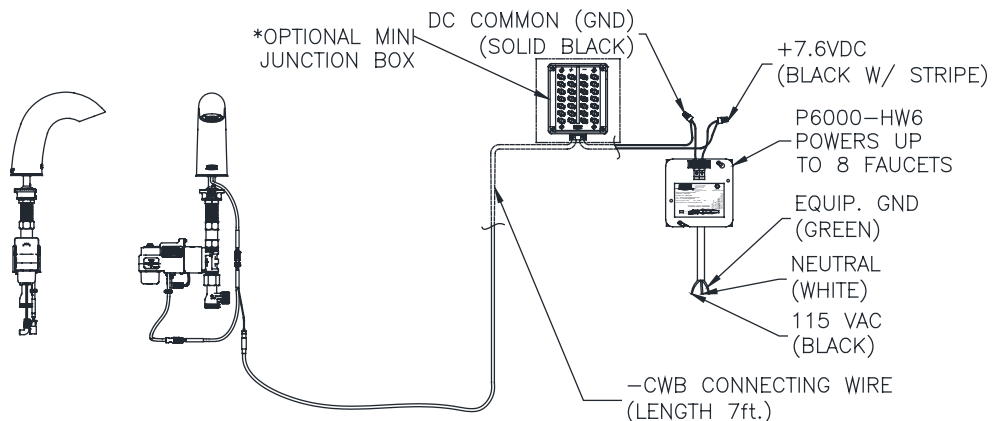


TYPICAL Z6950-XL-S-CWB

Hardwire Powered Faucet

* Optional: P6000-MJ mini junction box streamlines wiring for connecting up to 8 faucets to the P6000-HW6 power converter.

NOTE: MUST USE EITHER ZURN P6000-HW6 HARDWIRE POWER CONVERTER OR ZURN P6000-ACA PLUG-IN POWER CONVERTER TO ENSURE PROPER OPERATION. USING A POWER CONVERTER OTHER THAN ZURN MAY RESULT IN OPERATION MALFUNCTION OR UNIT FAILURE.



ESTATE® UNDERCOUNTER SINK

0484.000

- Classic oval undermount sink
- Made from vitreous china
- Unglazed rim for undercounter mount
- Front overflow
- Oval 17" x 14" Bowl
- Center drain
- Supplied with undercounter mounting kit and template
- Shown with Quentin Widespread Faucet 7440.801 (Not included)
- Coordinates with Estate® Suite of fixtures
- Available Exclusively at Ferguson® Showrooms



Nominal Dimensions:

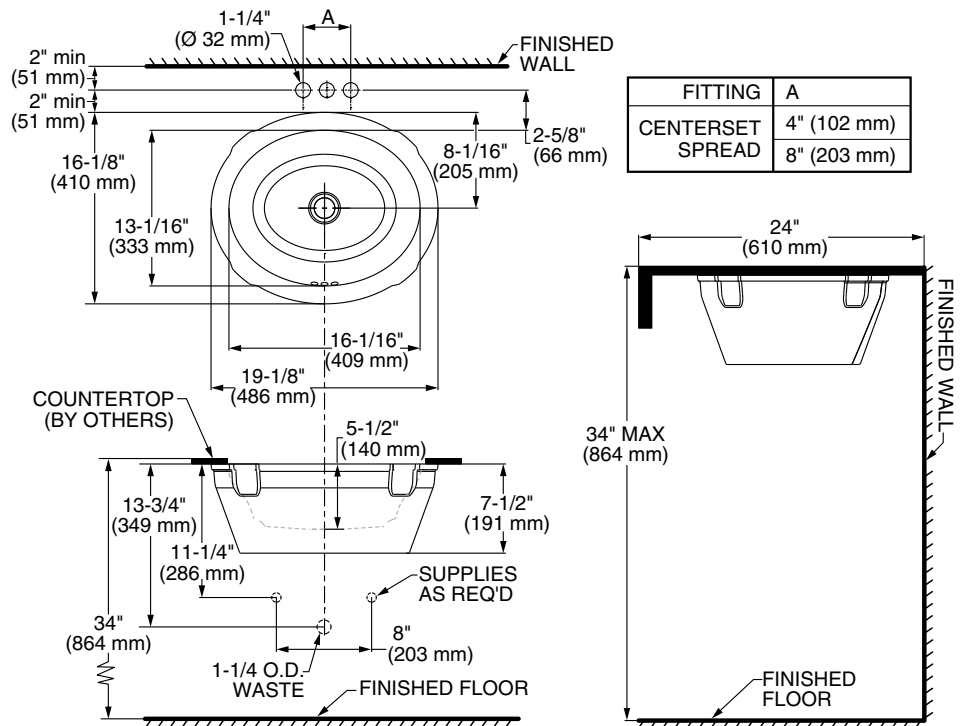
19-1/8" x 16-1/8" (486 x 410mm)

Bowl Size:

17" (432 mm) wide,
14" (356 mm) front to back,
5-1/2" (140 mm) deep

Compliance Certifications -
Meets or Exceeds the
Following Specifications:

- ASME A112.19.2M for Vitreous China Fixtures
- CAN/CSA B45 series



To Be Specified

- Color: White: Linen
- Faucet*:
- Faucet Finish:
- Supplies:
- 1-1/4" Trap:

* See faucet section for additional models available

NOTES:
* DIMENSIONS SHOWN FOR LOCATION OF SUPPLIES AND "P" TRAP ARE SUGGESTED. FOR COUNTERTOP CUTOUT AND INSTALLATION INSTRUCTIONS USE TEMPLATE SUPPLIED WITH SINK. FITTINGS NOT INCLUDED WITH FIXTURE AND MUST BE ORDERED SEPARATELY. SEALING COMPOUND SUPPLIED BY OTHERS.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ASME A112.19.2 / CSA B45.1. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.

Architectural/Engineering Specification:

Zurn HYDRO-X Power sensor faucets are ideal for high-use applications where **sustainable power**, **durability** and **hands-free operation** are necessary. Self-sustaining hydropower with battery backup for ten years of trouble-free operation, ADA compliant, polished chrome-plated cast brass sensor faucet with infrared proximity sensor for retrofit and new construction. Unit is furnished with a standard 0.5 GPM flow control and mounting hardware.

Zurn Lead Free products (-XL) is the line of durable, high quality brass faucets and fixtures that are designed and manufactured to comply with Section 1417 of the Safe Drinking Water Act (SDWA) which mandates the weighted average lead content of no more than 0.25% of the wetted surface.

Product Features:

- Self-Sustaining Hydropower for 10+ years operation
- Battery Backup
- Line Purge Mode (adjustable)
- Metering Mode (adjustable)
- 30 second Time Out Feature (adjustable)
- Infrared Convergence-Type Proximity Sensor
- Standard Chrome-plated Cast Brass Body
- In-line filter
- Inlet for 1/2" ball riser

Suffix Options:

- ADM Above Deck Mixer
- CP4 Cover Plate 4"[102] Centers
- CP8 Cover Plate 8"[203] Centers
- H4 Wrist Blade handle for ADM
- MV Temperature Mixing Valve
- SH Supply Hoses for Mixing Valve
- TMV-1 Thermostatic Mixing Valve for Single Faucets

Alternate Finishes:

- BN Brushed Nickel

Compliance and Certification:

- Low-Lead Compliant
- ADA Compliant
- ASME A112.18.1/CSA B125.1



*This device is WaterSense labeled when used with the appropriate flow rate and certified for residential and private restrooms.



Aerator Options:

	Flowrate GPM [LpM]	Vandal Resistant	*WaterSense Labeled	Outlet Type
-E	1.5[5.7]	✓	✓	Aerator
-F	0.5[1.9]	✓		Spray (Standard)
-J	1.5[5.7]	✓	✓	Laminar
-K	1.0[3.8]	✓	✓	Laminar
-L	1.0[3.8]	✓	✓	Aerator
-M	0.35[1.3]	✓		Spray
-N	0.5[1.9]	✓		Laminar

Power Supply Choices (Sold Separately):

- ACA 6 VDC Plug-In Power Converter
- HW6 Hardwired Power Converter

Optional Power Supply Accessories:

- CWB Connector Wire for Plug-In Power Converter
- MJ Mini Junction Box

NOTE: For Hardwire applications furnish P6000-HW6 power converter. Order P6000-HW6 power converter separately. The P6000-HW6 and P6000-MJ will power up to 8 sensor faucets. Hydropower assembly excluded on plug-in or hardwired faucet models.

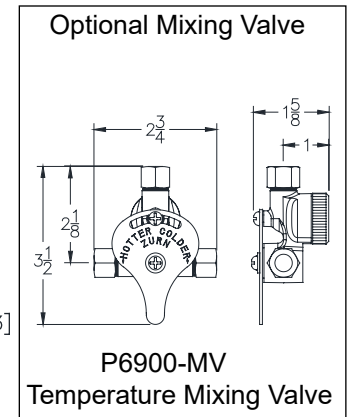
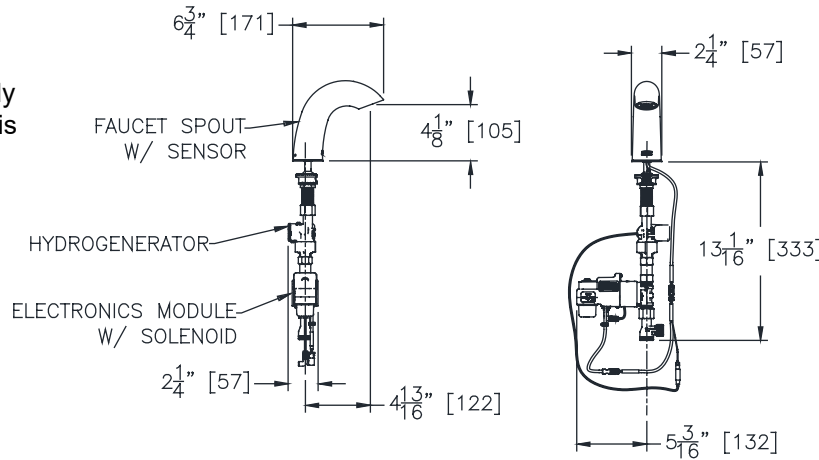
Architectural/Engineering Approval

The information contained in this document is subject to change without notice. Please contact Zurn for most up to date information.

TYPICAL Z6950-XL-S

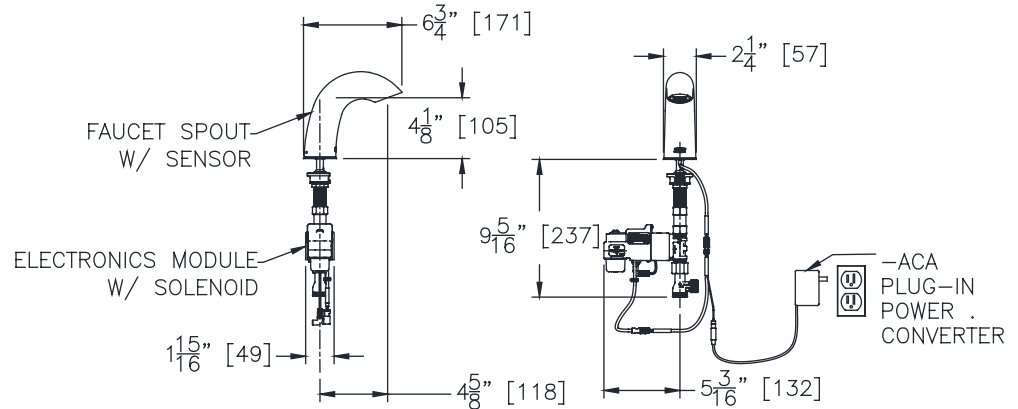
Self Sustaining Battery Powered Faucet

Recommended through hole diameter to properly mount the spout/shank is 1-1/8" to 1-1/4".



TYPICAL Z6950-XL-S-ACA

Plug-In Powered Faucet

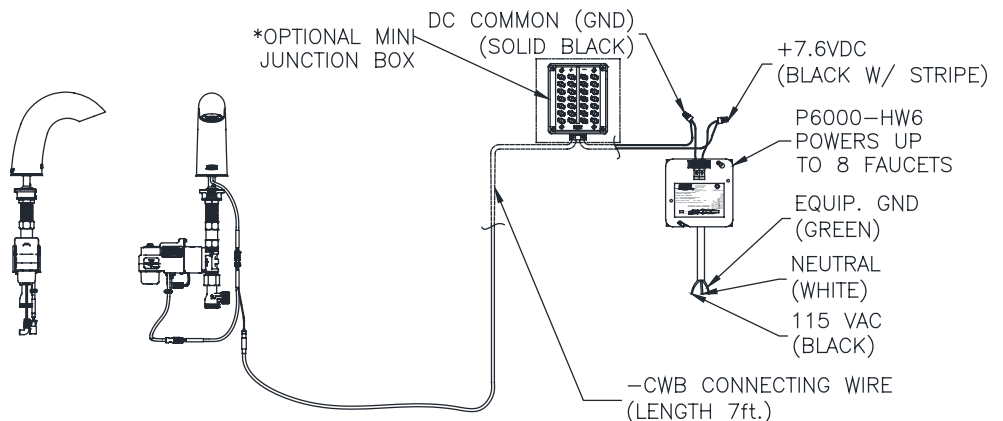


TYPICAL Z6950-XL-S-CWB

Hardwire Powered Faucet

* Optional: P6000-MJ mini junction box streamlines wiring for connecting up to 8 faucets to the P6000-HW6 power converter.

NOTE: MUST USE EITHER ZURN P6000-HW6 HARDWIRE POWER CONVERTER OR ZURN P6000-ACA PLUG-IN POWER CONVERTER TO ENSURE PROPER OPERATION. USING A POWER CONVERTER OTHER THAN ZURN MAY RESULT IN OPERATION MALFUNCTION OR UNIT FAILURE.





Z1350

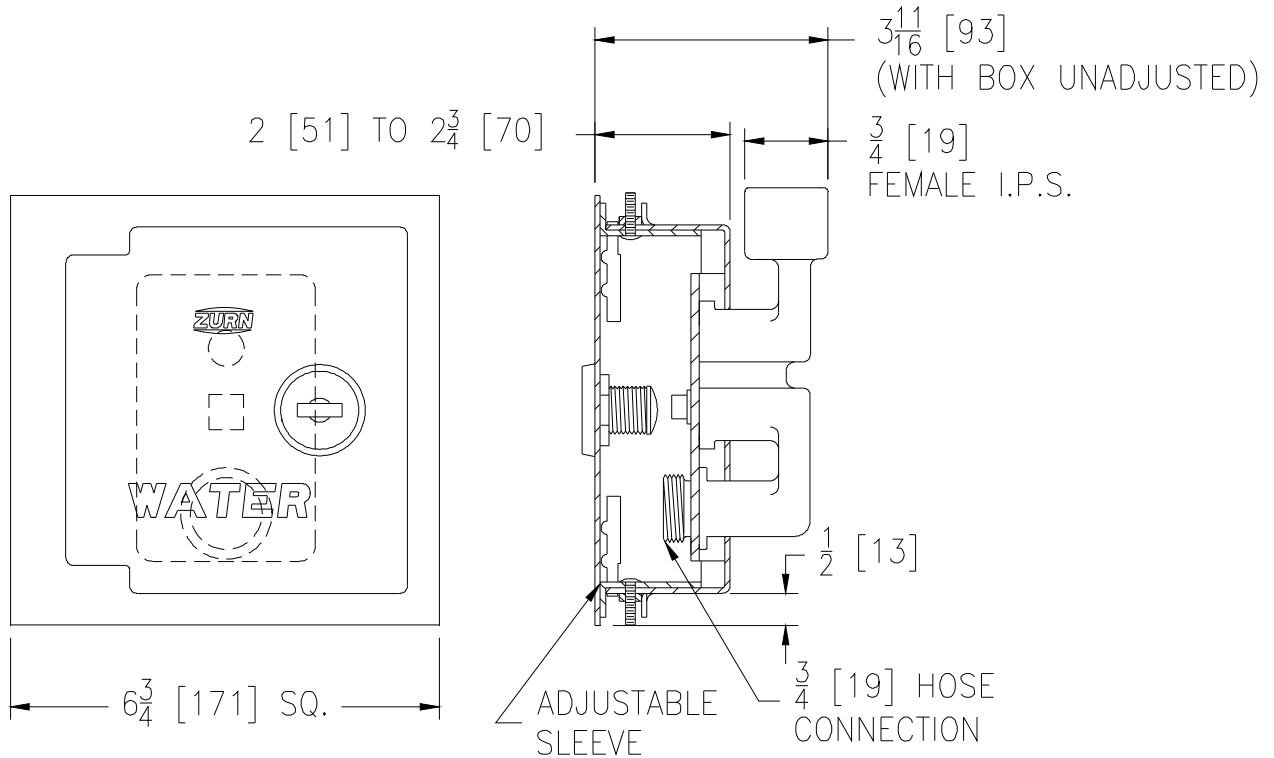
NARROW WALL HYDRANT

Encased, Moderate Climate

SPECIFICATION SHEET

TAG MWH

Dimensional Data (inches and [mm]) are Subject to Manufacturing Tolerances and Change Without Notice



Wall Thickness Inches	Approx. Wt. Lbs. [kg]
4 [102]	4 [2]

ENGINEERING SPECIFICATION: ZURN Z1350 Encased moderate climate wall hydrant for narrow wall installation. Complete with bronze body, all bronze interior parts, replaceable seat washer, screwdriver operated stop valve in supply, key operated control valve, and 3/4 [19] IP female inlet and 3/4 [19] male hose connection standard. Adjustable stainless steel box furnished with hinged cover, cylinder lock and "WATER" stamped on cover.

OPTIONS (Check/specify appropriate options)

SUFFIXES

- ___ -RK Hydrant Parts Repair Kit
- ___ -VB 3/4 [19] Adapter Vacuum Breaker
- ___ -34EL 3/4 [19] IP 90° Inlet Elbow Adapter
- ___ -34FS 3/4 [19] Solder Female Inlet Adapter

****NOTE:** The adjustable sleeve on the stainless steel box is provided with a gasket as standard, but additional caulking of all inside joints is required (by others) after the hydrant box has been properly set. Caulking should be performed on all open seams, including the seams where the gasket is present.

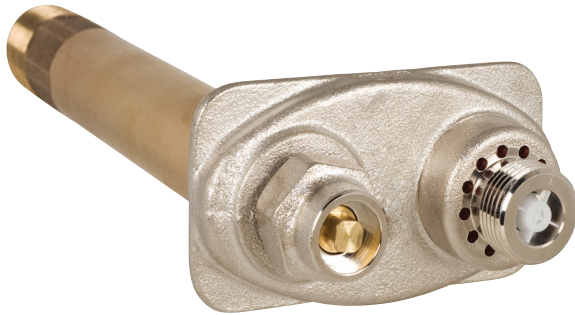
REV. J	DATE: 10/22/10	C.N. NO. 111945
DWG. NO. 58877		PRODUCT NO. Z1350



NW

C-634 Heavy Commercial Wall Hydrant

MasterSpec®



With Integral P-004 Vacuum Breaker

PRIER C-634 provides a year round source of water to areas that are subject to freezing temperatures. The hydrant valve is connected to the supply piping in the heated portion of the structure, eliminating the possibility of freezing. To assure freeze protection, the hydrant will drain even with the hose attached and under pressure.

- Anti-Siphon
- Freezeless
- Commercial / Industrial
- Double Backflow Check Valve

The integral vacuum breaker/backflow preventer provides protection against cross-connection with the potable water system, utilizing 2 check valves to prevent back pressure and a vacuum breaker to vent in the case of siphonage. This commercial wall hydrant is key operated, code approved, and flows up to 16 GPM. A removable operating key is provided to prevent unauthorized usage of the hydrant. No special installation tools are required.

FEATURES

- Field testable as required by ASSE 1052, pressure rated to 125 PSI, temperature to 140°
- Satin nickel plated body maintains an attractive finish
- Multiple vent holes ensure proper draining and reduce problems associated with insect nesting
- Patented PRIER "triple seal" positive shutoff system offers triple redundancy to assure shutoff
- High flow rate, 16 gallons per minute at 25 PSI differential
- Same key operates box lock and hydrant
- Tested to 250,000 cycles; designed to last the life of the plumbing system
- Heavy pattern cast brass hydrant for use with or without brass box or aluminum box
- Heavy duty brass piping, significantly stronger than copper, with threaded and sealed joints
- Simple, solderless design and solid non-ferrous operating rod for long wear life
- Design enables valve to be easily secured to any type of inner wall, utilizing the provided clamping ring
- Integral 3/8"-16 mounting lugs on box provide easy and secure installation.
- Round Box (RB1) installs through 6" hole or 6" Schedule 40 PVC sleeve
- Patented PRIER quick opening and modulating design requires less force and fewer turns to operate
- Gasket prevents water and air intrusion into the building

ORDERING

Wall Hydrant Only

C-634N10

Hose Thread Outlet

- 4- 3/4" Garden Hose
- 6- 1" Hose

Inlet

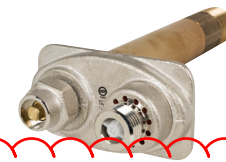
- N- 1" MPT x 3/4" FPT
- P- 1" Male SWT x 3/4" Female SWT
- V- 3/4" Copper-Press Fitting Ready

Handle

Add -HDL to end of part number to order handle

Length

- 04- 4" Insertion
- 06- 6" Insertion
- 08- 8" Insertion
- 10- 10" Insertion
- 12- 12" Insertion
- 14- 14" Insertion
- 16- 16" Insertion
- 18- 18" Insertion
- 20- 20" Insertion
- 22- 22" Insertion
- 24- 24" Insertion
- XX- Special Size



Optional Hydrant Box

C-634BX1



Box Finish

- BX1- Satin Nickel Plated
- BX2- Rough Brass
- BX3- Aluminum
- RB1- Round Box (Satin Nickel Plated)

C-634 Gasket

Included with C-634 hydrant boxes

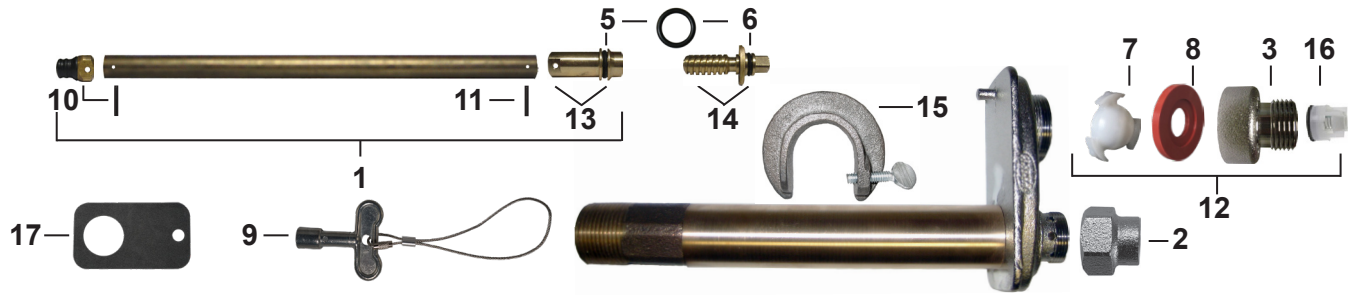
Cylinder Lock

Add -CL to end of part number to order cylinder lock



RB1

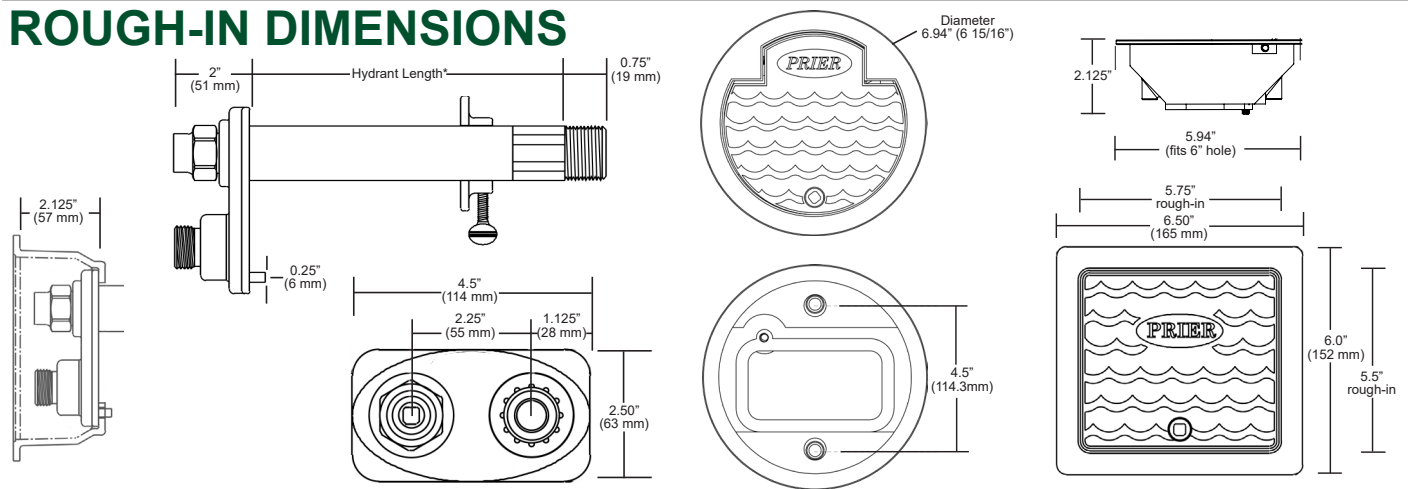
C-634 REPLACEMENT PARTS AND STEMS



ID	Part No.	Description	ID	Part No.	Description
1	See Below	Stem Assembly, Contains: 5, 6, 10, 11, 13	5	336-0001	O-Ring Worm Sleeve
	P-231-0604	Stem for 4" C-634 Hydrant, 4 11/16" OAL	6	336-6001	O-Ring Worm Drive
	P-231-0606	Stem for 6" C-634 Hydrant, 6 11/16" OAL	7	337-6001	Check Spider-Vacuum Breaker
	P-231-0608	Stem for 8" C-634 Hydrant, 8 11/16" OAL	8	346-6001	Diaphragm-Vacuum Breaker
	P-231-0610	Stem for 10" C-634 Hydrant, 10 11/16" OAL	9	C-108KT-808	Loose Key on Lanyard
	P-231-0612	Stem for 12" C-634 Hydrant, 12 11/16" OAL	10	C-634KT-802	Stopper Kit, Includes Stopper and Pin, Contains: 5, 10
	P-231-0614	Stem for 14" C-634 Hydrant, 14 11/16" OAL	11	324-0004	Pin Only
	P-231-0616	Stem for 16" C-634 Hydrant, 16 11/16" OAL	12	C-634KT-806	Vacuum Breaker Assembly
	P-231-0618	Stem for 18" C-634 Hydrant, 18 11/16" OAL	13	C-634KT-808	Worm Sleeve with O-Ring, Pin and Tool
	P-231-0620	Stem for 20" C-634 Hydrant, 20 11/16" OAL	14	C-634KT-809	Worm Drive Assembly with O-Ring
	P-231-0622	Stem for 22" C-634 Hydrant, 22 11/16" OAL	15	C-634WCR	Wall Clamping Ring
	P-231-0624	Stem for 24" C-634 Hydrant, 24 11/16" OAL	16	399-0001	Secondary Check for ASSE 1052
2	300-6003	Valve Stem Cap (NP Brass)	17	346-0004	C-634 Gasket
3	300-6004	3/4" Hose Piece (NP Brass)		C-634KT-807	C-634 Overhaul Kit, Contains: 9, 10, 11, 12, 13, 14
	310-6009	1" Hose Piece for C-636 (NP Brass)			

For the **old style C-634 Series wall hydrant stems, see C-634 Series retired style spec sheet at PRIER.com.

ROUGH-IN DIMENSIONS



SPECS

Furnish and install Model C-634 Heavy Commercial Wall Hydrant manufactured by PRIER Products, Inc. Hydrant shall be surface mount and installed through 1 3/8" round opening. Hydrant shall have automatic draining capabilities with integral vacuum breaker/double backflow preventor. Hydrant shall flow 16 gallons per minute minimum at 25 PSI Differential and be at full flow in 2 handle rotations. Hydrant shaft shall be brass with connections. Hydrant shall have 3/4" or 1" (choose one) hose connection with freezeless water flow and self-draining functions, one piece valve plunger, satin nickel finish, brass operating rod with positive triple seal shutoff mechanism. Hydrant shall be approved under ASSE 1052 standard. Operating key & wall clamping ring to be furnished with each hydrant. Hydrant insertion length to be x inches. (Length minimum of 4" to choice length in 2" increments.)

Optional: Furnish and install flush-mount hydrant box for each valve. Hydrant box shall be manufactured of solid cast brass or aluminum with a rough brass, satin nickel plated brass or aluminum (choose one) finish. Box shape may be round or square and round box only comes with satin nickel finish. Box may be installed separately and hydrant be insertable and removable from front of the box. Access to the hydrant box shall be provided by the same operating key as the valve. A gasket shall be installed between the box and hydrant to prevent water intrusion into the structure.

L

SMITH® JAY R. SMITH MFG. CO.®
 MEMBER OF MORRIS GROUP INTERNATIONAL
 POST OFFICE BOX 3237
 MONTGOMERY, ALABAMA 36109-0237 (USA)
 TEL: 334-277-8520 FAX: 334-272-7396 www.jrsmith.com

ASPE MEMBER OF: **PDPA**

LOCATION
ORD

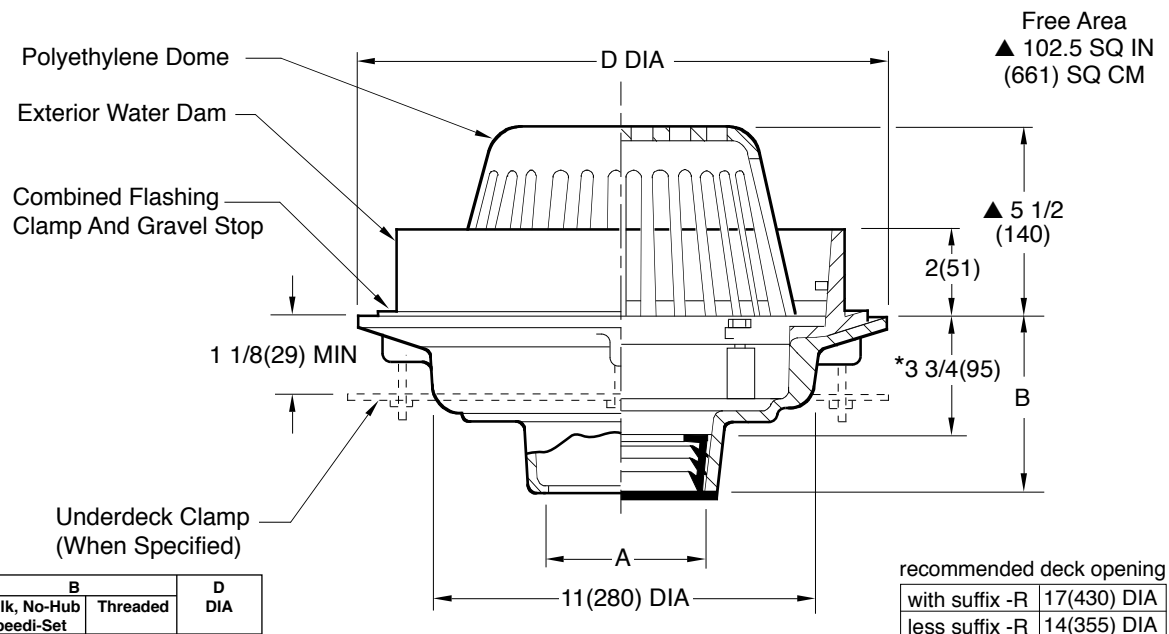
DRAWING NUMBER **S1080**
 SIZE **A**
 SCALE: **NONE**
 DATE: **8-19-83**
 APPROVED BY: **JD**
 CHECKED BY: **JD**
 DRAWN BY: **CR**
 FIGURE NUMBER **1080**

WE CAN ASSUME NO RESPONSIBILITY FOR USE OF SUPERSEDED OR VOID DATA
 DIMENSIONS ARE SUBJECT TO MANUFACTURERS TOLERANCE AND CHANGE WITHOUT NOTICE

SPECIAL PURPOSE ROOF DRAINS

WATER DAM TYPE

FUNCTION: Used in flat roofs of any construction where a constant height of water is desired on the roof. It may also be used as an emergency overflow for conventional roofs, draining rain water when the depth of the water on the roof reaches the water dam height.



A SIZE	B		D DIA
	Caulk, No-Hub Speedi-Set	Threaded	
02(50), 03(75) 04(100)	5(125)	3 3/4(95)	15 1/4(390)
05(125), 06(150)	5(125)	3 3/4(95)	15 1/4(390)
08(200)-16 10(250)-16	6(150)	5(125)	16(405)

*This Dimension to Internal Stop of Speedi-Set Gasket
NOTE: 08(200) & 10(250) outlet sizes are regularly furnished with a 20(510) dia. flange see back sheet. For 16(405) dia. flange it must be specified as -16. Ex: 1010Y08-16

REGULARLY FURNISHED:
 Duco Cast Iron Body, Flashing Clamp and Gravel Stop with Polyethylene Dome, and Cast Iron Water Dam.

NOTE: Dimensions shown in parentheses are in millimeters.

▲ When 10(250)-16 outlet size is specified dome height becomes 8 1/4(210) and free area of 122.5 SQ IN (790 SQ CM), furnished in cast iron and is not available in polyethylene.

- VARIATIONS:**
- Adjustable Extension(Specify Fig. 1045)
 - Expansion Joint (Specify Fig. 1710)
 - Extension -E (Specify Height)
 - "L" Shaped Underdeck Clamp -CL
 - L Speedi-Set Service Weight
 - LXH Speedi-Set Extra Heavy
 - Secondary Flashing Clamp -C2
 - Sump Receiver -R
 - Underdeck Clamp -C
 - Vandal Proof Dome -U
 - 2 1/2(64), 3(76) or 4"(100) Water Dams
- Available -WD025, -WD03, -WD04

- Fig. 1080C CAULK OUTLET
- Fig. 1080Y NO-HUB OUTLET
- Fig. 1080T THREADED OUTLET

NOTE: Stated flow rates for roof drains are based on particular test piping configurations and dimensions. Installed roof drain flow rates cannot be stated unless the attached piping configuration is known and the effects of the drainage calculated.

- OPTIONAL MATERIALS:**
- ▲▲ Aluminum Dome -AD
 - ▲▲ Cast Iron Dome -CID
 - Galvanized Cast Iron -G
 - ▲▲ Galvanized Cast Iron Dome -CIDG
 - ▲▲ Rough Bronze Dome -RBD

▲▲ **Optional domes' free area are as follows:**
 Aluminum 98 (632)
 Cast Iron 80 (516)
 Bronze 95 (613)

REV.	DATE	DESCRIPTION	BY	CKD. BY	WEIGHT POUNDS	VOLUME CUBIC FEET	FIGURE NUMBER
L	10-28-15	Added Flow Rate Note	TBW	BW			1080
K	3-13-13	Rev. Notes	JJ	CL			
J	06/04/09	Added Optional Dome Notes	JJ	CL			
H	9-8-08	Rev. Variations	RN	TK			

U

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 POST OFFICE BOX 3237
 MONTGOMERY, ALABAMA 36109-0237 (USA)
 TEL: 334-277-8520 FAX: 334-272-7396 www.jrsmith.com



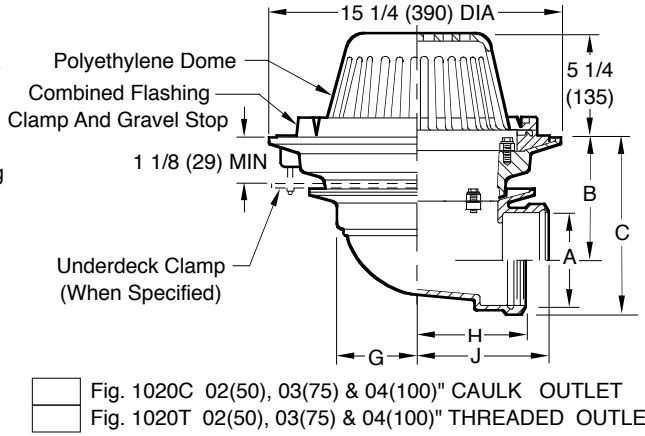
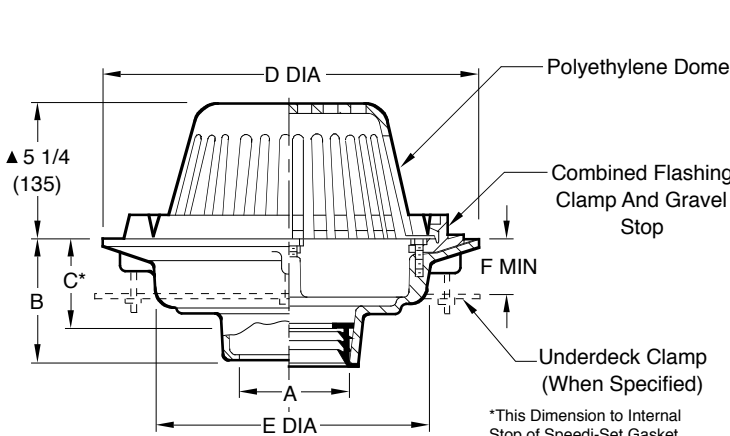
LOCATION

RD

LARGE GENERAL PURPOSE ROOF DRAINS

LOW PROFILE DOME

FUNCTION: Used in flat roof of any construction. Large low profile dome provides sufficient free area for quick drainage of rain water and protects the drain sump and connected piping from the intrusion of debris. Wide clamping surface holds flashing and roofing materials without puncturing.



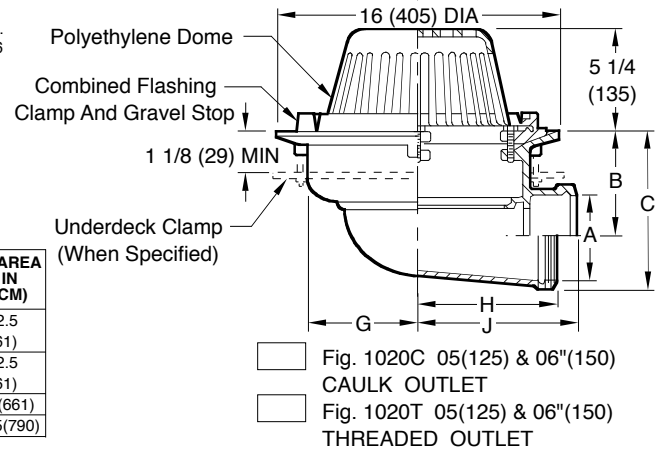
- Fig. 1010C CAULK OUTLET
- Fig. 1010Y NO-HUB OUTLET

*This Dimension to Internal Stop of Speedi-Set Gasket.
 **NOTE: 08(200) & 10(250) outlet sizes are regularly furnished with 20(510) dia. flange, see back sheet. If 16(405) dia. flange is required -16 MUST be specified.
 Ex: 1010Y08-16 or 1010Y10-16

recommended deck opening

outlet size	with suffix-R	less suffix-R
02(50),03(75),04(100) 05(125),06(150)	17(430) DIA	14(355) DIA
**08(200)-16, **10(250)-16	17(430) DIA	14 3/4 (375) DIA

A SIZE	B (BOTTOM OUTLET)			SIDE OUTLET			FREE AREA SQ IN (SQ CM)
	CAULK, NO-HUB, & SPEEDI-SET	THREADED	C	D DIA	E DIA	F MIN	
02(50),03(75), 04(100)	5 (125)	3 3/4 (95)	3 3/4 (95)	15 1/4 (390)	11 (280)	1 1/8 (29)	102.5 (661)
05(125), 06(150)	5 (125)	3 3/4 (95)	--	15 1/4 (390)	11 (280)	1 1/8 (29)	102.5 (661)
**08(200)-16, **10(250)-16	6 (150)	5 (125)	--	16 (405)	12 1/2 (320)	1 1/8 (29)	102.5(661) ▲122.5(790)



- Fig. 1020C 05(125) & 06"(150) CAULK OUTLET
- Fig. 1020T 05(125) & 06"(150) THREADED OUTLET

(SIDE OUTLET)

A SIZE	02 (50)	03 (75)	04 (100)	05 (125)	06 (150)
B	6 7/8 (175)	6 3/8 (162)	5 7/8 (149)	5 (125)	4 1/2 (115)
C	8 5/8 (219)	8 3/4 (220)	8 3/4 (220)	8 1/2 (215)	8 1/2 (215)

OPTIONAL MATERIALS:

- All Aluminum -AA (Fig. 1010 only)
- ▲ Aluminum Dome -AD
- ▲ Cast Iron Dome -CID
- ▲ Galvanized Cast Iron Dome -CIDG
- Galvanized Cast Iron Body & Collar -G
- ▲ Rough Bronze Dome -RBD
- Stainless Steel (Specify Fig. 9780)

▲▲ Optional Domes' free area are as follows:

Dome Mat'l	02-06 & 08-16 Outlets
Aluminum	98 (632)
Cast Iron	80 (516)
Bronze	95 (613)

REGULARLY FURNISHED:

Duco Cast Iron Body with Combined Flashing Clamp and Gravel Stop with Polyethylene Dome.

▲ NOTE: The dome height is 8 1/4" (210) for the 122.5 SQ IN free area dome and is regularly furnished in Cast Iron and is not available in polyethylene.

NOTE: Stated flow rates for roof drains are based on particular test piping configurations and dimensions. Installed roof drain flow rates cannot be stated unless the attached piping configuration is known and the effects of the drainage calculated.

NOTE: Dimensions shown in parentheses are in millimeters.

VARIATIONS:

- Expansion Joint (Specify Fig.1710) (Fig. 1010 only)
- Extension (Specify Height) -E
- "L" Shaped Underdeck Clamp -CL
- L Speedi-Set Service Weight 02(50), 03(75), and 04(100)" sizes only (Fig. 1010 Only)
- LXH Speedi-Set Extra Heavy 02(50), 03(75), and 04(100)" sizes only (Fig. 1010 only)
- NO-HUB Adaptor (Specify Fig. 2646Y) (Fig. 1020 only)
- Secondary Flashing Clamp -C2
- Sump Receiver -R
- Underdeck Clamp -C
- Vandal Proof Dome -U
- T Threaded Outlet

DRAWING NUMBER S1010

SIZE A

SCALE: NONE

DATE: 5-24-85

APPROVED BY: TD

CHECKED BY: TD

DRAWN BY: CR

1010, 1020

FIGURE NUMBER

REV.	DATE	DESCRIPTION	BY	CKD. BY
U	8-3-15	Added Flow Rate Note	TBW	BW
T	3-12-13	Rev. Tables, Notes	TBW	CL
S	06/01/09	Added Optional Dome free areas	JJ	CL
R	06-09-08	Added NOTE	RN	CL

WEIGHT POUNDS	VOLUME CUBIC FEET	FIGURE NUMBER
		1010, 1020

NO DRAIN, NO WINTERIZE Executive Roof Hydrant Installation Instructions

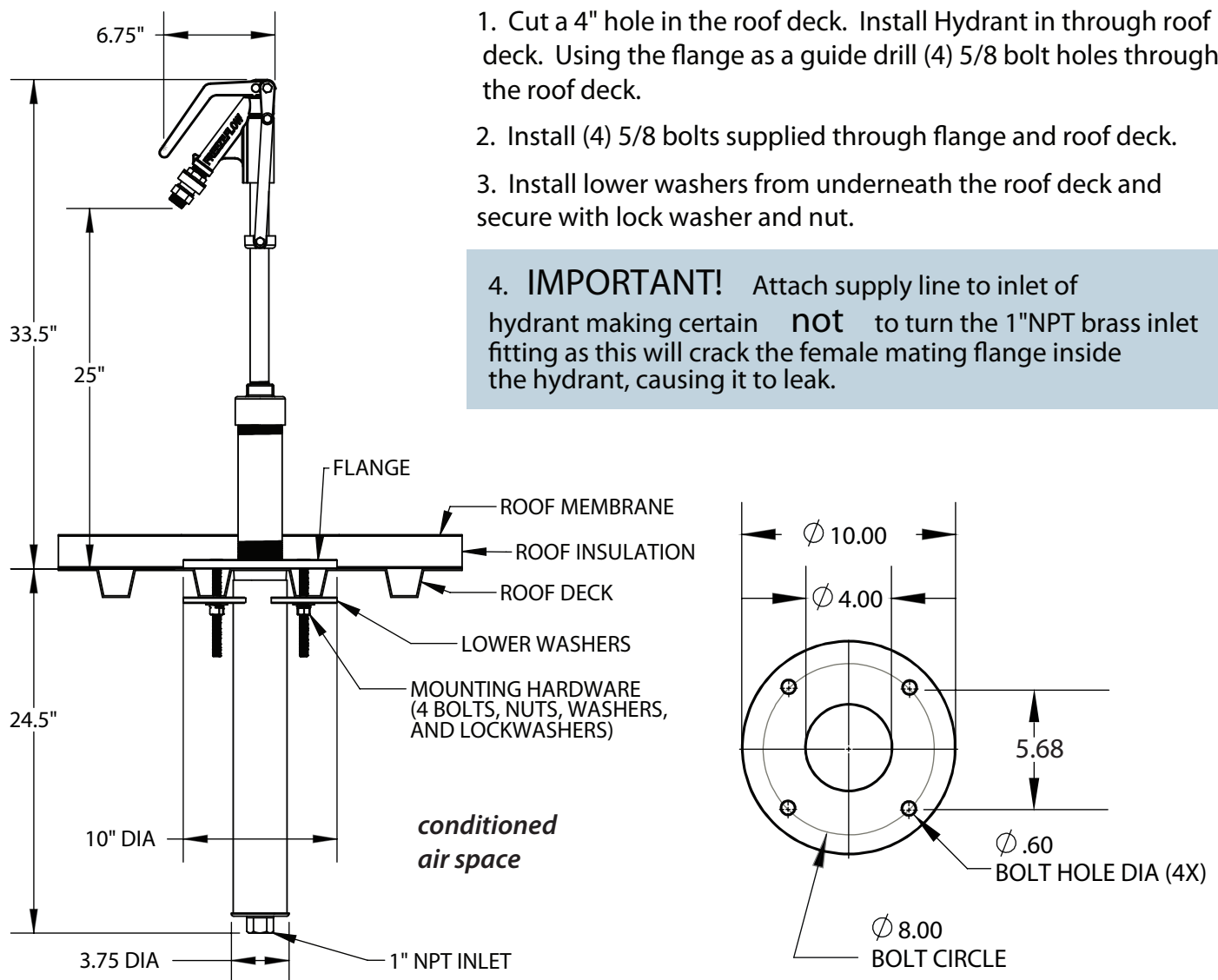
Freezeflow hydrants are designed for heavy-duty commercial use where safe potable water is needed. This hydrant drains into a reservoir below the roof frost line to prevent freeze ups and eliminates the need for a drain line or winterization.

Model# 2131RE

INSTALLATION

1. Cut a 4" hole in the roof deck. Install Hydrant in through roof deck. Using the flange as a guide drill (4) 5/8 bolt holes through the roof deck.
2. Install (4) 5/8 bolts supplied through flange and roof deck.
3. Install lower washers from underneath the roof deck and secure with lock washer and nut.

4. **IMPORTANT!** Attach supply line to inlet of hydrant making certain **not** to turn the 1"NPT brass inlet fitting as this will crack the female mating flange inside the hydrant, causing it to leak.



HOEPTNER PERFECTED PRODUCTS

7796 Oak Spring Circle, Gilroy, CA 95020 * Ph 408-847-7615 / Fax 408-847-0675
work@garlic.com * www.freezeflow.com

Job Name _____

Contractor _____

Job Location _____

Approval _____

Engineer _____

Contractor's P.O. No. _____

Approval _____

Representative _____

LEAD FREE*

Series 957, 957N, 957Z

Reduced Pressure Zone Assemblies

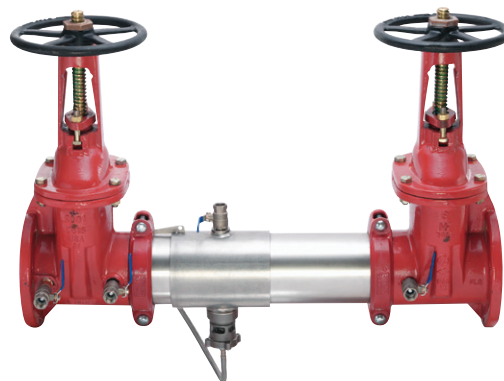
Sizes: 2½" – 10"

Series 957, 957N, 957Z Reduced Pressure Zone Assemblies provide protection to the potable water system from contamination in accordance with national plumbing codes. Series 957, 957N, 957Z are normally used in health hazard applications for protection against backsiphonage or backpressure.

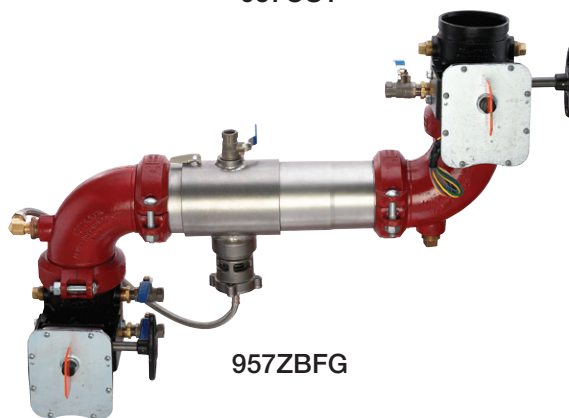
Series 957 is also available with SentryPlus™ Alert technology to detect catastrophic relief valve discharge that could potentially cause flooding, and issue a multi-channel alert (call, email, text) to selected users so they can take action to avoid potentially costly flooding.

Features

- 2½", 3" and 4" sizes available with quarter-turn ball valve shutoffs
- Replaceable check disc rubber
- Extremely compact design
- 70% Lighter than traditional designs
- 304 (Schedule 40) stainless steel housing & sleeve
- Groove fittings allow integral pipeline adjustment
- Patented torsion spring checks provide lowest pressure loss
- Unmatched ease of serviceability
- Bottom mounted cast stainless steel relief valve
- Available with grooved butterfly valve shutoffs



957OSY



957ZBFG



957QT

NOTICE

Inquire with governing authorities for local installation requirements

*The wetted surface of this product contacted by consumable water contains less than 0.25% of lead by weight.

NOTICE

The information contained herein is not intended to replace the full product installation and safety information available or the experience of a trained product installer. You are required to thoroughly read all installation instructions and product safety information before beginning the installation of this product.

Watts product specifications in U.S. customary units and metric are approximate and are provided for reference only. For precise measurements, please contact Watts Technical Service. Watts reserves the right to change or modify product design, construction, specifications, or materials without prior notice and without incurring any obligation to make such changes and modifications on Watts products previously or subsequently sold.

WATTS®

Specifications

The Reduced Pressure Zone Assembly shall consist of two independent torsion spring check modules, a differential pressure relief valve located between and below the two modules, two drip tight shutoff valves, and required torsion spring check modules and relief valve shall be contained with a sleeve accessible single housing constructed from 304 (Schedule 40) stainless steel pipe with groove end connections. Torsion spring checks shall have replaceable elastomer discs and in operation produce drip tight closure against the reverse flow of liquid caused by backpressure or backsiphonage. Assembly shall be a Watts Regulator Company Series 957, 957N, 957Z.

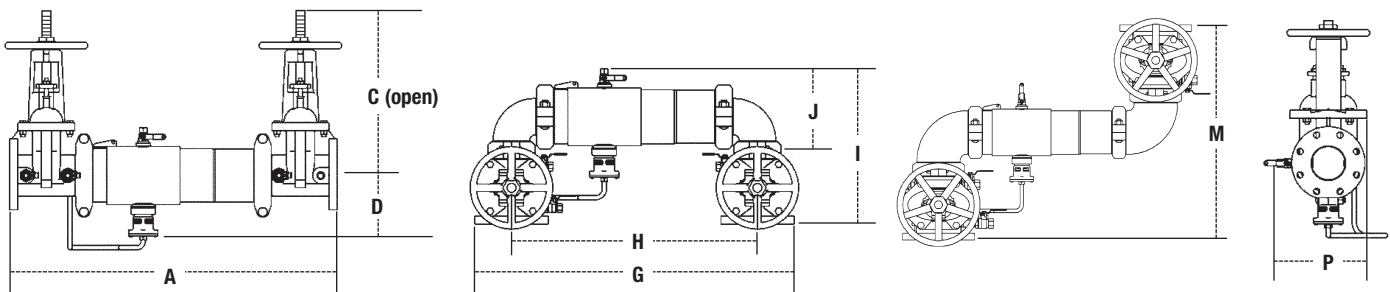
NOTICE

When installing a drain line on Series 957 backflow preventers, use 957AG air gaps. See ES-AG/EL/TC for additional information.

Available Models & Options

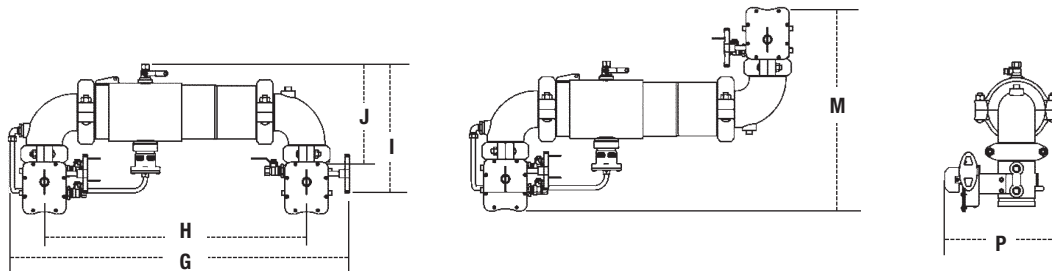
Suffix:

- NRS** – non-rising stem, resilient seated gate valves
- OSY – UL/FM outside stem and yoke resilient seated gate valves
- BFG – UL/FM grooved gear operated butterfly valves with tamper switch
- QT – 2½" - 4" (65 - 100mm) quarter-turn ball valves
- *OSY FxG – Flanged inlet gate connection and grooved outlet gate connection
- **OSY GxG – Grooved inlet gate connection and flanged outlet gate connection
- ***OSY GxG – Grooved inlet gate connection and grooved outlet gate connection
- ****ALERT with SentryPlus™ Alert flood detection system
- *Available with grooved NRS gate valves – consult factory
- **Post indicator plate and operating nut available – consult factory
- ***Consult factory for dimensions
- **** Not available with the 957N or 957Z



957, 957N, 957Z

SIZE	DIMENSIONS														WEIGHT													
	A		C (OSY)		C (NRS)		D		G		H		I		J		M		P		957NRS	957OSY	957N NRS	957N OSY				
in.	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.	lbs.	kgs.	lbs.	kgs.		
2½	30¾	781	16⅞	416	9⅞	238	6½	165	29⅛	738	21½	546	15½	393	8⅜	223	21¼	540	9⅞	234	118	54	128	58	126	57	136	62
3	31¾	806	18⅞	479	10¼	260	6⅜	170	30¼	768	22¼	565	17⅞	435	9⅞	233	23	584	10½	267	134	61	148	67	147	67	161	73
4	33¾	857	22¾	578	12⅜	310	7	178	33	838	23½	597	18½	470	9⅞	252	26¼	667	11⅜	284	164	74	164	74	187	85	187	85
6	43½	1105	30⅞	765	16	406	8½	216	44¾	1137	33½	851	23⅜	589	13⅞	332	34¼	870	15	381	276	125	298	135	317	144	339	154
8	49¾	1264	37¾	959	19⅞	506	9⅞	246	54⅞	1375	40⅞	1019	27⅞	697	15⅞	399	36⅞	937	17⅞	437	441	200	483	219	516	234	558	253
10	57¾	1467	45¾	1162	23⅞	605	11⅞	285	66	1676	49½	1257	32½	826	17⅞	440	44½	1124	20	508	723	328	783	355	893	405	950	431



957NBF, 957ZBFG

SIZE	DIMENSIONS								WEIGHT					
	G		H		I		J		M		P		957N/957Z	
in.	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.
2½	32½	826	23	584	15½	394	9½	241	19¾	502	11⅞	300	67	30
3	34	864	24	610	16⅞	414	10⅞	256	21¼	540	12⅞	308	70	32
4	35⅞	905	25½	648	17⅞	437	10⅞	279	23½	597	12⅞	321	87	39
6	46½	1181	35¼	895	20½	521	13½	343	27¼	692	15	382	160	73

Dimensions — Weight

Materials

Housing & Sleeve: 304 (Schedule 40) Stainless Steel

Elastomers: EPDM, Silicone and Buna-N

Torsion Spring Checks: Noryl®, Stainless Steel

Check Discs: Reversible Silicone or EPDM

Test Cocks: Lead Free* Bronze Body

Pins & Fasteners: 300 Series Stainless Steel

Springs: Stainless Steel

Approvals

- Approved by the Foundation for Cross-Connection Control and Hydraulic Research at The University of Southern California (FCCCHR-USC)
(Excluding 'N' Pattern – 10", 'Z' Pattern – 6" and 10")
- AWWA C511-97



1013



B64.4



(**BFG & OSY Only)



Approved



Certified to NSF/ANSI 61-G

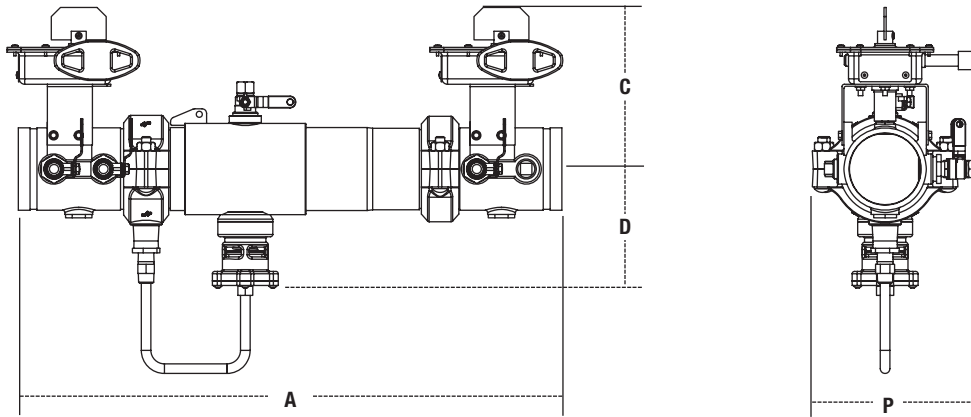
Pressure — Temperature

Temperature Range: 33°F – 140°F (0.5°C – 60°C)

Maximum Working Pressure: 175psi (12.1 bar)

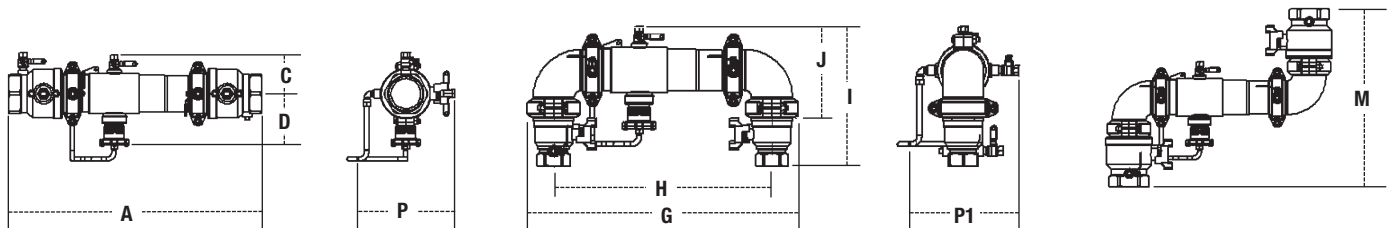
For additional approval information please contact the factory or visit our website at Watts.com

Dimensions — Weight continued



957 BFG

SIZE		DIMENSIONS						WEIGHT		
in.	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.
4	29	737	7 ³ / ₄	197	6 ³ / ₈	162	9 ¹ / ₂	241	66	30
6	36 ¹ / ₂	927	9 ¹¹ / ₁₆	246	7 ⁷ / ₁₆	189	14 ³ / ₄	362	122	55



957QT

SIZE		DIMENSIONS										WEIGHT												
in.	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	in.	mm	lbs.	kgs.	lbs.	kgs.						
2 ¹ / ₂	27 ¹ / ₂	698	4 ⁷ / ₈	124	6 ⁷ / ₈	175	30 ¹ / ₄	768	21 ¹ / ₂	546	16 ¹ / ₁₆	407	11 ³ / ₈	289	19 ⁷ / ₈	505	11 ⁵ / ₁₆	287	11 ⁵ / ₁₆	287	46	21	57	26
3	28	711	4 ⁷ / ₈	124	6 ⁷ / ₈	175	30 ¹ / ₄	768	22 ¹ / ₄	565	16 ⁹ / ₁₆	420	11 ³ / ₈	289	20 ⁷ / ₈	531	11 ⁵ / ₁₆	287	11 ⁵ / ₁₆	287	56	25	67	30
4	28 ³ / ₄	730	4 ⁷ / ₈	124	6 ⁷ / ₈	175	30 ¹ / ₄	768	23 ¹ / ₂	597	18 ⁵ / ₁₆	465	11 ³ / ₈	289	24 ³ / ₈	619	11 ⁵ / ₁₆	287	11 ⁵ / ₁₆	287	76	34	87	39

Capacity

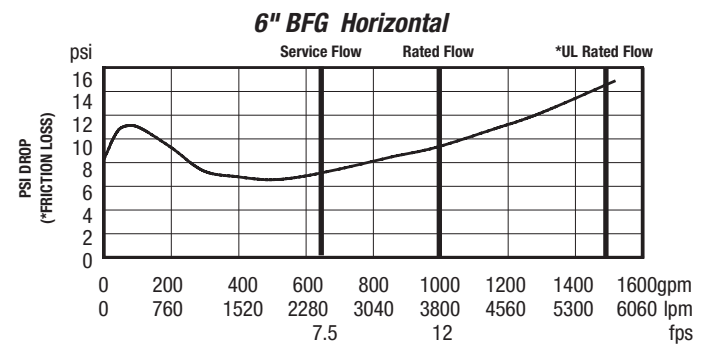
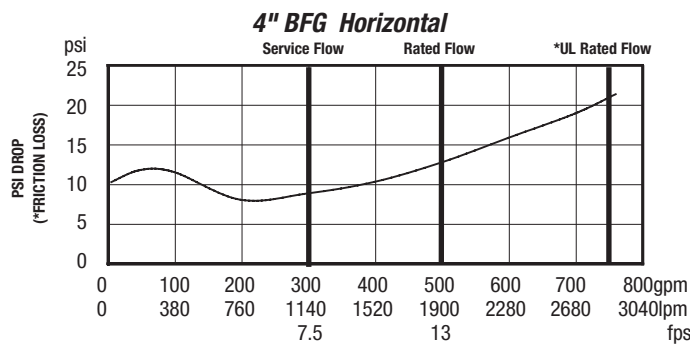
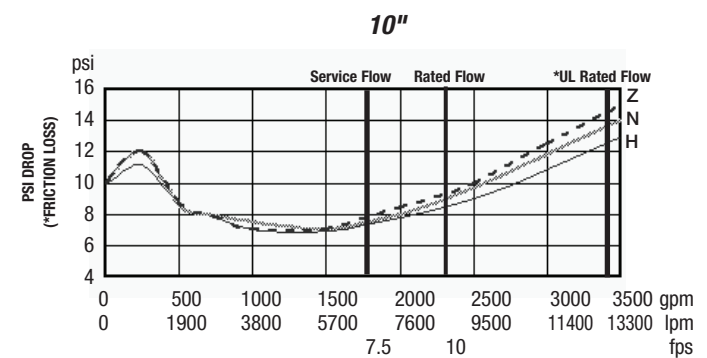
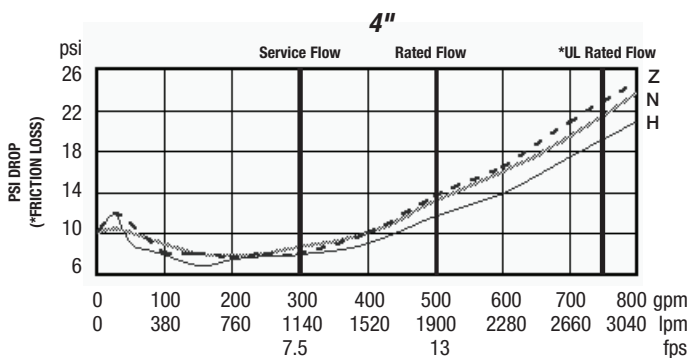
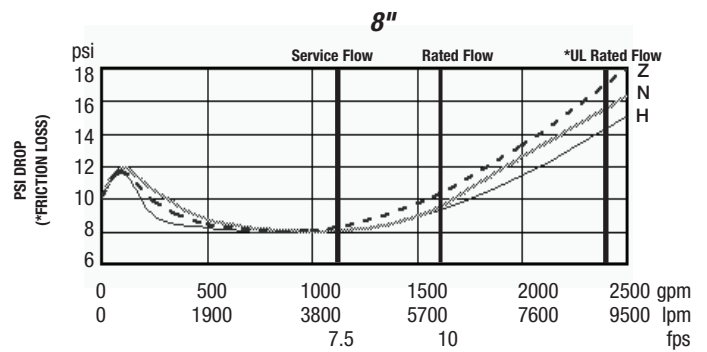
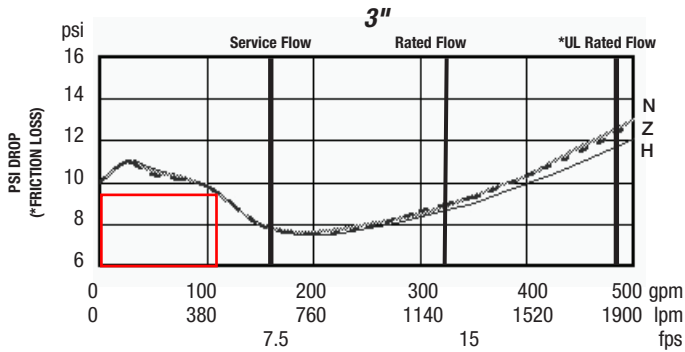
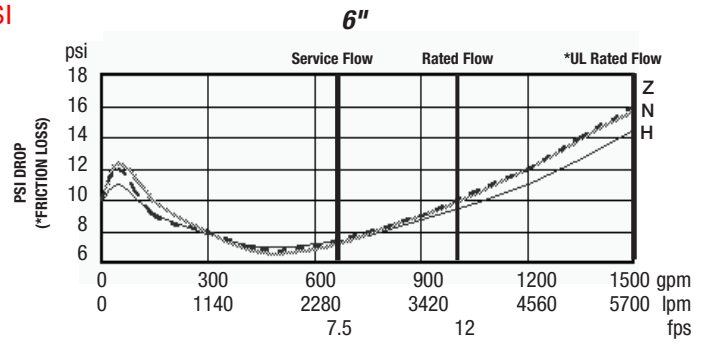
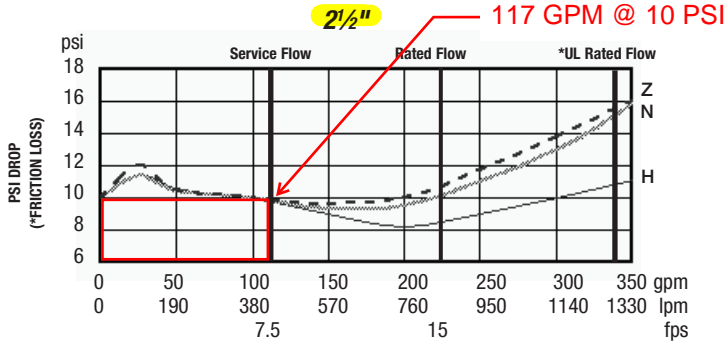
Series 957, 957N, 957Z flow curves as tested by Underwriters Laboratory.

Flow characteristics collected using butterfly shutoff valves

— Horizontal — N-Pattern - - - - Z-Pattern

Flow capacity chart identifies valve performance based upon rated water velocity up to 25fps

- Service Flow is typically determined by a rated velocity of 7.5fps based upon schedule 40 pipe.
- Rated Flow identifies maximum continuous duty performance determined by AWWA.
- UL Flow Rate is 150% of Rated Flow and is not recommended for continuous duty.
- AWWA Manual M22 [Appendix C] recommends that the maximum water velocity in services be not more than 10fps.



PRODUCT SPECIFICATIONS

Elkay Lustertone™ Classic Stainless Steel 22" x 19-1/2" x 6", Single Bowl Drop-in ADA Sink. Sink is manufactured from 18 gauge 304 Stainless Steel with a Lustrous Satin finish, Rear Center drain placement, and Bottom only pads.

Installation Type:	Drop-in
Material:	304 Stainless Steel
Finish:	Lustrous Satin
Gauge:	18
Sound Deadening:	Bottom only pads
Number of Bowls:	1
Sink Dimensions:	22" x 19-1/2" x 6"
Bowl 1 Dimensions:	18" x 14" x 5-7/8"
Drain Size:	3-1/2" (89mm)
Drain Location:	Rear Center
Minimum Cabinet Size:	27"
Mounting Hardware:	Part # 64090012 included for countertops up to 3/4" (19mm) thick
Cutout Template #:	1000001255

Template is available for download at elkay.com. CAD software will be required to open the template.

Cutout Dimensions for Drop-in Installation:

21-3/8" x 18-7/8" (543mm x 479mm) with 1-1/2" (38mm) corner radius

Custom Options	
<input type="checkbox"/> Type 316 Stainless Steel	
Drain Location	
<input type="checkbox"/> Right Rear	<input type="checkbox"/> Left Rear
<input type="checkbox"/> Center	<input type="checkbox"/> Center Rear
Overflow Location	
<input type="checkbox"/> Front	<input type="checkbox"/> Rear
Alternate Punching	
<input type="checkbox"/> Faucet Model:	<input type="checkbox"/> Punch Required:
Sink Size	
<input type="checkbox"/> Bowl Depth:	<input type="checkbox"/> Drainboard Width:



AMERICAN PRIDE. A LIFETIME TRADITION.
Like your family, the Elkay family has values and traditions that endure. For almost a century, Elkay has been a family-owned and operated company, providing thousands of jobs that support our families and communities.



Product Compliance: ADA & ICC A117.1
ASME A112.19.3/CSA B45.4
BUY AMERICAN ACT



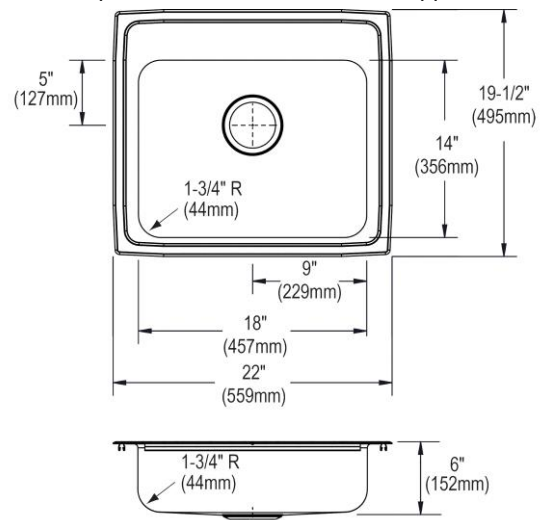
Sinks are listed by IAPMO® as meeting the applicable requirements of the Uniform Plumbing Code®, International Plumbing Code®, and National Plumbing Code of Canada.



Complies with ADA & ICC A117.1 accessibility requirements when installed according to the requirements outlined in these standards.

[Clean and Care Manual \(PDF\)](#)
[Installation Instructions \(PDF\)](#)
[Warranty \(PDF\)](#)

Similar models are available with: Quick-Clip Mounting System, additional ADA depths, CuVerro antimicrobial copper



PART: _____ QTY: _____

PROJECT: _____

CONTACT: _____

DATE: _____

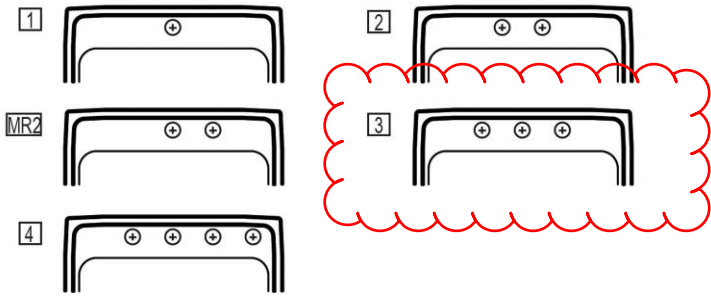
NOTES: _____

APPROVAL: _____

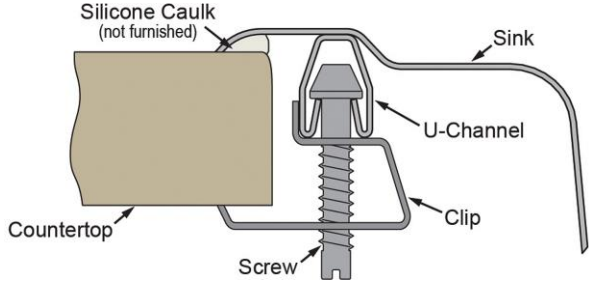
In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

Hole Drilling Configurations:

1-1/2" (38mm) Diameter Faucet Holes on 4" (102mm) Centers



Installation Profile:



OPTIONAL ACCESSORIES

Cutting Board:	CBS1418
Drain:	LK99, LKAD35
Faucet:	LKGT1041CR, LKGT1041NK, LKGT1041RB
Hardware:	LK364, LK463
Rinsing Basket:	LKWRB1418SS, LKWERBSS
Soap Dispenser:	LKGT1054

In keeping with our policy of continuing product improvement, Elkay reserves the right to change product specifications without notice. Please visit elkay.com for the most current version of Elkay product specification sheets. This specification describes an Elkay product with design, quality, and functional benefits to the user. When making a comparison of other producers' offerings, be certain these features are not overlooked.

Manual Sink Faucets 786-GN2FCXKABCP

@ SK

**CHICAGO
FAUCETS**
Geberit Group

Product Type

Deck-mounted manual sink faucet with 8" centers

Features & Specifications

- 1.5 GPM (5.7 L/min) laminar flow control insert in spout inlet
- 8" fixed centers
- 5-1/4" rigid/swing gooseneck spout with flow control
- Vandal Proof 4" wristblade handle
- Ceramic 1/4-turn operating cartridge, left-hand
- Ceramic 1/4-turn operating cartridge, right-hand
- ECAST® design provides durable cast brass construction with total lead content equal to or less than 0.25% by weighted average
- Complies with the requirements of the Buy American Act of 1933.
- CFNow! Item Ships in 3 Days






Performance Specification

- Rated Operating Pressure: 20-125 PSI
- Rated Operating Temperature: 40-140°F (Note: 180°F max. during temporary high-temperature system flush)

Warranty

- 5-Year Limited Cartridge Warranty
- Lifetime Limited Faucet Warranty
- 1-Year Limited Finish Warranty

Codes & Standards

-  ASME A112.18.1/CSA B125.1
-  ADA ANSI/ICC A117.1
- Complies with CALGreen requirements
-  NSF/ANSI 372 Low Lead Content
-  NSF/ANSI 61, Section 9
-  Certified to WaterSense by ICC-ES

Job Name _____

Item Number _____

Section/Tag _____

Model Specified _____

Architect _____

Engineer _____

Contractor _____

Submitted as Shown Submitted with Variations

Date _____



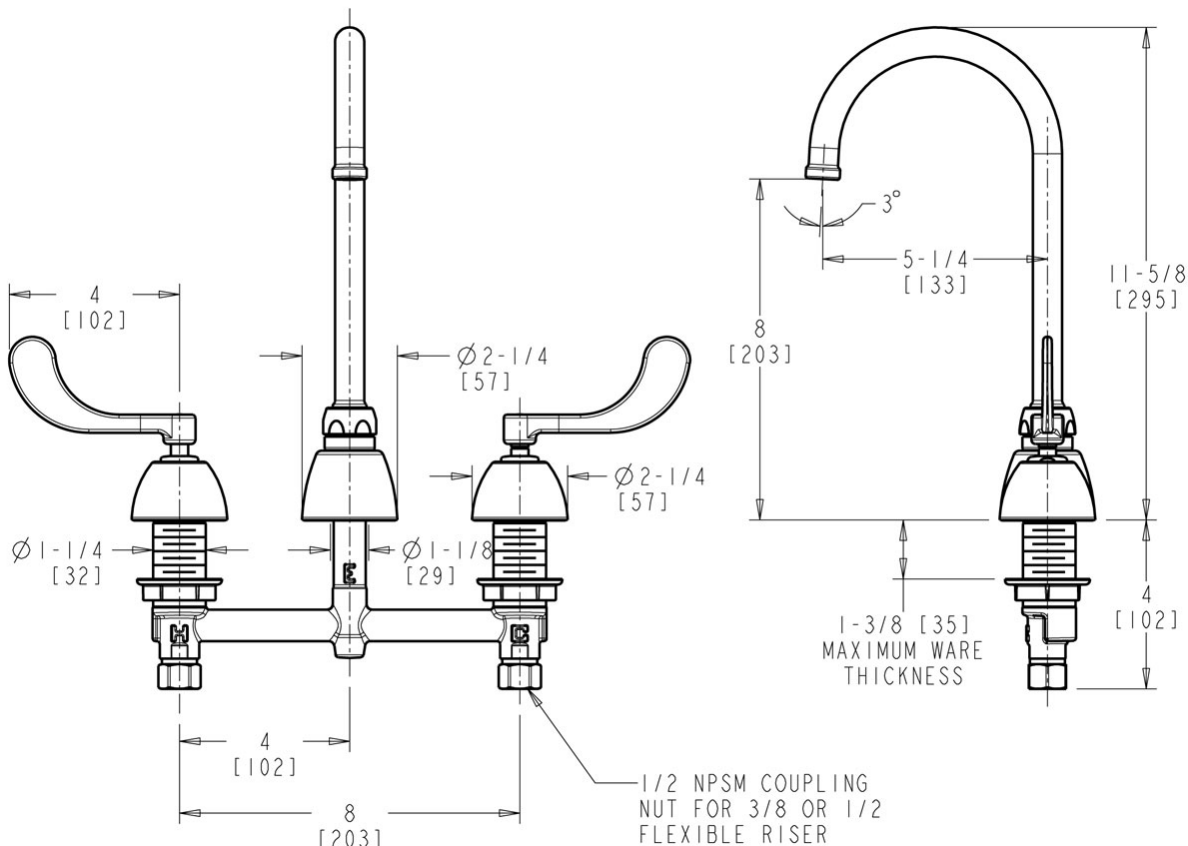
ECAST

ECAST products are intended for installation where state laws and local codes mandate lead content levels or in any location where lead content is a concern.

2100 South Clearwater Drive
Des Plaines, IL
P: 847/803-5000
F: 847/803-5454
Technical: 800/TEC-TRUE
www.chicagofaucets.com

Architect/Engineer Specification

Chicago Faucets No. 786-GN2FCXKABCP, Sink Faucet for hot and cold water, concealed deck-mount with 8" fixed centers, chrome plated. Rigid/swing gooseneck spout, 5-1/4" center-to-center, with 1.5 GPM (5.7 L/min) laminar flow control insert in spout inlet. 4" metal, vandal-proof, wristblade handles with sixteen-point, tapered broach and secured blue and red index buttons. Ceramic quarter-turn cartridge, features square, tapered stem. 1/2" NPSM supply inlets and coupling nut for 3/8" or 1/2" flexible riser. ECAST® construction with less than 0.25% lead content by weighted average. CALGreen compliant. This product meets ADA ANSI/ICC A117.1 requirements and is tested and certified to industry standards: ASME A112.18.1/CSA B125.1, Certified to NSF/ANSI 61, Section 9 by CSA, California Health and Safety Code 116875 (AB1953-2006), Vermont Bill S.152, NSF/ANSI 372 Low Lead Content, and California Green Building Standards Code (CALGreen).



Operation and Maintenance

Installation should be in accordance with local plumbing codes. Flush all pipes thoroughly before installation. After installation, remove spout outlet or flow control and flush faucet thoroughly to clear any debris. Care should be taken when cleaning the product. Do not use abrasive cleaners, chemicals or solvents as they can result in surface damage. Use mild soap and warm water for cleaning and protecting the life of Chicago Faucet products. For specific operation and maintenance refer to the installation instructions and repair parts documents that are located at www.chicagofaucets.com.

Chicago Faucets, member of the Geberit Group, is the leading brand of commercial faucets and fittings in the United States, offering a complete range of products for schools, laboratories, hospitals, office buildings, food service, airports and sport facilities. Call 1.800.TECTRUE or 1.847.803.5000 Option 1 for installation or other technical assistance.



NOTES:

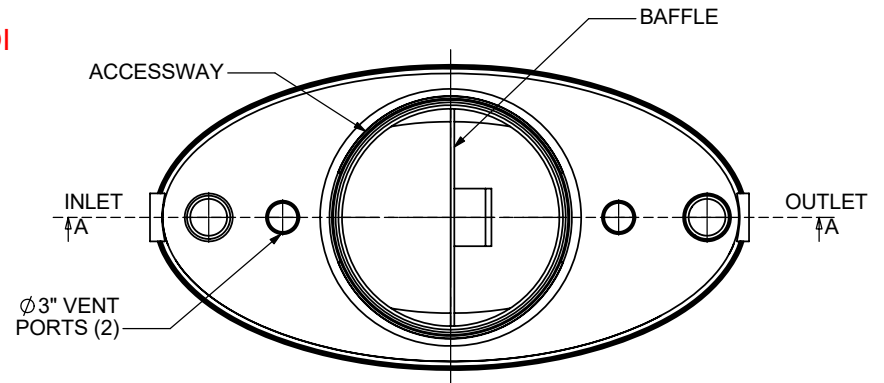
1. FOR GRAVITY APPLICATIONS ONLY.
2. ALL PROCEPTOR® UNITS ARE MANUFACTURED WITH FIBERGLASS REINFORCED PLASTICS. PHYSICAL CHARACTERISTICS AND THICKNESS: POLYESTER RESIN AND E GLASS MINIMUM THICKNESS 3/16" WALL AND 5/16" TOP AND BOTTOM BOWLS.
3. ALL PROCEPTOR® UNITS ARE TO BE INSTALLED IN ACCORDANCE WITH THE MANUFACTURERS INSTALLATION INSTRUCTION.
4. STANDARD PIPING IS SCH. 40 PVC.
5. GMC/OMC/SMC 50 - 300 UNITS COME STANDARD WITH 4" INLET AND OUTLET (OTHER PIPE SIZE OPTIONS AVAILABLE ON REQUEST).
6. EXTENSION COLLAR TO BE ORDERED TO MEET FINISHED GRADE, CUT ON SITE FOR FINAL ADJUSTMENT AND CAULKED WITH SIKAFLEX BY CONTRACTOR FOR WATERTIGHT SEAL.
7. COVERS AVAILABLE FOR H20 TRAFFIC LOADING, PEDESTRIAN LOADING OR ABOVE GROUND INSTALLATION.
8. CONSULT GREEN TURTLE™ FOR OTHER SIZES.
9. 30 YEAR WARRANTY AGAINST LEAKS, AND STRUCTURAL FAILURE.
10. U.S. PATENT #5,746,912; CDN PATENT #2,195,822

SPECIFICATIONS

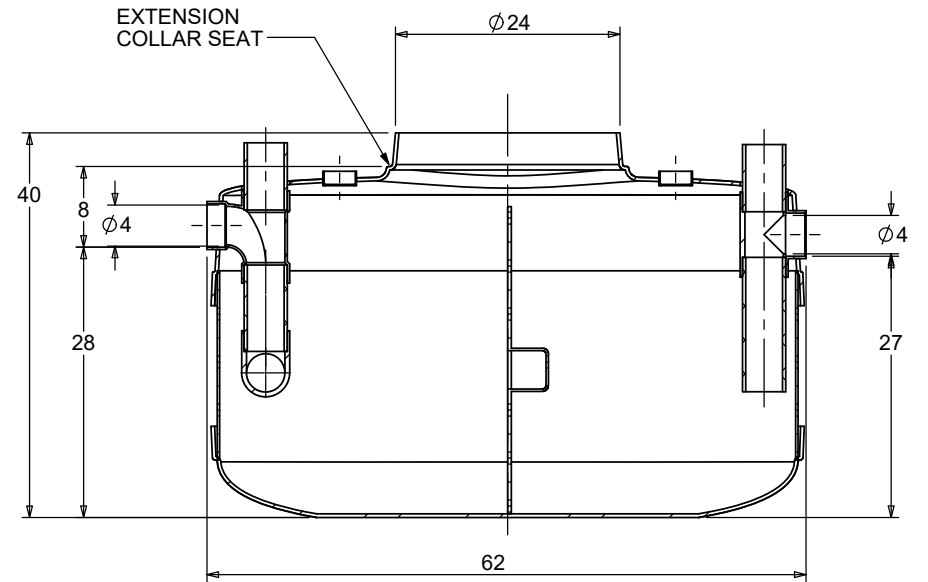
PIPE SIZE: 4 INCH PVC SCH 40
 INSTALLATION: BURIED
 ACCESSWAY SIZE: 24 INCHES

OPTIONS

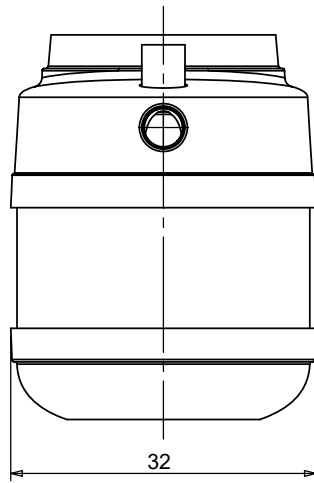
SOI



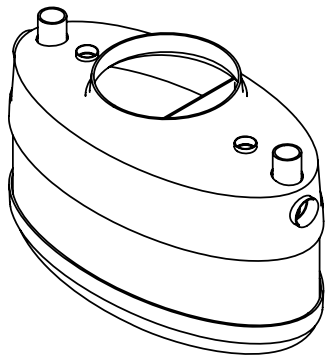
TOP VIEW



SECTION A-A



SIDE VIEW



ISOMETRIC VIEW

TOTAL WET VOLUME:	150 GAL
MAX. OIL CAPACITY:	66 GAL
MAX SOLIDS CAPACITY:	48 GAL

CONSULT LOCAL AUTHORITIES FOR MINIMUM SIZE OF SEPARATORS

TITLE: PROCEPTOR® OIL SEPARATOR
 OMC 150

ALL DIMENSIONS IN INCHES

PROJECT: WO:

NOTES:

REV	DATE	DRAWN
1		
2		
3	1/2005	
4	OCT. 27, 2006	L. SIMKINS
5	JAN. 04, 2007	L. SIMKINS
6	NOV. 17, 2009	L. SIMKINS
7	FEB. 23, 2012	L. SIMKINS
8	AUGUST 19, 2016	
9	MARCH 30, 2017	
10		

DRAWN BY: F CHANDLER
 DRAWN DATE 9/14/04



SIZE	DWG. NO.	REV.
A	OMC 150	9
SCALE:1:20	DO NOT SCALE DRAWING	SHEET 1 OF 1



Z886-HD

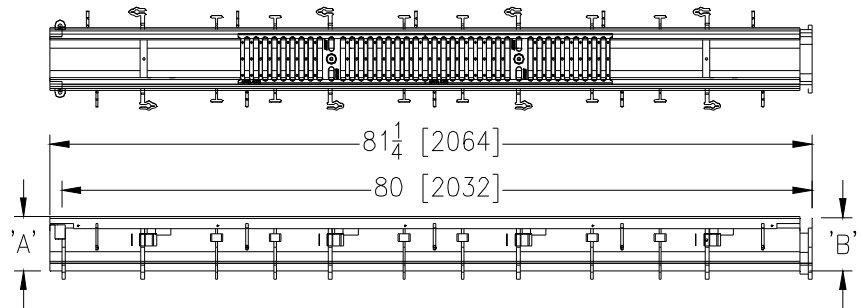
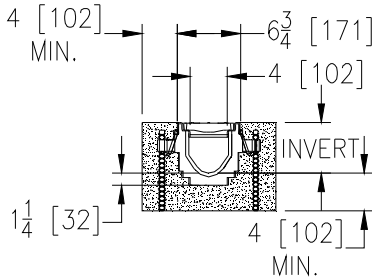
6-3/4 [171] WIDE REVEAL TRENCH DRAIN SYSTEM WITH HEAVY-DUTY FRAME ASSEMBLY

SPECIFICATION SHEET

TAG **TD**

Dimensional Data (inches and [mm]) are Subject to Manufacturing Tolerances and Change Without Notice

SPECIFYING ENGINEER IS RESPONSIBLE FOR CONCRETE ENCASEMENT AND REINFORCING BASED UPON APPLICATION AND LOCAL CODES



NOTE: + Actual Channel length is 81 1/4 [2064] to allow for overlap.

ENGINEERING SPECIFICATION: Zurn Z886-HD

Channels are 80" [2032 mm] long, 6-3/4" [171 mm] wide reveal and have a 4" [102 mm] throat. Modular channel sections are made of 0% water absorbent High Density Polyethylene (HDPE). Channels have a positive mechanical connection between channel sections that will not separate during the installation and mechanically lock into the concrete surround every 10" [254 mm]. Channels weigh less than 2.31 lbs. [1.05kg] per linear foot, have a smooth, 1-1/2" [38 mm] radiused self cleaning bottom with a Manning's coefficient of .009 and .75% or neutral 0% built in slope. Channels have rebar clips standard to secure trench in its final location. Channels provided with standard DGC grates that lock down to frame. Zurn 5.375" [137 mm] wide reveal Ductile Iron Slotted Grate conforming to ASTM specification A536-84, Grade 80-55-06. Ductile Iron grate is rated class C per the DIN EN1433 top load classifications. Supplied in 20" [508 mm] nominal lengths with 1/2" [13 mm] wide slots, and 3/4" [19 mm] bearing depth. Grate has an open area of 28.1 sq. in per ft. [59,463 sq. mm per meter]. The .105" [2.67 mm] thick Heavy-Duty Carbon Steel Frame Assembly conforms to ASTM specification A36 with 10 - 4" [102 mm] long concrete anchors per 80" [2032 mm]. Grate lockdown bars are to be integral to the frame. Frame supplied with powder coated finish. All welds must be performed by a certified welder per ASTM standard AWS D1.1. Frames produced in the U.S.A.

PREFIX OPTIONS (Check/specify appropriate options)

Z Six-foot, Eight-inch High Density Polyethylene (HDPE)*

SUFFIX OPTIONS (Check/specify appropriate options)

Outlet Adapters Add/Each

- E1 Closed End Cap
- E2 2 [51] No-Hub End Outlet
- E3 3 [76] No-Hub End Outlet
- E4 4 [102] No-Hub End Outlet
- E6 6 [152] No-Hub End Outlet
- U2 2 [51] No-Hub Bottom Outlet
- U3 3 [76] No-Hub Bottom Outlet
- U4 4 [102] No-Hub Bottom Outlet
- U6 6 [152] No-Hub Bottom Outlet

Frame Options

- CBF Black Acid Resistant Coated Top Frame
- LD Light Duty Grates on Heavy Duty Frame
- SW Sidewall Extension - 9 [229] High
- SW2 Sidewall Extension - 18 [457] High

Grate Options (Load Classifications are per DIN EN1433)

- BDC Black Acid Resistant Epoxy Coated Ductile Grate - Class C
- BDE Black Acid Resistant Epoxy Coated Ductile Grate - Class E
- BG Galvanized Ductile Iron Bar Grate - Class C
- DBG Ductile Iron Cast Bar Grate - Class C
- DC Ductile Iron Solid Cover - Class C
- DGC Ductile Iron Slotted Grate - Class C *
- DGE Ductile Iron Slotted Grate - Class E
- GDC Galvanized Ductile Iron Slotted Grate - Class C
- GDE Galvanized Ductile Iron Slotted Grate - Class E
- GHPDE Galvanized Heel-Proof Ductile Grate - Class E
- HPDE Heel-Proof Ductile Slotted Grate - Class E
- RFGC Reinforced Slotted Galvanized Grate - Class C
- RFSC Reinforced Slotted Stainless Steel Grate - Class C
- RPGC Reinforced Perforated Galvanized Grate - Class C
- RPGRC Reinforced Perforated Galvanized Reverse Punch Grate - Class C
- RPSC Reinforced Perforated Stainless Steel Grate - Class C
- RPSRC Reinforced Perforated Stainless Steel Reverse Punch Grate - Class C

Miscellaneous Options

- JC Joint Connector
- VP Vandal-Proof Lockdown

Trench No.	'A'		'B'		Flow		
	Shallow Inv.	Deep Inv.	Shallow Inv.	Deep Inv.	(cfs)	(gpm)	(lps)
8601	3.50 [89]	4.10 [104]	4.10 [104]	4.70 [119]	0.21	93	6
8602	4.10 [104]	4.70 [119]	4.70 [119]	5.30 [135]	0.27	122	8
8603	4.70 [119]	5.30 [135]	5.30 [135]	5.90 [150]	0.34	152	10
8603N	5.30 [135]	5.90 [150]	5.90 [150]	6.50 [165]	-	-	-
8604	5.90 [150]	6.50 [165]	6.50 [165]	7.10 [180]	0.41	183	12
8605	6.50 [165]	7.10 [180]	7.10 [180]	7.70 [196]	0.48	214	13
8606	7.10 [180]	7.70 [196]	7.70 [196]	8.30 [211]	0.55	245	15
8606N	7.70 [196]	8.30 [211]	8.30 [211]	8.90 [226]	-	-	-
8607	8.30 [211]	8.90 [226]	8.90 [226]	9.50 [241]	0.62	276	17
8608	8.90 [226]	9.50 [241]	9.50 [241]	10.10 [257]	0.69	308	19
8609	9.50 [241]	10.10 [257]	10.10 [257]	10.70 [272]	0.76	339	21
8610	10.10 [257]	10.70 [272]	10.70 [272]	11.30 [287]	0.83	371	23
8611	10.70 [272]	11.30 [287]	11.30 [287]	11.90 [302]	0.90	403	25
8612	11.30 [287]	11.90 [302]	11.90 [302]	12.50 [318]	0.97	435	27
8612N	11.90 [302]	12.50 [318]	12.50 [318]	-	-	-	-
8613	12.50 [318]	-	-	-	1.04	467	29
8614	-	-	-	-	1.11	498	31
8615	-	-	-	-	1.18	530	33

Decorative Grate Options (Load Classifications are per DIN EN1433)

- SBG Stainless Steel Bar Grate - Class E

MADE in the U.S.A.

- BDE-USA Black Acid Resistant Epoxy Coated Ductile Grate - Class E
- DGC-USA Ductile Iron Slotted Grate - Class C
- DGE-USA Ductile Iron Slotted Grate - Class E
- GDC-USA Galvanized Ductile Slotted Grate - Class C
- GDE-USA Galvanized Ductile Slotted Grate - Class E
- GHPDE-USA Galvanized Heel-Proof Ductile Grate - Class E
- HPDE-USA Heel-Proof Ductile Slotted Grate - Class E
- PPC Plastic Perforated Grate - Class C

Miscellaneous Options

- DB Bottom Dome Strainer

* Regularly furnished unless otherwise specified.

Zurn Industries, LLC | Specification Drainage Operation

1801 Pittsburgh Avenue, Erie, PA U.S.A. 16502 · Ph. 855-663-9876, Fax 814-454-7929

In Canada | Zurn Industries Limited

3544 Nashua Drive, Mississauga, Ontario L4V 1L2 · Ph. 905-405-8272, Fax 905-405-1292

www.zurn.com

Rev. F

Date: 1/26/2017

C.N. No. 136162

Prod. | Dwg. No. Z886-HD



Precision Plumbing Products
"Specify with Confidence - Install with Pride"

PR-500 PRESSURE DROP ACTIVATED TRAP PRIMER SUBMITTAL

TP

www.pppinc.net

The Prime Rite all brass automatic pressure drop activated trap primer valve will prime up to 2 floors drains with our patented distribution DU-U unit.

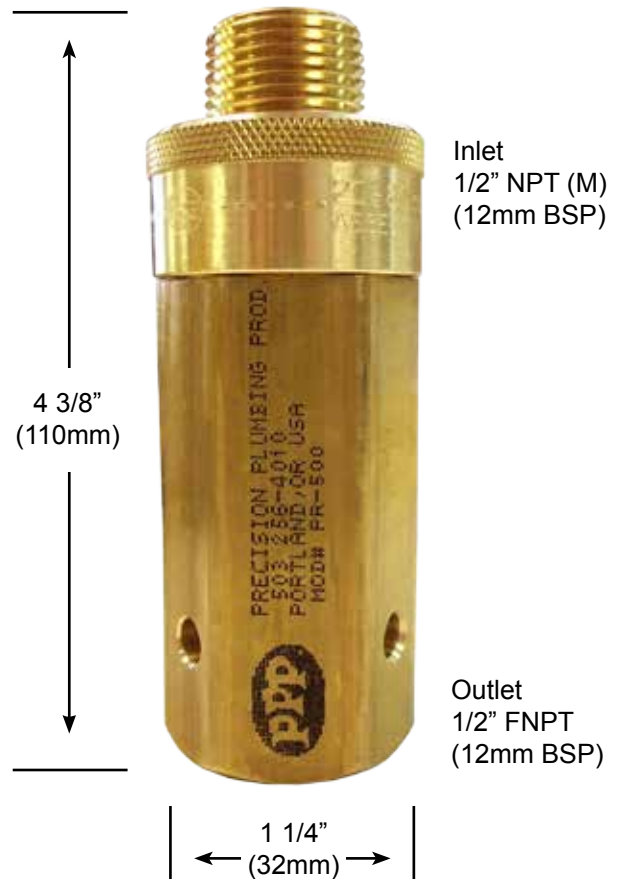
This valve requires no adjustment and will compensate for pressure fluctuations without going out of adjustment with automatic activation.

System operating range is 20 psi minimum to 80 psi (138 to 552 kpa) maximum.

The valve requires a 10 psi (70 kpa) pressure drop across the valve to activate and will deliver a metered amount of water to the floor drain. Trap primer is to be connected to a cold water supply only

Constructed of 360 brass, EPDM E70 O-rings, Dow #7 Silicone, #60 stainless steel mesh screen.

NO Adjustment Required!



PROJECT SUBMITTAL MODEL # _____

Project: _____

Contractor: _____

Engineer: _____

Date Submitted: _____

Prepared By: _____

PART NO's:

**PR-500
 PR-500AUS**

INSTALLATION REQUIREMENTS

This valve is designed to be installed on 1/2" to 1 1/2" cold water line, feeding a flush valve or other open and closing valve supply line that is frequently used.

Trap Primer valve makeup line to floor drain is recommended to be a minimum of 12" off the finished floor before a 90° elbow can be installed.

The furthest recommended distance of makeup line is 20' to the floor drain.

Trap primer make up line must have continuous slope to the floor drain (consult local code requirements).

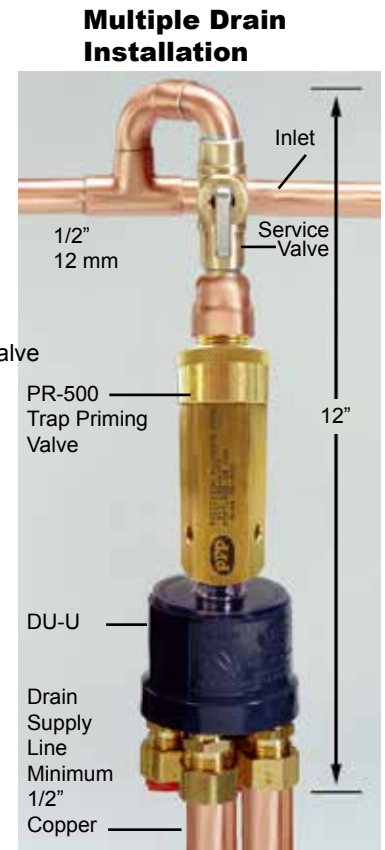
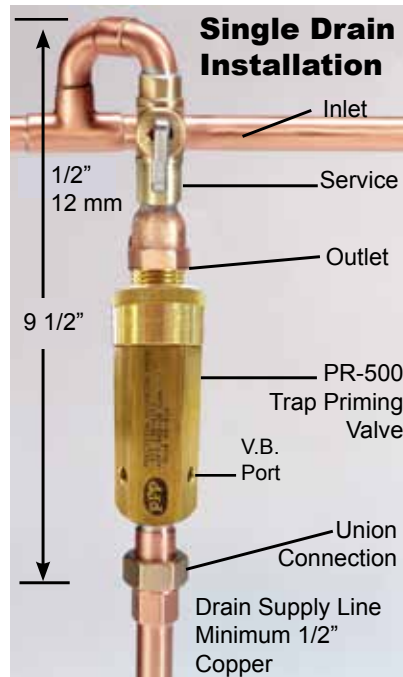
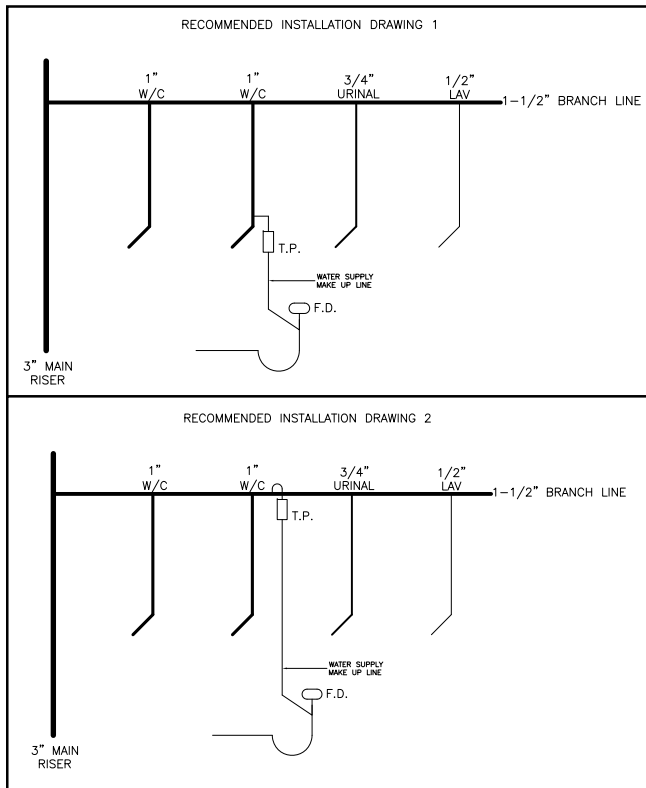
Install with a shut off valve for servicing on the inlet side and a union connection on the outlet side.

The valve must be installed level.

If using the distribution unit the clear plastic cover must be used.

Do not subject the valve to rough in pressure test.

FLOOR DRAIN TRAP PRIMER DIST. CHART		
# of Drains	Supply Tube	Dist. Units
1	N/A	N/A
2	N/A	DU-4/DU-U
Max. Water delivery based upon pressure drop and fixture unit activity on the system.		
Primer Model: PR-500 PRIME-RITE		



Precision Plumbing Products

Division of JL Industries, Inc.

802 SE 199th Ave, Suite E
Portland, Oregon 97218

T (503) 256-4010
F (503) 253-8165

www.pppinc.net




Washbrook® FloWise®
Universal Urinal
0.5gpf

- Vitreous china
- Ultra High Efficiency, Low Consumption. Operates in the range of 0.125gpf to 1.0gpf (0.5 Lpf to 3.8 Lpf)
- Flushing rim
- Elongated 14" rim from finished wall
- Washout flush action
- Extended sides for privacy
- 3/4" inlet spud
- Outlet connection threaded 2" inside (NPTF)
- 2 wall hangers
- Fixture only
- Strainer included
- Meets ASME flush requirements at 0.125 to 1.0 gpf

 6590.001 Universal Top spud
 6515.001 Universal Back spud
Nominal Dimensions:

360 x 480 x 664mm

(14-1/8" x 18-7/8" x 26-1/8")

 Recommended working pressure – between
 20 psi at valve when flushing and 80 psi static

Compliance Certifications -
Meets or Exceeds the Following Specifications:

- ASME A112.19.2-2008/CSA B45.1-08 for Vitreous China Fixtures



SEE REVERSE FOR ROUGHING-IN DIMENSIONS

To Be Specified:
 Color: White

 Flush Valve:

1.0 gpf Flush Valve: Sensor-Operated:

 American Standard Selectronic® #6063.101.002
 DC Power (Top Spud)

 American Standard Selectronic® #6062.101.002
 AC Power (Back Spud)

1.0 gpf Flush Valve: Manual-Operated:

 American Standard # 6045.101.002

0.5 gpf Flush Valve: Sensor-Operated:

 American Standard Selectronic® #6063.051.002
 DC Power (Top Spud)

 American Standard Selectronic® #6062.051.002
 AC Power (Back Spud)

0.5 gpf Flush Valve: Manual-Operated:

 American Standard #6045.051.002

0.125 gpf Flush Valve: Sensor-Operated:

 American Standard Selectronic® #6063.013.002
 DC Power (Top Spud)

 American Standard Selectronic® #6062.013.002
 AC Power (Back Spud)

0.125 gpf Flush Valve: Manual-Operated:

 American Standard #6045.013.002

 MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES
 AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND
 FACILITIES - CHECK LOCAL CODES.

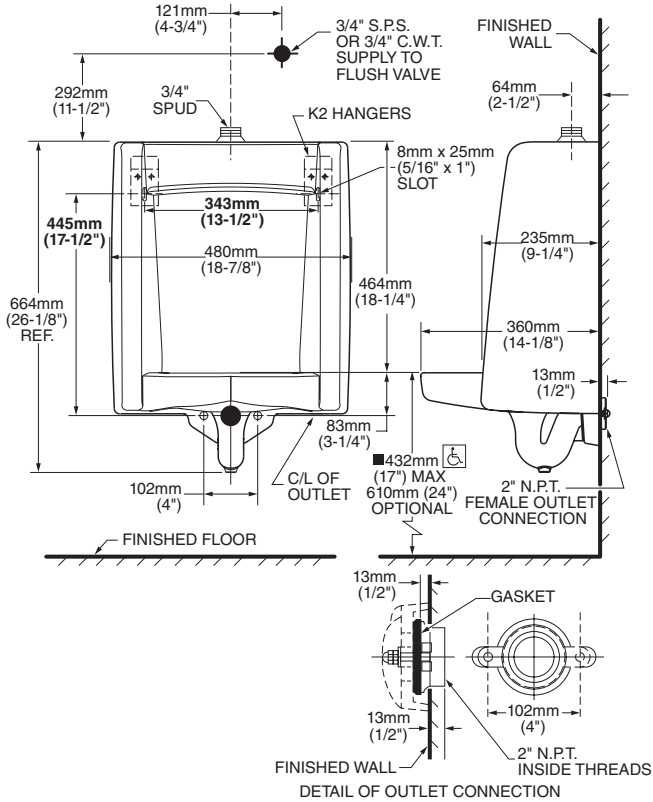
- When installed so top of rim is 432mm (17") MAXIMUM from finished floor.


 When used with
 0.125 gpf
 urinal flush valve

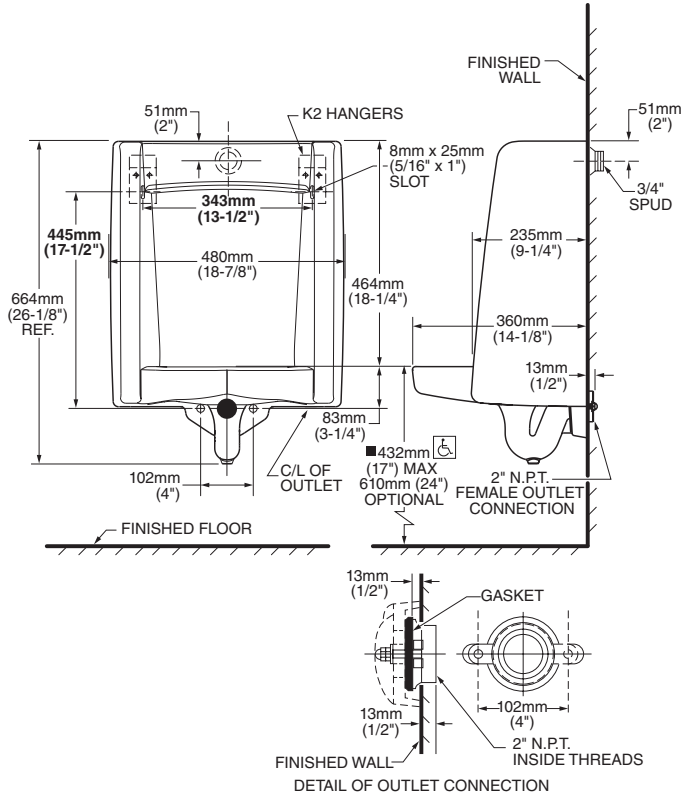
 When used with
 0.125 or 0.5 gpf
 urinal flush valve

 ADA
 COMPLIANT

6590.001 TOP SPUD



6515.001 BACK SPUD



MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 ACCESSIBLE AND USABLE BUILDINGS AND FACILITIES - CHECK LOCAL CODES.

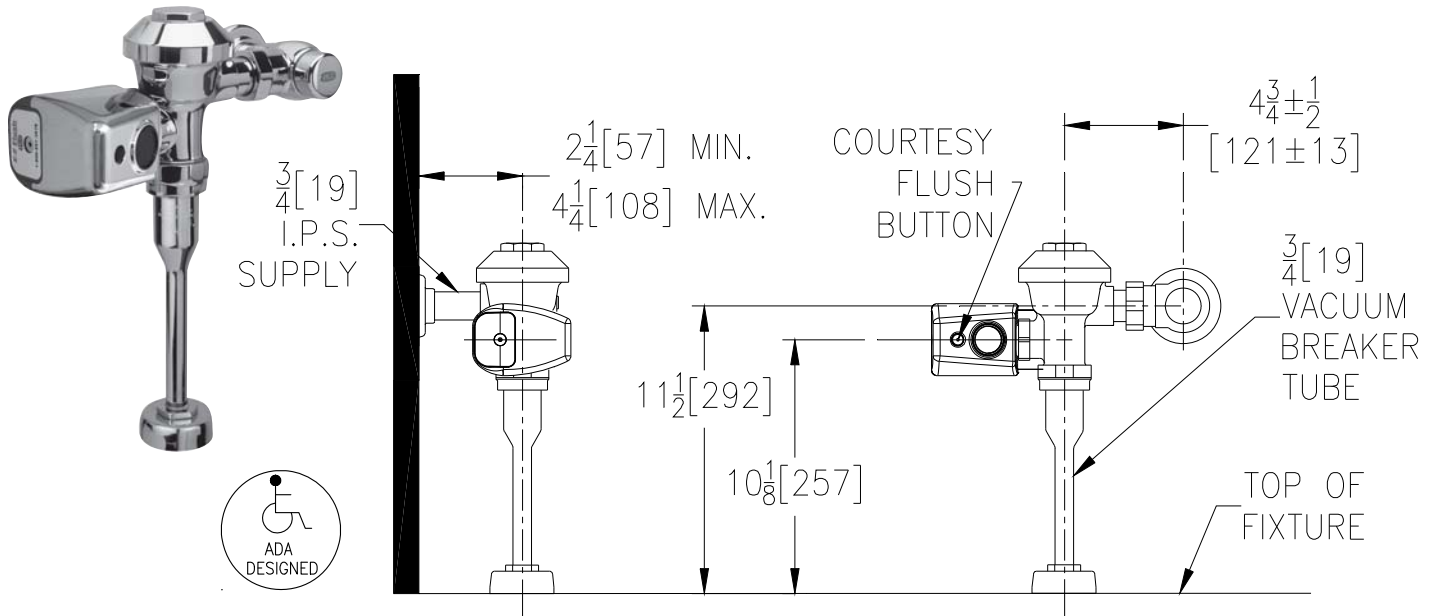
● When installed so top of rim is 432mm (17") MAXIMUM from finished floor.

NOTES:
FLUSH VALVE NOT INCLUDED AND MUST BE ORDERED SEPARATELY.
PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORTS.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages.



Exposed ZER6003PL-CPM Model Sensor Operated Battery Powered Flush Valve For 3/4" Urinals



Flow Options

<input type="checkbox"/> -ULF	0.125 GPF
<input type="checkbox"/> -EWS	0.5 GPF
<input type="checkbox"/> -WS1	1.0 GPF
<input type="checkbox"/>	1.5 GPF

Suffix Options (Check/Specify Appropriate Options)

_____ -TFB	Triple Filter Bypass (Not available for -ULF)
_____ -YJ	Split Ring Pipe Support
_____ -YK	Solid Ring Pipe Support
_____	Other

This space is for Architectural/Engineering Approval

ENGINEERING SPECIFICATION: ZURN ZER6003PL-CPM AquaSense Exposed Urinal Flush Valve - Exposed, quiet diaphragm-type, chrome plated, flushometer with a polished exterior. Complete with chloramine resistant, dual seal diaphragm with a clog resistant by-pass. The valve incorporates a 6VDC motor actuator, a battery powered automatic sensor, high impact resistant polycarbonate housing and chrome plated metal cover with manual override push button and 10 degree angled sensor, high back pressure vacuum breaker, one piece hex coupling nut, adjustable tailpiece, spud coupling and flange for top spud connection. The AquaFlush® Plus is also furnished with a sweat solder kit, vandal resistant stop cap, and cast wall flange with set screw. Control stop has internal siphon-guard protection. Internal seals are made of chloramine resistant materials.

The information contained in this document is subject to change without notice. Please contact Zurn for most up to date information.

ZURN INDUSTRIES, LLC. ♦ COMMERCIAL BRASS OPERATION ♦ 5900 ELWIN BUCHANAN DRIVE ♦ SANFORD NC 27330

Phone: 1-800-997-3876 ♦ Fax: 919-775-3541 ♦ World Wide Web: www.zurn.com

In Canada: ZURN INDUSTRIES LIMITED ♦ 3544 Nashua Drive ♦ Mississauga, Ontario L4V1L2 ♦ Phone: 905-405-8272 Fax: 905-405-1292



WC1 & WC2

AFWALL® MILLENNIUM™ FloWise® ELONGATED FLUSHOMETER TOILET

VITREOUS CHINA with EVERCLEAN®

BARRIER FREE

AFWALL® MILLENNIUM™ FloWise® ELONGATED FLUSHOMETER TOILET with EVERCLEAN®

- Wall-mounted flushometer valve toilet
- Vitreous china
- High Efficiency, Low Consumption. Operates in the range of 1.1 gpf to 1.6 gpf (4.2 Lpf to 6.0 Lpf)
- Meets definition of HET (High Efficiency Toilet) when used with a high efficiency flush valve (1.1 gpf - 1.6 gpf or 1.28/1.1 gpf dual flush)
- Maximum Performance (MaP) score of 1,000 grams at 1.1 gpf - 1.6 gpf
- Permanent EverClean® antimicrobial surface inhibits the growth of stain- and odor-causing bacteria, mold, and mildew on the surface
- Condensation channel
- Concealed trapway design
- Elongated bowl
- Powerful direct-fed siphon jet action
- 1-1/2" inlet spud
- Fully-glazed 2-1/8" trapway
- 10" x 12" water surface area
- Static weight load of 1,000 lbs.*
- 100% factory flush tested

- 3351.101** Elongated bowl only, top spud
- 3352.101** Elongated bowl only, top spud with slotted rim for bedpan holding
- 3353.101** Elongated bowl only, back spud
- 3354.101** Elongated bowl only, back spud with slotted rim for bedpan holding

System MaP* Score:

- 1,000 grams of miso @ 1.1 gpf to 1.6 gpf when used with an American Standard flush valve

* Maximum Performance (MaP) testing performed by IAPMO R&T Lab. MaP Report conducted by Veritec Consulting, Inc. and Koeller and Company.

Component Parts:

- 047007-0070A** Inlet Spud (furnished with bowl)

Nominal Dimensions:

660 x 356 x 381mm
(26" x 14" x 15")

Recommended working pressure—between 25 psi at valve when flushing and 80 psi static

Fixture only, less seat, bolt caps, and flushometer valve

Compliance Certifications - Meets or Exceeds the Following Specifications:

- ASME A112.19.2/CSA B45.1 for Vitreous China Fixtures

* This product is not recommended for bariatric use.



SEE REVERSE FOR ROUGHING-IN DIMENSIONS

To Be Specified:

- Color: White
- Seat:
 - American Standard #5901.100 Heavy duty open front less cover
 - American Standard #5905.100 Extra heavy duty open front less cover
- Flushometer Valve:
 - 1.6 gpf:
 - Sensor-Operated: American Standard Selectronic® DC Power #6065.161.002 (Top Spud) AC Power #6067.161.002 (Top Spud)
 - Manual: American Standard #6047.161.002 (Top Spud)
 - 1.28 gpf:
 - Sensor-Operated: American Standard Selectronic® DC Power #6065.121.002 (Top Spud) AC Power #6067.121.002 (Top Spud)
 - Manual: American Standard #6047.121.002 (Top Spud)
 - 1.6 / 1.1 gpf Dual Flush:
 - Sensor-Operated: American Standard Selectronic® DC Power #6065.761.002 (Top Spud) AC Power #6067.761.002 (Top Spud)
 - 1.28 / 1.1 gpf Dual Flush:
 - Sensor-Operated: American Standard Selectronic® DC Power #6065.721.002 (Top Spud) AC Power #6067.721.002 (Top Spud)



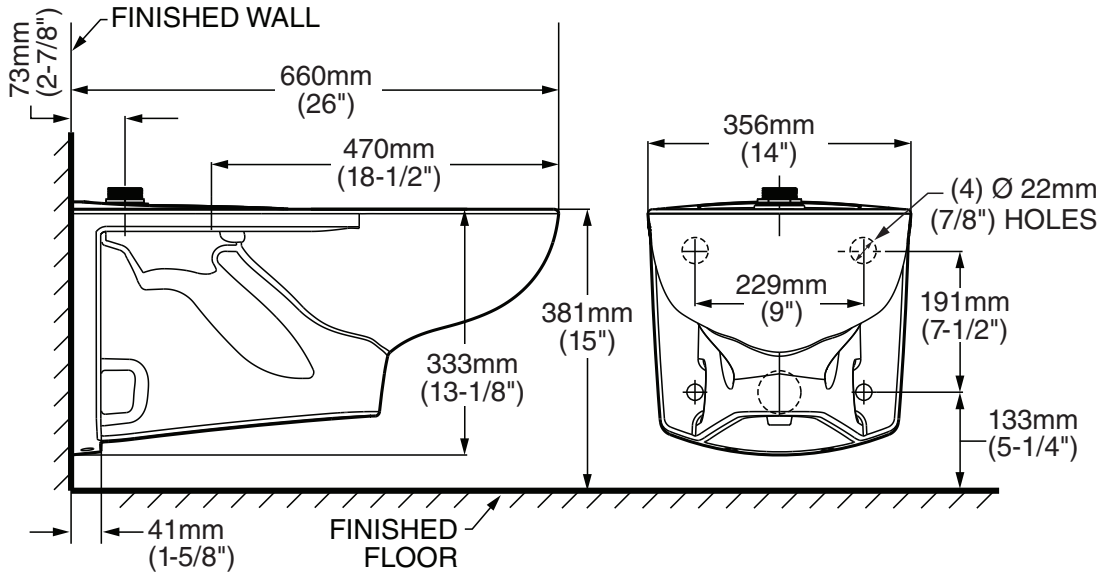
MEETS THE AMERICANS WITH DISABILITIES ACT GUIDELINES AND ANSI A117.1 REQUIREMENTS FOR ACCESSIBLE AND USABLE BUILDING FACILITIES - CHECK LOCAL CODES.

- When installed so top of seat is 432 to 483mm (17" to 19") from the finished floor.

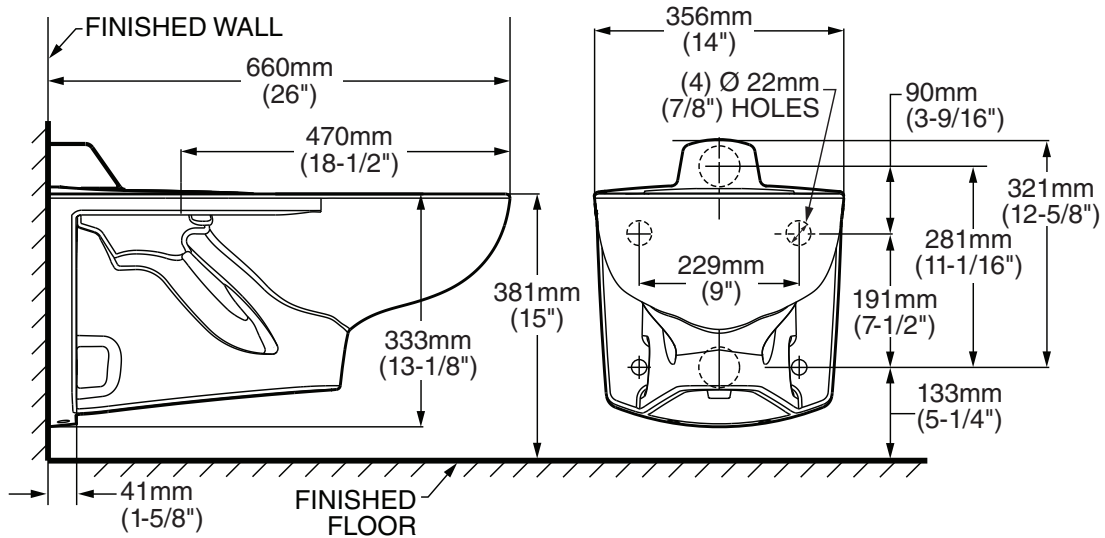
EVERCLEAN®
Surface



3351.101/3352.101



3353.101/3354.101



NOTES:

● Toilet designed to meet ADA accessibility standards when top of seat height set at 432 to 483mm (17" to 19") from finished floor.

PRODUCT 3351 AND 3353 SHOWN, 3352 AND 3354 SAME EXCEPT WITH SLOTTED RIM FOR BED PAN HOLDING.

WASTE OUTLET SEAL RING MUST BE NEOPRENE OR GRAPHITE-FELT (WAX RING NOT RECOMMENDED).

SUGGESTED 2mm (1/16) CLEARANCE BETWEEN FACE OF WALL AND BACK OF BOWL.

TO COMPLY WITH AREA CODE GOVERNING THE HEIGHT OF VACUUM BREAKER ON THE FLUSHOMETER VALVE, THE PLUMBER MUST VERIFY DIMENSIONS SHOWN FOR SUPPLY ROUGHING.

FLUSHOMETER VALVE NOT INCLUDED WITH FIXTURE AND MUST BE ORDERED SEPARATELY.

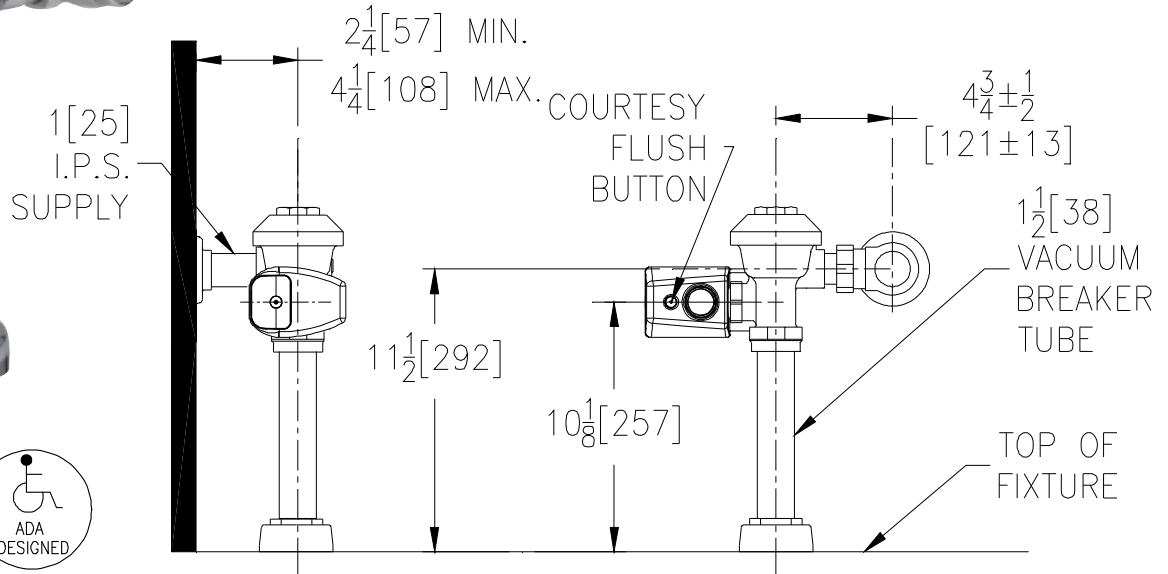
CARRIER FITTING AS REQUIRED TO BE FURNISHED BY OTHERS.

PROVIDE SUITABLE REINFORCEMENT FOR ALL WALL SUPPORT.

IMPORTANT: Dimensions of fixtures are nominal and may vary within the range of tolerances established by ANSI Standard A112.19.2. These measurements are subject to change or cancellation. No responsibility is assumed for use of superseded or voided pages



Exposed ZER6000-CPM Model Sensor Operated Battery Powered Flush Valve For Water Closets



Flow Options

- | | | |
|--------------------------|------------------------|--------------------------|
| <input type="checkbox"/> | -HET | 1.28 GPF High Efficiency |
| <input type="checkbox"/> | -WS1 | 1.6 GPF Low Consumption |
| <input type="checkbox"/> | -Standard Flush | 3.5 Gallons Per Flush |
| <input type="checkbox"/> | -FF | 4.5 Gallons Full Flush |

Suffix Options (Check/Specify Appropriate Options)

- | | | |
|-------|------------|-----------------------------|
| _____ | -YJ | Split Ring Pipe Support |
| _____ | -YK | Solid Ring Pipe Support |
| _____ | -YO | Bumper On Angle Stop |
| _____ | -VC | Vandal Resistant Stop Cover |
| _____ | -YB | Sweat Solder Kit |
| _____ | -YC | Cast Wall Flange |
| _____ | | Other |

ENGINEERING SPECIFICATION: ZURN ZER6000-CPM

AquaSense Exposed Closet Flush Valve - Exposed, quiet diaphragm-type, chrome plated flushometer valve with a polished exterior. Complete with chloramine resistant, dual seal diaphragm with a clog resistant by-pass. The valve incorporates a 6VDC motor actuator, a battery powered automatic sensor, high impact resistant polycarbonate housing and chrome plated metal cover with manual override push button and 10 degree angled sensor, high back pressure vacuum breaker, one piece hex coupling nut, adjustable tailpiece, spud coupling and flange for top spud connection. Control stop has internal siphon-guard protection. Internal seals are made of chloramine resistant materials.

- ZER6000PL-CPM - Aquaflush Plus** is furnished as specified above and includes sweat solder kit, vandal resistant stop cap, and cast wall flange with set screw.

This space is for Architectural/engineering Approval

ZURN INDUSTRIES, INC. ♦ COMMERCIAL BRASS OPERATION ♦ 5900 ELWIN BUCHANAN DRIVE ♦ SANFORD NC 27330

Phone: 1-800-997-3876 ♦ Fax: 919-775-3541 ♦ World Wide Web: www.zurn.com

In Canada: ZURN INDUSTRIES LIMITED ♦ 3544 Nashua Drive ♦ Mississauga, Ontario L4V1L2 ♦ Phone: 905-405-8272 Fax: 905-405-1292



@ WC1 & WC2

COMMERCIAL HEAVY-DUTY PLASTIC TOILET SEAT

MODEL #

COLOR #

9500CT/9500SSCT

DESCRIPTION :

Open front less cover, elongated, heavy-duty, injection molded solid plastic toilet seat. Features four molded-in bumpers, non self-sustaining (9500CT) or self-sustaining (9500SSCT) check hinges with non-corrosive 300 Series stainless steel posts and pintles and STA-TITE® Commercial Fastening System™. This seat complies with IAPMO/ANSI Z124.5-2013 Plastic Toilet Seats as a class Commercial Heavy Duty.

SPECIFICATIONS :

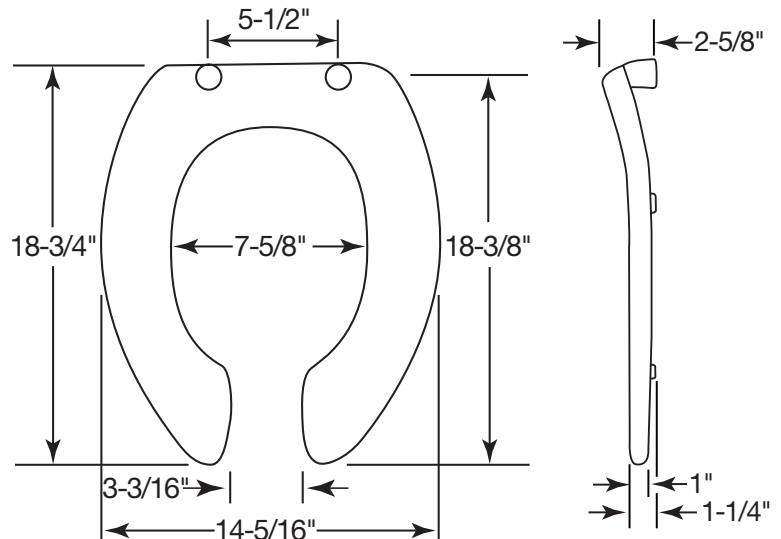
Size:	Elongated
Material:	Plastic
Style:	Open Front less Cover
Bumpers:	Four
Hinges:	Plastic Non Self-Sustaining (9500CT) or Self-Sustaining (9500SSCT) with 300 Series Stainless Steel Posts and Pintles
Fastening System:	STA-TITE® Commercial Fastening System™

FEATURES :

STA-TITE® Commercial Fastening System™

Non-Corrosive 300 Series Stainless Steel Posts and Pintles

DIMENSIONS :



PLASTIC HINGES WITH
STAINLESS STEEL POSTS
AND PINTLES



STA-TITE® COMMERCIAL
FASTENING SYSTEM™

Proudly Made in the USA

Church Seats, Sheboygan Falls, WI 53085
www.ToiletSeats.com

Phone: 800-233-7328 Fax: 800-292-3647
©2014 0B7082257 REVA



Electromagnetic Flow Meter

M2000

DESCRIPTION

The Badger Meter ModMAG® M2000 is the result of years of research and field use of electromagnetic flow meter technology. Based on Faraday's law of induction, these meters can measure water, wastewater, water-based fluids and other liquids that meet minimum electrical conductivity.

Designed, developed and manufactured under strict quality standards, this meter features sophisticated, processor-based signal conversion with accuracies of $\pm 0.20\%$ of rate ± 1 mm/s. The wide selection of liner and electrode materials helps provide maximum compatibility and minimum maintenance over a long operating period.

The meter is best suited for bidirectional flow measurement of fluids with a conductivity $> 5 \mu\text{S}/\text{cm}$ ($> 20 \mu\text{S}/\text{cm}$ for demineralized water). The meter has high accuracy, is easy to use, and can be chosen for a wide variety of applications. The backlit, four-line display shows all actual flow measuring data, daily and complete information, including alarm messages. The standard transmitter has 4 programmable digital outputs, one digital input, power output and different interfaces. Integrated system self checkup makes putting into operation and service easier. For service purpose, the meter configuration can be kept or transferred to another meter without a new parametering via the optional back-up parameter function.

APPLICATION

The M2000 transmitter can be integrally mounted to the sensor or can be remote-mounted, if necessary and has many advantages over other conventional technologies. The meter targets a variety of applications and is well suited for the diverse water and wastewater treatment industry. The M2000 meter can accurately measure fluid flow—whether the fluid is water or a highly corrosive liquid, very viscous, contains a moderate amount of solids, or requires special handling. Today, electromagnetic meters are successfully used in industries including building automation, oil and gas, food and beverage, pharmaceutical, water and wastewater, and chemical.



FEATURES

- Available in sizes 0.25...78 in. (6...2000 mm)
- Accuracy of $\pm 0.2\%$ of reading ± 1 mm/s
- Flow Range 0.03...12 m/s
- Pulsed DC magnetic field for zero point stability
- Integral and remote signal converter availability
- Power Supply of 85...265V AC / 9...36V DC
- Corrosion resistant liners for long life
- Measurement largely independent of flow profile
- User friendly programming procedure
- Empty pipe detection
- Power loss totalization
- Digital signal processor (32-bit)
- Non-volatile programming memory
- LCD display
- Rotating cover
- IP67 Housing
- Calibrated in state-of-the-art facilities
- Modbus®, HART, Profibus DP, M-Bus
- Integrated data logger
- Verifications device
- NSF listed
- CSA certified





HIGH ACCURACY DIGITAL PRESSURE TRANSMITTER

PRECISELINE

THERMALLY-COMPENSATED, RANGEABLE, DUAL OUTPUT TRANSMITTER

The Preciseline by Keller America provides standard features that far exceed those of comparably priced transmitters by combining proven piezoresistive silicon sensor technology with Keller's state-of-the-art signal conditioning circuitry. The result is outstanding $\pm 0.25\%$ FS standard ($\pm 0.1\%$ optional) Total Error Band (TEB)₄ accuracy over a wide compensated temperature range.

The ability of the Preciseline to provide this level of sustained performance over a wide range of operating conditions makes it ideally suited to pressure monitoring applications such as tank level measurement, pump control, and VFD control. Plus, guaranteed lightning protection makes this transmitter ideal for installation in areas prone to chronic damage due to transients caused by lightning.

For more information on the Preciseline, or any other Keller product, please contact Keller America, or view the entire Keller catalog at <http://www.kelleramerica.com/datasheets.html>.

FEATURES

NSF 61 / NSF 372 approved construction for use in drinking water applications

4...20mA models include guaranteed lightning protection at no additional cost.

16-bit internal digital error correction for cost-effective low Total Error Band (TEB)₄.

316L stainless steel construction

2-year warranty covers defects in materials and workmanship.

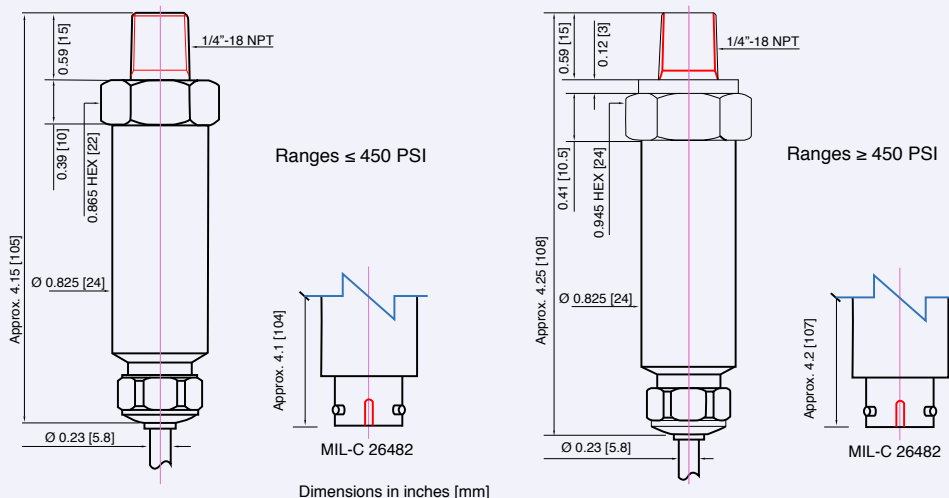
User-rangeable analog output ensures compatibility as requirements change. Converter cable required, sold separately.

RS485 modified-MODBUS compatible interface allows up to 128 transmitters on a single bus.

Standard dual (analog & RS485) outputs simplify interface to controls, data collection, and telemetry systems.

Built in the U.S.A. ARRA Section 1605 Compliant.

Standard 3-day lead time.



Wiring	2-wire (mA)	3-wire (VDC)	4-wire (RS485)
White / C	OUT / GND	GND	GND
Red / B	N/A	+OUT	N/A
Black / A	+Vcc	+Vcc	+Vcc
Blue / D	RS485A	RS485A	RS485A
Yellow / F	RS485B	RS485B	RS485B

Colors correspond to cable conductors. A, B, C refer to the MIL style connector.

Braided shield wire connected to transmitter housing. For lightning protection to function properly (4-20 mA only) the shield wire must be connected to a good earth ground.

Specifications are subject to change without notice.





Pressure Ranges_{1,2,3}

Relative	Infinite between 0...2 to 0...450 PSIG
Absolute	Infinite between 0...2 to 0...450 PSIA
Sealed	Infinite between 0...500 to 0...15,000 PSIS
Proof Pressure	10X for 1 PSI to 1.1X for 15k PSI

1. PSIG = Gage; Zero-point referenced to local atmospheric pressure.
PSIA = Absolute; Zero-point set at hard vacuum.
PSIS = Sealed Gage; Zero-point set at 1 bar absolute (14.504 PSIA).

2. Zero-point can be suppressed or elevated for special applications.

3. Intermediate ranges are realized by deranging the analog output from the next highest basic range: 1, 3, 10, and 30 bar (relative) 1, 3, 10, and 30 bar (absolute), and 100, 300, and 1000 bar (sealed). Level range may be specified in units of lb/in²(psi), inches WC or feet WC. Keller America uses the International Standard conversion of 2.3067 feet WC/psi.

Accuracy₄

Static	Standard ±0.1% FS, Optional ±0.05% FS
Total Error Band	Standard ±0.25% BR, Optional ±0.1% BR

4. Static accuracy includes the combined effects of non-linearity, hysteresis, and non-repeatability at room temperature (25°C). Static accuracy includes the combined effects of non-linearity, hysteresis, and non-repeatability at room temperature (25°C). Total Error Band (TEB) includes the combined effects of non-linearity, hysteresis, and non-repeatability as well as thermal dependencies, over the compensated temperature range, expressed as a percentage of the basic range (BR).

The calculation for maximum TEB on intermediate ranges (IR) is: $TEB_{IR} = (BR/IR) \times TEB_{BR}$

Output

Current	4...20mA + RS485
Voltage	0...5 VDC + RS485
	0...10 VDC + RS485
Digital	RS485 Only
Resolution	0.002% FS ₅

5. Resolution applies to digital output only. Analog resolution is continuous and limited by the process meter and not the instrument.

Connection

Process	1/4"-18NPT Male ₆
Electrical	10 ft. PE Cable Standard (Hytrel, Tefzel optional) ₇
	MIL-C 26482 ₇

6. Other process connections available on request. Consult the factory.
7. Tefzel Cable and MIL-C available at additional cost. MIL-C mating connector included.

Electrical₈

Supply (4-20mA)	11...28 VDC
Supply (0-5VDC)	8...28 VDC
Supply (0-10VDC)	13...28 VDC
Supply (RS485 Only)	Standard 8...28 VDC Optional 3.2...32 VDC
Load Resistance (mA)	<(Supply-11V)/0.022A
Load Resistance (VDC)	>4k ohm

8. Nominal values may be higher depending upon cable length. Internal lightning protection increases the minimum-required supply voltage from 8VDC to 11VDC, due to internal resistance of the surge protectors. In addition, cable resistance (~70Ω / 1000ft) adds to the supply requirement. In order to insure proper system operation, calculate the minimum required supply voltage (at the source) as follows:

For two-part (internal+external) system (recommended):
MINIMUM SUPPLY VOLTAGE = 11.6 + 0.022 (CABLE LENGTH x 0.07) VDC

For internal only protector (standard with 4-20mA output):
MINIMUM SUPPLY VOLTAGE = 11 + 0.022 (CABLE LENGTH x 0.07) VDC

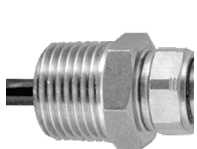
Certifications

CE	EN50081-1, EN50082-2
Shock	20g (11ms)
Vibration	20g (5-2KHz, max. amp ±3mm per IEC68-2-6)
NSF / ANSI	61, 372

Environmental

Protection Rating	
Cable	IP68
Mil-C 26482	IP65
Operating Temp.	
Cable	-10...60° C
Mil-C 26482	-30...100° C
Compensated Temp.	-10...80° C
Wetted Materials	316 L Stainless Steel

Optional Accessories



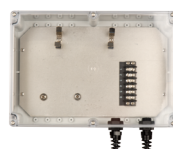
1/2" NPT Conduit Fitting



Drying Tube Assembly



Bellows Assembly



Termination Enclosure



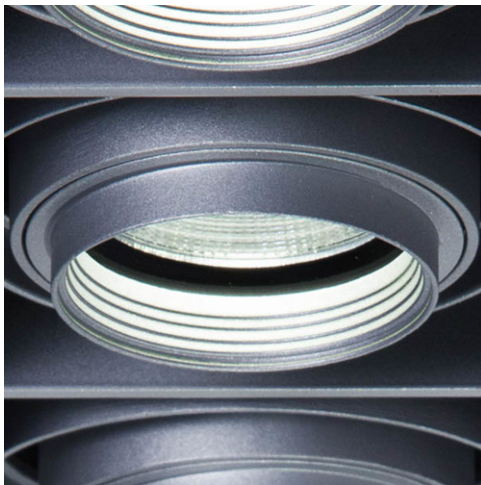
RS485 Converter Cable



Process Meter



Signal Line Surge Protector



Collection of multi-lamps directional LED downlights. Multiple Small is most suitable for small scale commercial and residential lighting applications where scalable lighting solutions are required. Highly reliable thermal design ensures long lasting performance and color consistency.

Luminaire characteristics:

Power input: 13.5W to 81W
Lumens: 895 to 1300lm per lamp
Luminaire efficacy: 66 to 96lm/W

Source: BRIDGELUX VERO13 LED module, (LM-80 tested).
2700K: 90CRI, or 97CRI
3000K: 80CRI, 90CRI, or 97CRI
3500K: 80CRI, or 90CRI
4000K: 80CRI

Lumen maintenance: 90% of initial lumens at 100 000 hours (L90),(LM-79 tested).

Optics: Available in spot, narrow flood, flood, or wide flood. Each optical assembly is adjustable 30° in all axes. A wide range of optical accessories is available.

Material: Body: Die-cast aluminum optical assembly and frame
Reflector: High bright anodized aluminum
Hardware: Black steel housing, connection box and fasteners.

Electrical: Integral high efficiency electronic power supply, rated 50 000 hours, 120-277V.

Dimming: Standard power supply compatible with Leading (TRIAC) and Trailing edge (ELV) dimmer (120V only), or with 0-10V dimming (120-277V)

Mounting: New construction plaster frame, new construction housing suitable for insulated ceiling or remodeling. No plaster frame needed for remodeling option. See page 4 for details.

Finish: White RAL9003, Black RAL9004, or Gray RAL9006 painted finish.

Weight: Range TBC.

Warranty: 5 year limited warranty.

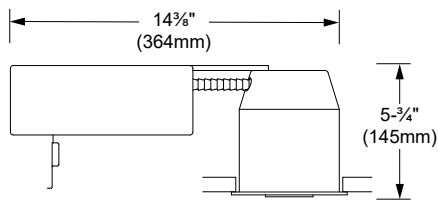
Ratings: IP20.

Certification: Damp location.
Energy star certified product. To confirm which versions are certified, please consult the product list: www.energystar.gov/productfinder

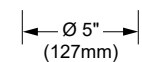
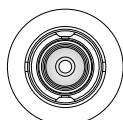


MODELS

8108

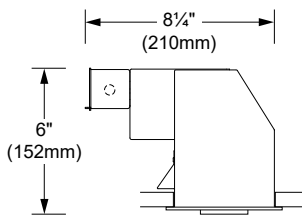


SIDE VIEW

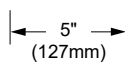
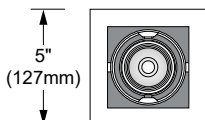


BOTTOM VIEW

8118

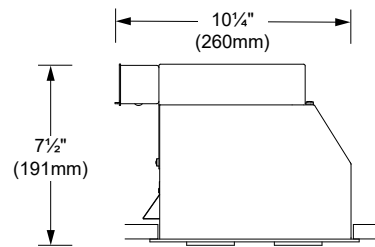


SIDE VIEW

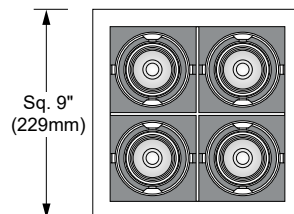


BOTTOM VIEW

8148



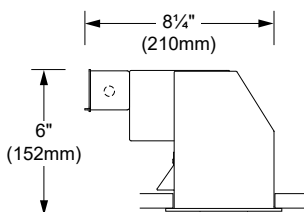
SIDE VIEW



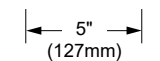
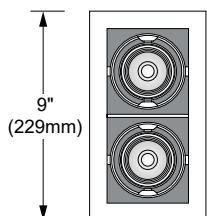
Sq. 9"
(229mm)

BOTTOM VIEW

8128

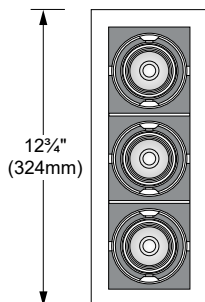


SIDE VIEW

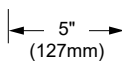


BOTTOM VIEW

8138

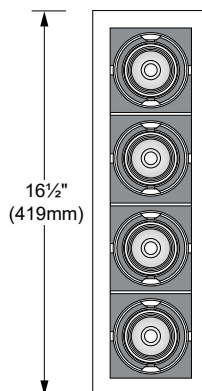


12 3/4"
(324mm)

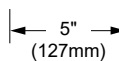


BOTTOM VIEW

8148-L

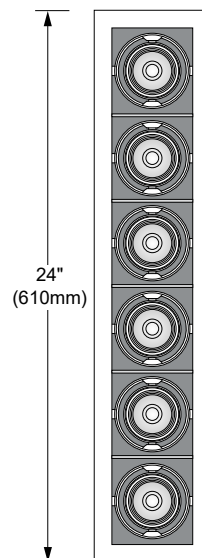


16 1/2"
(419mm)

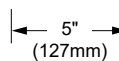


BOTTOM VIEW

8168



24"
(610mm)



BOTTOM VIEW

LED COLOR FIDELITY DATA

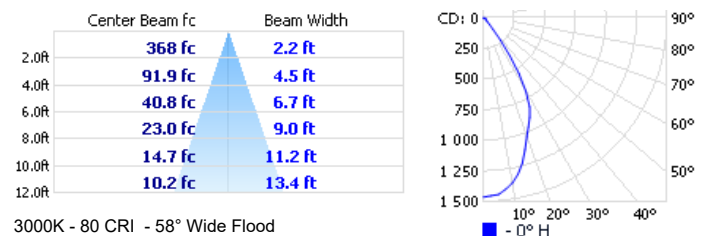
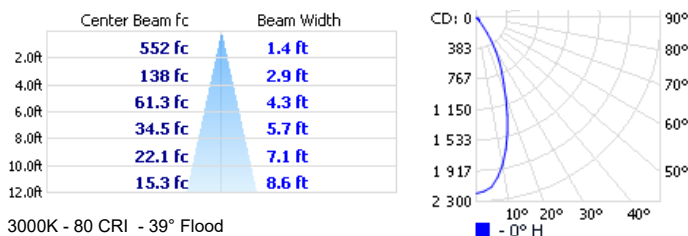
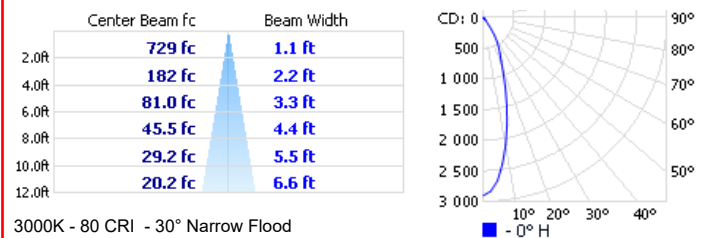
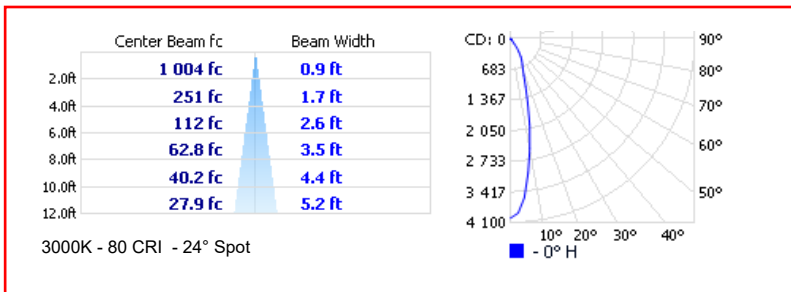
CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
80	3000K	82	92	97	83	83	90	84	61	12	81	82	75	85	99	75	86	96	0.52
	3500K	81	89	95	80	80	84	85	63	9	73	78	61	82	97	75	83	97	0.58
	4000K	80	88	93	81	80	83	87	66	10	71	79	56	82	96	74	83	95	0.67
90	2700K	91	94	93	90	89	91	93	82	60	83	89	74	91	95	88	89	101	0.44
	3000K	94	96	96	91	92	94	93	85	66	89	90	77	94	97	92	90	100	0.51
97	3500K	95	98	96	92	93	94	94	88	74	91	91	74	96	97	94	90	99	0.65
	2700K	99	99	98	98	99	97	95	92	84	98	97	89	99	98	98	94	102	0.50
	3000K	99	99	97	99	99	97	98	98	95	98	97	85	99	97	99	95	101	0.58

TECHNICAL DATA

Photometric performance is measured at an accredited independent laboratory in accordance with IESNA LM-79. Visit sistemalux.com for complete photometric data.

REFER TO ONE LAMP

LOAD (W)	CCT (K)	CRI	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODEL
13.5W	3000K	80	Spot	1250	92	4015	8118-830-SP
			Narrow Flood	1195	88	2915	8118-830-NF
			Flood	1205	89	2205	8118-830-FL
			Wide Flood	1230	91	1470	8118-830-WF



*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

CCT options	2700K	2700K	3000K	3000K	3000K	3500K	3500K	4000K
CRI options	90CRI	97CRI	80CRI	90CRI	97CRI	80CRI	90CRI	80CRI
Multiplier	0.80	0.75	1	0.83	0.81	1.03	0.83	1.04

INSTALLATIONS OPTIONS

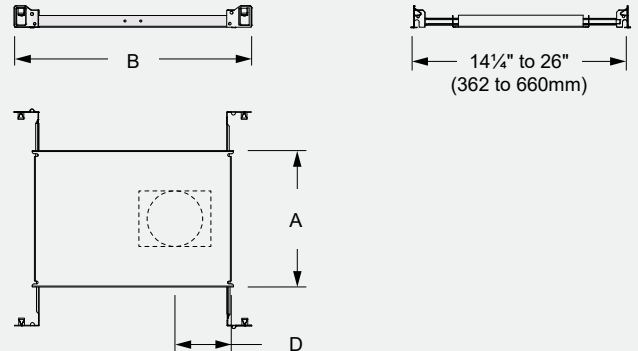
Remodel (RF)

Versatile housing for new or existing ceiling structure. Suitable for non-insulated ceiling assemblies, like sheetrock, or paneling. Fixture is ready for remodeling installation. See page 2 for dimensions.

New construction with plaster frame (NC)

Plaster frame with hanger bars system to be installed during rough-in phase. Suitable for non-insulated new construction ceiling assemblies, like sheetrock, acoustic tiles, or paneling. Housing and trim can be shipped separately.

Ceiling thickness: 1/8" to 1 3/8" (3mm - 35mm)

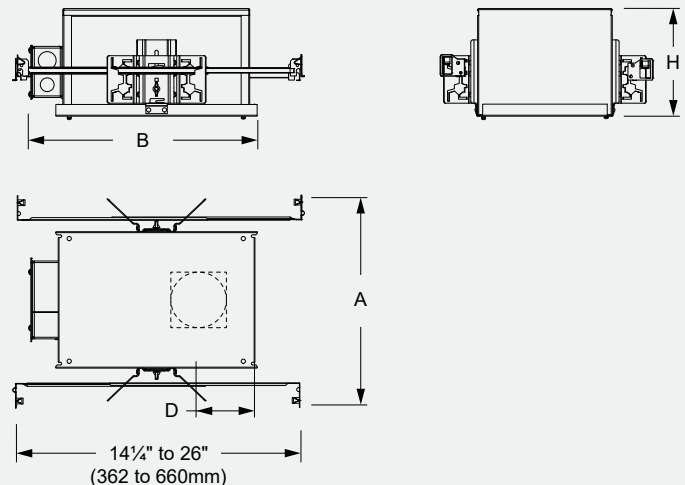


Model	Plaster frame	Overall dimensions (AxB)	Cut-out position (D)	Cut-out dimensions	Clearance
Single round	BN-8108-NC	15 5/8" x 16"	4" (102mm)	Ø 4 3/4" (Ø 121mm)	10" (254mm)
Single square	BN-8118-NC	8 5/8" x 15 5/8"	3 3/4" (95mm)	4 1/2" X 4 1/2" (114 x 114mm)	
Double	BN-8128-NC	8 5/8" x 15 5/8"	6 3/8" (162mm)	8 1/2" X 4 1/2" (216 x 114mm)	6" (152mm)
Triple	BN-8138-NC	7 5/8" x 20"	9 5/8" (232mm)	12 1/4" X 4 1/2" (311 x 114mm)	
Four square	BN-8148-NC	12" x 16 1/4"	7 3/8" (187mm)	8 1/2" X 8 1/2" (216 x 216mm)	7 1/2" (191mm)
Four long	BN-8148L-NC	7 5/8" x 23 5/8"	11" (279mm)	16" X 4 1/2" (406 x 114mm)	6" (152mm)
Six	BN-8168-NC	7 5/8" x 31 1/8"	14 3/4" (375mm)	23 1/2" X 4 1/2" (570 x 114mm)	

New construction with housing suitable for insulated ceiling (IC)

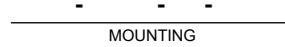
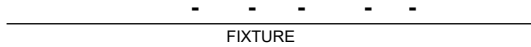
(For Single and Double models only)
Housing with hanger bars system for new construction installations. Suitable for insulated ceiling or Chicago Plenum applications. Housing and trim can be shipped separately.

Ceiling thickness: 1/8" to 1 3/8" (3mm - 35mm)
Total weight: TBC



Model	Insulated box	Box overall dimensions (AxB,H)	Cut-out position (D)	Cut-out dimensions	Clearance
Single round insulated	BI-8108-IC	12 1/4" X 14 3/8", 6 5/8" (327 x 365mm, h:175mm)	3 3/4" (95mm)	Ø 4 3/4" (Ø121mm)	6 5/8" (174mm)
Single round insulated w/ 0-10V	BI-8108-IC-D10			4 1/2" X 4 1/2" (114 x 114mm)	
Single square insulated	BI-8118-IC				
Single square insulated w/ 0-10V	BI-8118-IC-D10				
Double insulated	BI-8128-IC	14 1/2" X 21 1/8", 8 5/8" (368 x 556mm, h:219mm)	6" (152mm)	8 1/2" X 4 1/2" (216 x 114mm)	8 5/8" (219mm)
Double insulated w/ 0-10V	BI-8128-IC-D10				

ORDERING INFO



MODEL

- 8108** - Single, round
 8118 - Single
 8128 - Double
 8138 - Triple
 8148 - Four, Square
 8148L - Four, long
 8168 - Six

INSTALLATION

- RF** - no plaster frame
 NC - New construction
 IC - Insulated ceiling (for Single and Double models only)

LED

- 927** - 2700K, 90 CRI
 027* - 2700K, 97 CRI
 830 - 3000K, 80 CRI
 930 - 3000K, 90 CRI
 030* - 3000K, 97 CRI
 835 - 3500K, 80 CRI
 935 - 3500K, 90 CRI
 840* - 4000K, 80 CRI

OPTIC

- SP** - Spot
 NF - Narrow Flood
 FL - Flood
 WF - Wide flood

VOLTAGE

- 120** - 120V
 UNV - 120-277V

FINISH

- 01** - White
 02 - Black
 10 - Gray







DIMMING

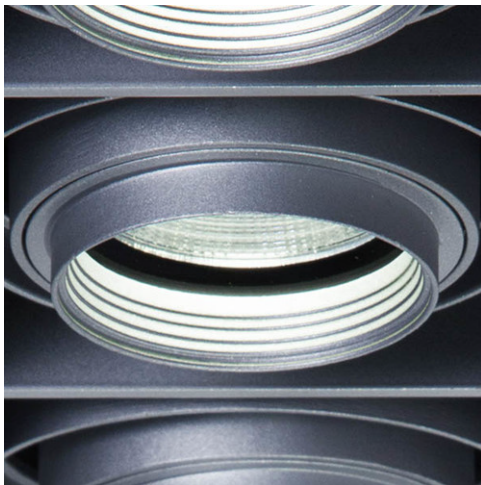
- LTE** - Leading and Trailing edge dimming (120V only)
 D10 - 0-10V dimming

* These LED options may require a longer lead time than standard. Please contact factory for details.

ACCESSORIES (TO BE ORDERED SEPARATELY)

*Maximum of 3 accessories per optical assembly.

- | | | | |
|---|---|---|---|
| <input type="checkbox"/> 8050 - Frosted glass lens |  | <input type="checkbox"/> 8111-02 - Black snoot
Length: 1-3/4" (44mm) |  |
| <input type="checkbox"/> 8675-02 - Black louver |  | <input type="checkbox"/> 1597A-52 - Black snoot
Length: 1-5/8" (40mm) |  |
| | | <input type="checkbox"/> 1594A-52 - Black cross baffle
Length: 7/8" (22.5mm) |  |
| | | <input type="checkbox"/> 1595A-52 - Black visor Wall Washer
Length: 1-3/4" (44mm) |  |



Collection of multi-lamps directional LED downlights. Multiple Small is most suitable for small scale commercial and residential lighting applications where scalable lighting solutions are required. Highly reliable thermal design ensures long lasting performance and color consistency.

Luminaire characteristics:

Power input: 13.5W to 81W
Lumens: 895 to 1300lm per lamp
Luminaire efficacy: 66 to 96lm/W

Source: BRIDGELUX VERO13 LED module, (LM-80 tested).
2700K: 90CRI, or 97CRI
3000K: 80CRI, 90CRI, or 97CRI
3500K: 80CRI, or 90CRI
4000K: 80CRI
Lumen maintenance: 90% of initial lumens at 100 000 hours (L90),(LM-79 tested).

Optics: Available in spot, narrow flood, flood, or wide flood. Each optical assembly is adjustable 30° in all axes. A wide range of optical accessories is available.

Material: Body: Die-cast aluminum optical assembly and frame
Reflector: High bright anodized aluminum
Hardware: Black steel housing, connection box and fasteners.

Electrical: Integral high efficiency electronic power supply, rated 50 000 hours, 120-277V.

Dimming: Standard power supply compatible with Leading (TRIAC) and Trailing edge (ELV) dimmer (120V only), or with 0-10V dimming (120-277V)

Mounting: New construction plaster frame, new construction housing suitable for insulated ceiling or remodeling. No plaster frame needed for remodeling option. See page 4 for details.

Finish: White RAL9003, Black RAL9004, or Gray RAL9006 painted finish.

Weight: Range TBC.

Warranty: 5 year limited warranty.

Ratings: IP20.

Certification: Damp location.



Energy star certified product. To confirm which versions are certified, please consult the product list: www.energystar.gov/productfinder

MULTIPLE SMALL

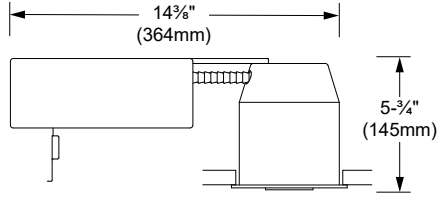
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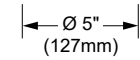
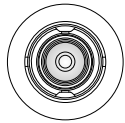
Project :

MODELS

8108

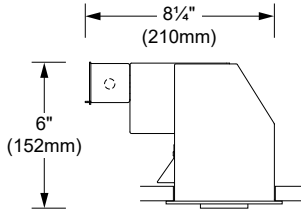


SIDE VIEW

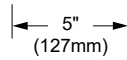
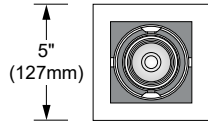


BOTTOM VIEW

8118

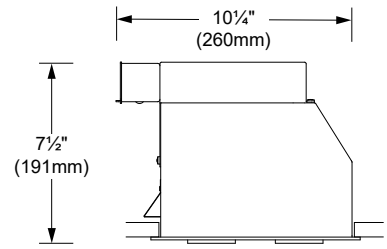


SIDE VIEW

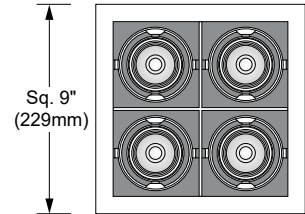


BOTTOM VIEW

8148



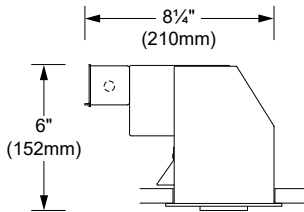
SIDE VIEW



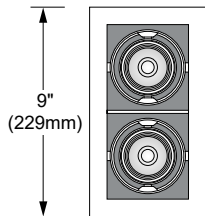
Sq. 9"
(229mm)

BOTTOM VIEW

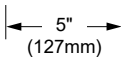
8128



SIDE VIEW

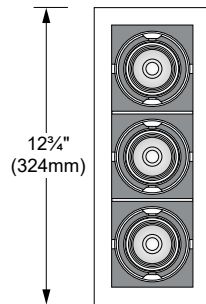


9"
(229mm)

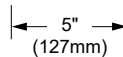


BOTTOM VIEW

8138

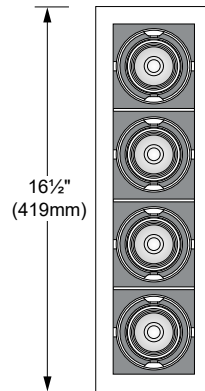


12 3/4"
(324mm)

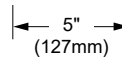


BOTTOM VIEW

8148-L

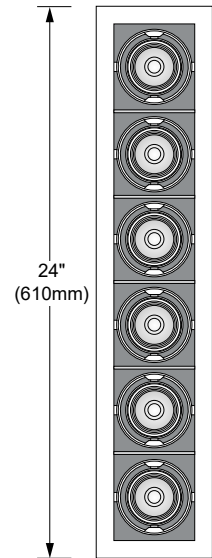


16 1/2"
(419mm)

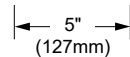


BOTTOM VIEW

8168



24"
(610mm)



BOTTOM VIEW

LED COLOR FIDELITY DATA

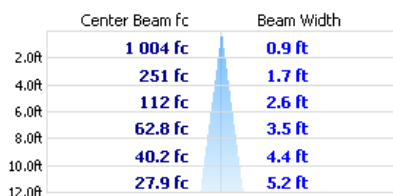
CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
80	3000K	82	92	97	83	83	90	84	61	12	81	82	75	85	99	75	86	96	0.52
	3500K	81	89	95	80	80	84	85	63	9	73	78	61	82	97	75	83	97	0.58
	4000K	80	88	93	81	80	83	87	66	10	71	79	56	82	96	74	83	95	0.67
90	2700K	91	94	93	90	89	91	93	82	60	83	89	74	91	95	88	89	101	0.44
	3000K	94	96	96	91	92	94	93	85	66	89	90	77	94	97	92	90	100	0.51
97	3500K	95	98	96	92	93	94	94	88	74	91	91	74	96	97	94	90	99	0.65
	2700K	99	99	98	98	99	97	95	92	84	98	97	89	99	98	98	94	102	0.50
	3000K	99	99	97	99	99	97	98	98	95	98	97	85	99	97	99	95	101	0.58

TECHNICAL DATA

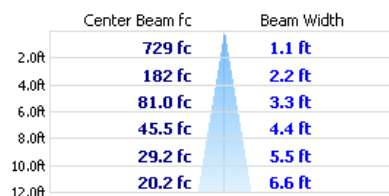
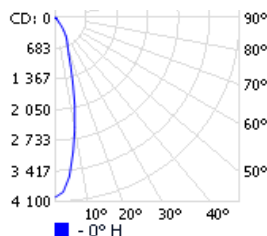
Photometric performance is measured at an accredited independent laboratory in accordance with IESNA LM-79. Visit sistemalux.com for complete photometric data.

REFER TO ONE LAMP

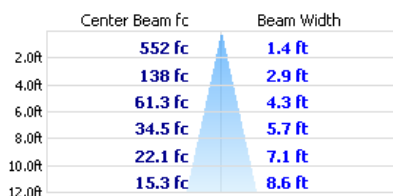
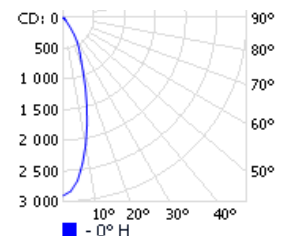
LOAD (W)	CCT (K)	CRI	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODEL
13.5W	3000K	80	Spot	1250	92	4015	8118-830-SP
			Narrow Flood	1195	88	2915	8118-830-NF
			Flood	1205	89	2205	8118-830-FL
			Wide Flood	1230	91	1470	8118-830-WF



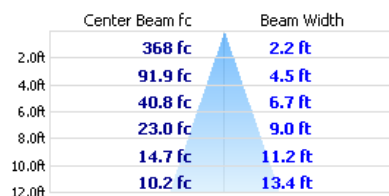
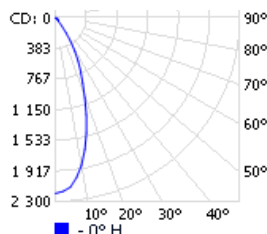
3000K - 80 CRI - 24° Spot



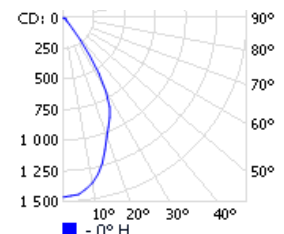
3000K - 80 CRI - 30° Narrow Flood



3000K - 80 CRI - 39° Flood



3000K - 80 CRI - 58° Wide Flood



*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

CCT options	2700K	2700K	3000K	3000K	3000K	3500K	3500K	4000K
CRI options	90CRI	97CRI	80CRI	90CRI	97CRI	80CRI	90CRI	80CRI
Multiplier	0.80	0.75	1	0.83	0.81	1.03	0.83	1.04

INSTALLATIONS OPTIONS

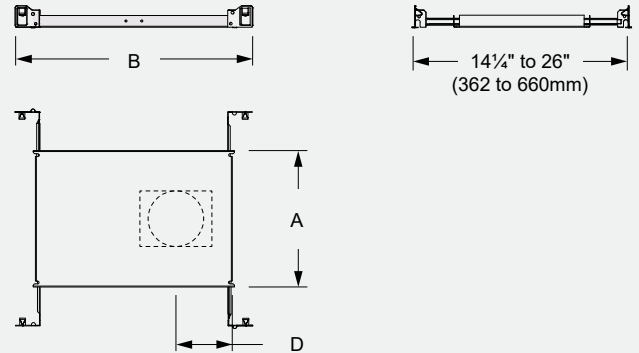
Remodel (RF)

Versatile housing for new or existing ceiling structure. Suitable for non-insulated ceiling assemblies, like sheetrock, or paneling. Fixture is ready for remodeling installation. See page 2 for dimensions.

New construction with plaster frame (NC)

Plaster frame with hanger bars system to be installed during rough-in phase. Suitable for non-insulated new construction ceiling assemblies, like sheetrock, acoustic tiles, or paneling. Housing and trim can be shipped separately.

Ceiling thickness: 1/8" to 1 3/8" (3mm - 35mm)



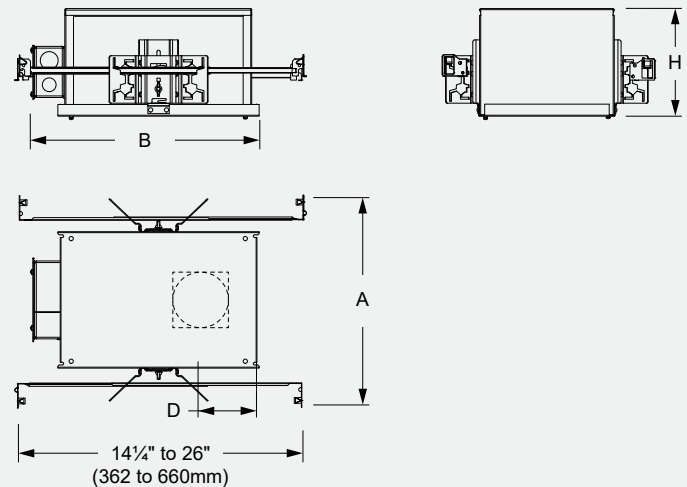
Model	Plaster frame	Overall dimensions (AxB)	Cut-out position (D)	Cut-out dimensions	Clearance
Single round	BN-8108-NC	15 5/8" x 16"	4" (102mm)	Ø 4 3/4" (Ø 121mm)	10" (254mm)
Single square	BN-8118-NC	8 5/8" x 15 5/8"	3 3/4" (95mm)	4 1/2" X 4 1/2" (114 x 114mm)	
Double	BN-8128-NC	8 5/8" x 15 5/8"	6 3/8" (162mm)	8 1/2" X 4 1/2" (216 x 114mm)	6" (152mm)
Triple	BN-8138-NC	7 5/8" x 20"	9 5/8" (232mm)	12 1/4" X 4 1/2" (311 x 114mm)	
Four square	BN-8148-NC	12" x 16 1/4"	7 3/8" (187mm)	8 1/2" X 8 1/2" (216 x 216mm)	7 1/2" (191mm)
Four long	BN-8148L-NC	7 5/8" x 23 5/8"	11" (279mm)	16" X 4 1/2" (406 x 114mm)	6" (152mm)
Six	BN-8168-NC	7 5/8" x 31 1/8"	14 3/4" (375mm)	23 1/2" X 4 1/2" (570 x 114mm)	

New construction with housing suitable for insulated ceiling (IC)

(For Single and Double models only)
Housing with hanger bars system for new construction installations. Suitable for insulated ceiling or Chicago Plenum applications. Housing and trim can be shipped separately.

Ceiling thickness: 1/8" to 1 3/8" (3mm - 35mm)

Total weight: TBC

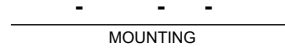


Model	Insulated box	Box overall dimensions (AxB,H)	Cut-out position (D)	Cut-out dimensions	Clearance
Single round insulated	BI-8108-IC	12 1/4" X 14 3/8", 6 5/8" (327 x 365mm, h:175mm)	3 3/4" (95mm)	Ø 4 3/4" (Ø121mm)	6 5/8" (174mm)
Single round insulated w/ 0-10V	BI-8108-IC-D10			4 1/2" X 4 1/2" (114 x 114mm)	
Single square insulated	BI-8118-IC			14 1/2" X 21 1/8", 8 5/8" (368 x 556mm, h:219mm)	6" (152mm)
Single square insulated w/ 0-10V	BI-8118-IC-D10				
Double insulated	BI-8128-IC				
Double insulated w/ 0-10V	BI-8128-IC-D10				

MULTIPLE SMALL
RECESSED

Type:
Project :

ORDERING INFO



MODEL

- 8106** - Single, round
- 8118** - Single
- 8128** - Double
- 8138** - Triple
- 8148** - Four, Square
- 8148L** - Four, long
- 8168** - Six

INSTALLATION

- RF** - no plaster frame
- NC** - New construction
- IC** - Insulated ceiling (for Single and Double models only)

LED

- 927** - 2700K, 90 CRI
- 927*** - 2700K, 97 CRI
- 830** - 3000K, 80 CRI
- 930** - 3000K, 90 CRI
- 030*** - 3000K, 97 CRI
- 835** - 3500K, 80 CRI
- 935** - 3500K, 90 CRI
- 840*** - 4000K, 80 CRI

OPTIC

- SP** - Spot
- NF** - Narrow Flood
- FL** - Flood
- WF** - Wide flood

VOLTAGE

- 120** - 120V
- UNV** - 120-277V

FINISH

- 01** - White
- 02** - Black
- 10** - Gray







DIMMING

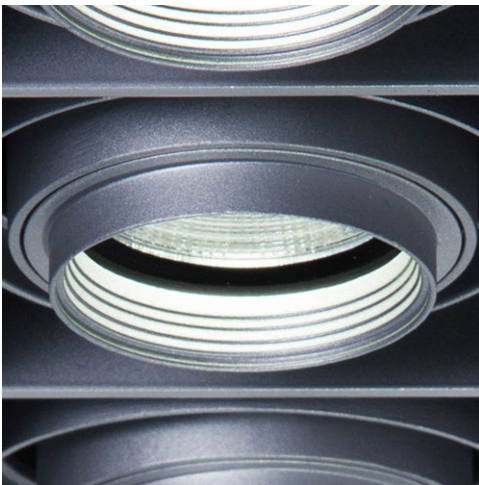
- LTE** - Leading and Trailing edge dimming (120V only)
- D10** - 0-10V dimming

* These LED options may require a longer lead time than standard. Please contact factory for details.

ACCESSORIES (TO BE ORDERED SEPARATELY)

*Maximum of 3 accessories per optical assembly.

- 8050** - Frosted glass lens 
- 8675-02** - Black louver 
- 8111-02** - Black snoot
Length: 1-3/4" (44mm) 
- 1597A-52** - Black snoot
Length: 1-5/8" (40mm) 
- 1594A-52** - Black cross baffle
Length: 7/8" (22.5mm) 
- 1595A-52** - Black visor Wall Washer
Length: 1-3/4" (44mm) 



Collection of multi-lamps directional LED downlights. Multiple Small is most suitable for small scale commercial and residential lighting applications where scalable lighting solutions are required. Highly reliable thermal design ensures long lasting performance and color consistency.

Luminaire characteristics:

Power input: 13.5W to 81W
Lumens: 895 to 1300lm per lamp
Luminaire efficacy: 66 to 96lm/W

Source: BRIDGELUX VERO13 LED module, (LM-80 tested).
2700K: 90CRI, or 97CRI
3000K: 80CRI, 90CRI, or 97CRI
3500K: 80CRI, or 90CRI
4000K: 80CRI
Lumen maintenance: 90% of initial lumens at 100 000 hours (L90),(LM-79 tested).

Optics: Available in spot, narrow flood, flood, or wide flood. Each optical assembly is adjustable 30° in all axes. A wide range of optical accessories is available.

Material: Body: Die-cast aluminum optical assembly and frame
Reflector: High bright anodized aluminum
Hardware: Black steel housing, connection box and fasteners.

Electrical: Integral high efficiency electronic power supply, rated 50 000 hours, 120-277V.

Dimming: Standard power supply compatible with Leading (TRIAC) and Trailing edge (ELV) dimmer (120V only), or with 0-10V dimming (120-277V)

Mounting: New construction plaster frame, new construction housing suitable for insulated ceiling or remodeling. No plaster frame needed for remodeling option. See page 4 for details.

Finish: White RAL9003, Black RAL9004, or Gray RAL9006 painted finish.

Weight: Range TBC.

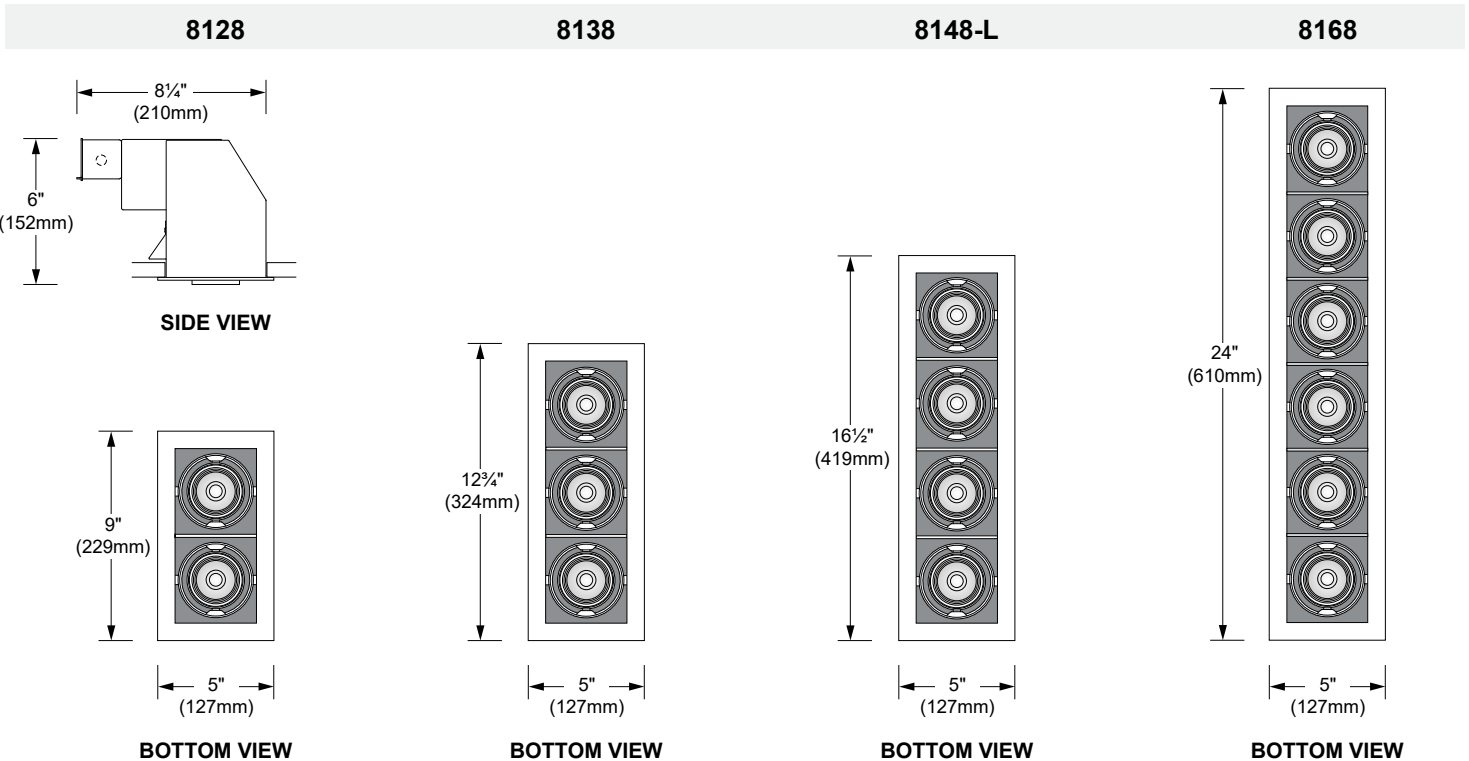
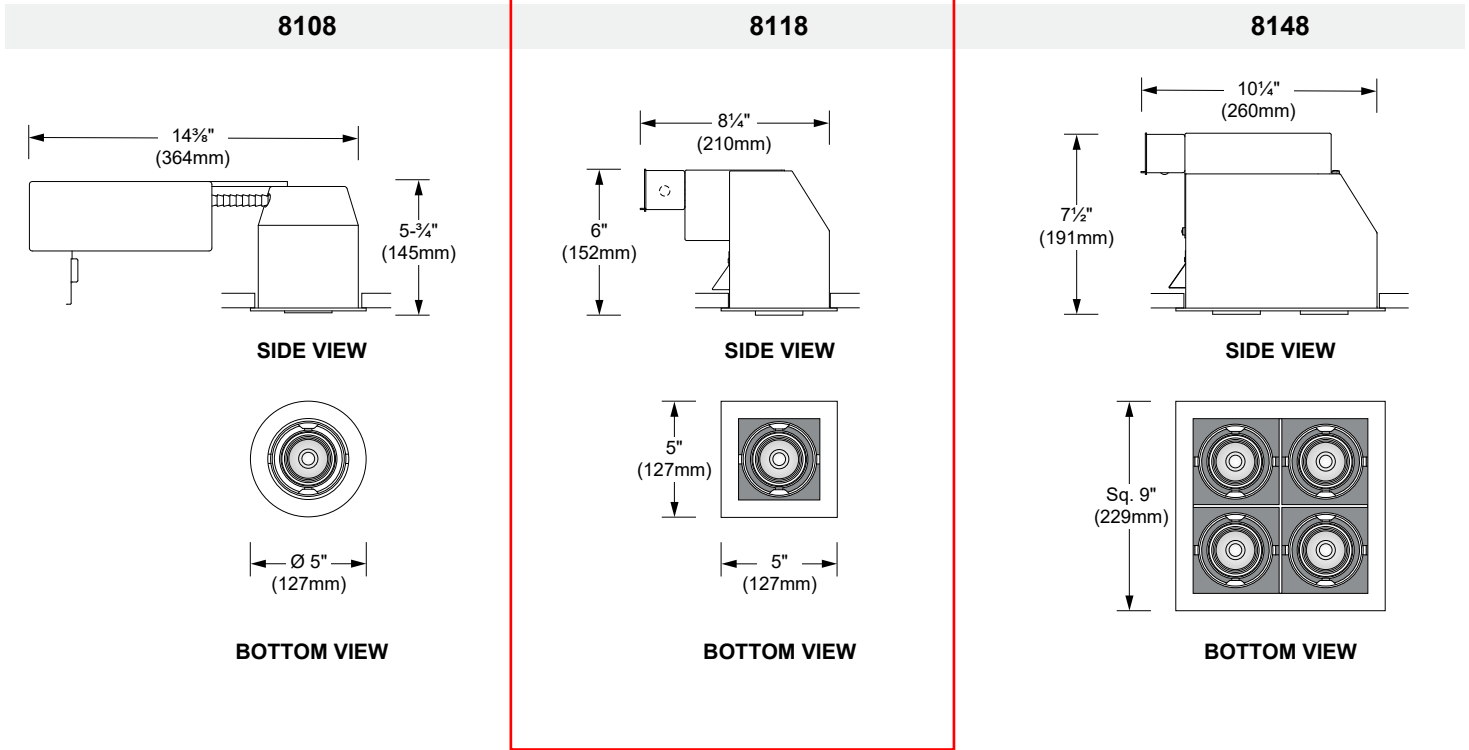
Warranty: 5 year limited warranty.

Ratings: IP20.

Certification: Damp location.
Energy star certified product. To confirm which versions are certified, please consult the product list: www.energystar.gov/productfinder



MODELS



LED COLOR FIDELITY DATA

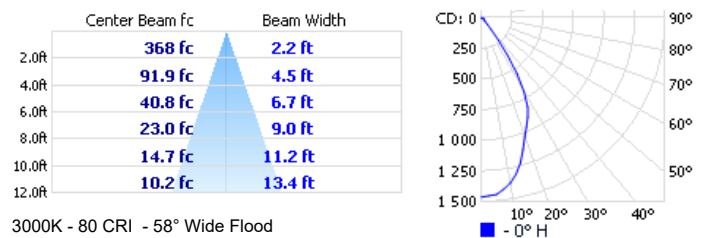
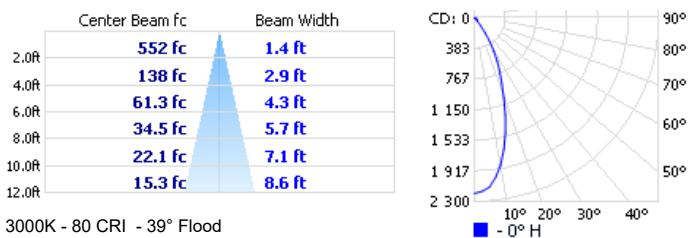
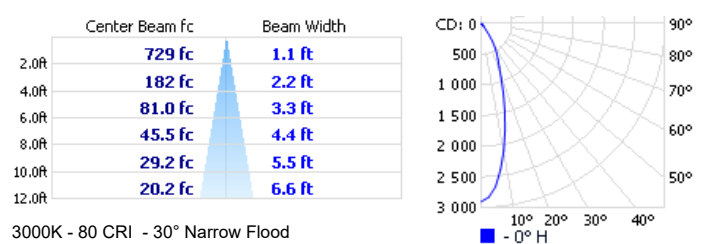
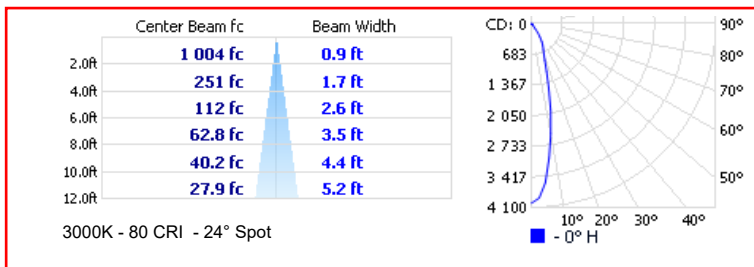
CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
80	3000K	82	92	97	83	83	90	84	61	12	81	82	75	85	99	75	86	96	0.52
	3500K	81	89	95	80	80	84	85	63	9	73	78	61	82	97	75	83	97	0.58
	4000K	80	88	93	81	80	83	87	66	10	71	79	56	82	96	74	83	95	0.67
90	2700K	91	94	93	90	89	91	93	82	60	83	89	74	91	95	88	89	101	0.44
	3000K	94	96	96	91	92	94	93	85	66	89	90	77	94	97	92	90	100	0.51
	3500K	95	98	96	92	93	94	94	88	74	91	91	74	96	97	94	90	99	0.65
97	2700K	99	99	98	98	99	97	95	92	84	98	97	89	99	98	98	94	102	0.50
	3000K	99	99	97	99	99	97	98	98	95	98	97	85	99	97	99	95	101	0.58

TECHNICAL DATA

Photometric performance is measured at an accredited independant laboratory in accordance with IESNA LM-79. Visit sistemalux.com for complete photometric data.

REFER TO ONE LAMP

LOAD (W)	CCT (K)	CRI	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODEL
13.5W	3000K	80	Spot	1250	92	4015	8118-830-SP
			Narrow Flood	1195	88	2915	8118-830-NF
			Flood	1205	89	2205	8118-830-FL
			Wide Flood	1230	91	1470	8118-830-WF



*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

CCT options	2700K	2700K	3000K	3000K	3000K	3500K	3500K	4000K
CRI options	90CRI	97CRI	80CRI	90CRI	97CRI	80CRI	90CRI	80CRI
Multiplier	0.80	0.75	1	0.83	0.81	1.03	0.83	1.04

INSTALLATIONS OPTIONS

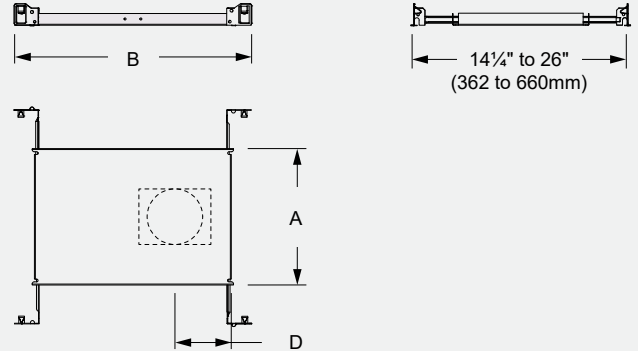
Remodel (RF)

Versatile housing for new or existing ceiling structure. Suitable for non-insulated ceiling assemblies, like sheetrock, or paneling. Fixture is ready for remodeling installation. See page 2 for dimensions.

New construction with plaster frame (NC)

Plaster frame with hanger bars system to be installed during rough-in phase. Suitable for non-insulated new construction ceiling assemblies, like sheetrock, acoustic tiles, or paneling. Housing and trim can be shipped separately.

Ceiling thickness: 1/8" to 1 3/8" (3mm - 35mm)



Model	Plaster frame	Overall dimensions (AxB)	Cut-out position (D)	Cut-out dimensions	Clearance
Single round	BN-8108-NC	15 5/8" x 16"	4" (102mm)	Ø 4 3/4" (Ø 121mm)	10" (254mm)
Single square	BN-8118-NC	8 5/8" x 15 5/8"	3 3/4" (95mm)	4 1/2" X 4 1/2" (114 x 114mm)	
Double	BN-8128-NC	8 5/8" x 15 5/8"	6 3/8" (162mm)	8 1/2" X 4 1/2" (216 x 114mm)	6" (152mm)
Triple	BN-8138-NC	7 7/8" x 20"	9 7/8" (232mm)	12 1/4" X 4 1/2" (311 x 114mm)	
Four square	BN-8148-NC	12" x 16 1/4"	7 3/8" (187mm)	8 1/2" X 8 1/2" (216 x 216mm)	7 1/2" (191mm)
Four long	BN-8148L-NC	7 7/8" x 23 5/8"	11" (279mm)	16" X 4 1/2" (406 x 114mm)	6" (152mm)
Six	BN-8168-NC	7 7/8" x 31 1/8"	14 3/4" (375mm)	23 1/2" X 4 1/2" (570 x 114mm)	

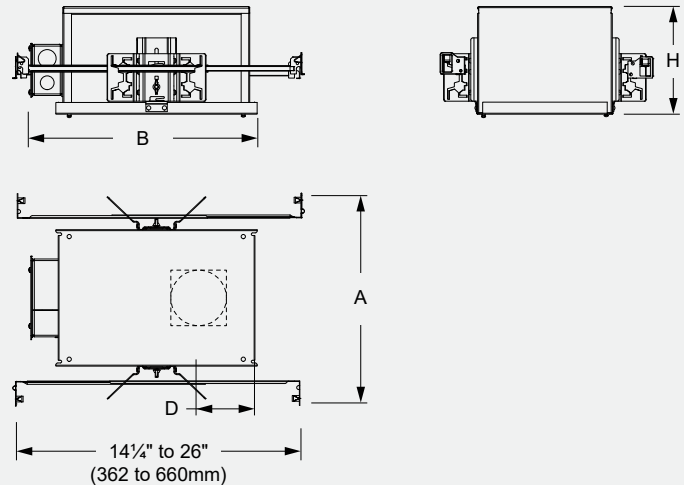
New construction with housing suitable for insulated ceiling (IC)

(For Single and Double models only)

Housing with hanger bars system for new construction installations. Suitable for insulated ceiling or Chicago Plenum applications. Housing and trim can be shipped separately.

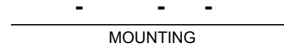
Ceiling thickness: 1/8" to 1 3/8" (3mm - 35mm)

Total weight: TBC



Model	Insulated box	Box overall dimensions (AxB,H)	Cut-out position (D)	Cut-out dimensions	Clearance
Single round insulated	BI-8108-IC	12 1/4" X 14 3/8", 6 5/8" (327 x 365mm, h:175mm)	3 3/4" (95mm)	Ø 4 3/4" (Ø121mm)	6 5/8" (174mm)
Single round insulated w/ 0-10V	BI-8108-IC-D10			4 1/2" X 4 1/2" (114 x 114mm)	
Single square insulated	BI-8118-IC			8 1/2" X 4 1/2" (216 x 114mm)	8 5/8" (219mm)
Single square insulated w/ 0-10V	BI-8118-IC-D10	14 1/2" X 21 7/8", 8 5/8" (368 x 556mm, h:219mm)	6" (152mm)	8 1/2" X 4 1/2" (216 x 114mm)	8 5/8" (219mm)
Double insulated	BI-8128-IC				
Double insulated w/ 0-10V	BI-8128-IC-D10				

ORDERING INFO



MODEL

- 8106** - Single, round
 8118 - Single
 8128 - Double
 8138 - Triple
 8148 - Four, Square
 8148L - Four, long
 8168 - Six

INSTALLATION

- RF** - no plaster frame
 NC - New construction
 IC - Insulated ceiling (for Single and Double models only)

LED

- 927** - 2700K, 90 CRI
 930 - 3000K, 90 CRI
 935 - 3500K, 80 CRI
 935 - 3500K, 90 CRI
 840* - 4000K, 80 CRI
 027* - 2700K, 97 CRI
 030* - 3000K, 97 CRI
 830 - 3000K, 80 CRI

OPTIC

- SP** - Spot
 NF - Narrow Flood
 FL - Flood
 WF - Wide flood

VOLTAGE

- 120** - 120V
 UNV - 120-277V

FINISH

- 01** - White
 02 - Black
 10 - Gray







DIMMING

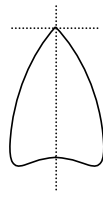
- LTE** - Leading and Trailing edge dimming (120V only)
 D10 - 0-10V dimming

* These LED options may require a longer lead time than standard. Please contact factory for details.

ACCESSORIES (TO BE ORDERED SEPARATELY)

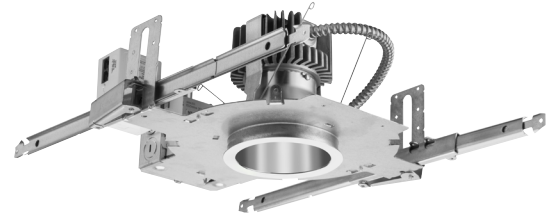
*Maximum of 3 accessories per optical assembly.

- | | | | |
|---|---|---|---|
| <input type="checkbox"/> 8050 - Frosted glass lens |  | <input type="checkbox"/> 8111-02 - Black snoot
Length: 1-3/4" (44mm) |  |
| <input type="checkbox"/> 8675-02 - Black louver |  | <input type="checkbox"/> 1597A-52 - Black snoot
Length: 1-5/8" (40mm) |  |
| | | <input type="checkbox"/> 1594A-52 - Black cross baffle
Length: 7/8" (22.5mm) |  |
| | | <input type="checkbox"/> 1595A-52 - Black visor Wall Washer
Length: 1-3/4" (44mm) |  |



General Illumination Round Downlight

4"



OVERVIEW

Feature Set

- Bounding Ray™ optical design
- Unitized optics mechanically attach the light engine to the lower reflector for complete optical alignment.
- 45° cutoff to source and source image
- Fully serviceable and upgradeable lensed LED light engine
- 70% lumen maintenance at 60,000 hours
- 2.5 SDCM; 85 CRI typical, 90+ CRI optional
- Fixtures are wet location, covered ceiling
- Available with 10% dimming, 1% dimming, or dim to dark
- Batwing distribution with feathered edges provides even illumination on horizontal and vertical surfaces
- ENERGY STAR® certified product

Distribution



Superior Performance

Nominal Lumens	250	500	750	1000	1500	2000	2500	3000	3500
Delivered Lumens	271	573	808	1001	1527	1994	2580	3110	3612
Wattage	3.1	7.2	7.9	8.8	13.7	19.5	25.7	31.2	38.4
Lumens per Watt	87.4	79.6	102.3	113.8	111.5	102.3	100.4	99.7	94.1

COMPLEMENTARY PRODUCTS

Coordinated Apertures | Multiple Layers of Light



General Illumination Layer | EVO



High Center Beam Layer | Incito



EVO + Incito — Multiple Layers of Light

Core



Healthcare



Special Applications



ORDERING INFORMATION

A+ Capable options indicated by this color background.

DS Design2Ship Quick Ship Program: Options in green text qualify for Design2Ship — 5 business days from order entry to ship. Refer to Design2Ship Brochure for complete program details. **Maximum Order Quantity: 100 units; 50 for Chicago Plenum.**

Luminaire Type:

Catalog Number:

EXAMPLE: EV04 35/25 AR MWD LSS 120 EZ1

Series	Color Temperature	Nominal Lumen Values	Reflector & Flange Color	Trim Style	Distribution	Finish	Voltage
EV04	27/ 2700 K	02 250 lumens	AR Clear	(blank) Self-flanged	MD Medium (0.9 s/mh)	LSS Semi-specular	MVOLT
	30/ 3000 K	05 500 lumens	PR Pewter	FL Flangeless	MWD Medium wide (1.0 s/mh)	LD Matte-diffuse	120
	35/ 3500 K	07 750 lumens	WTR Wheat		WD Wide (1.2 s/mh)	LS Specular	277
	40/ 4000 K	10 1000 lumens	GR Gold				347 ^{2,3}
	50/ 5000 K	15 1500 lumens	WR ¹ White				
		20 2000 lumens	BR ¹ Black				
		25 2500 lumens	WRAMF ¹ White Anti-microbial				
		30 3000 lumens					
		35 3500 lumens					

Driver ⁴	Control Interface	Options
GZ10 0-10V driver dims to 10%	NLT ⁵ nLight [®] dimming pack controls	SF Single Fuse. Specify 120V or 277V
GZ1 0-10V driver dims to 1%	NLTER ^{2,6,10} nLight [®] dimming pack controls emergency circuit	TRW ⁷ White painted flange
EZ10 eldoLED 0-10V ECOdrive. Linear dimming to 10% min.	NLTAIR ^{2,13} nLight [®] Air enabled	TRBL ⁸ Black painted flange
EZ1 eldoLED 0-10V ECOdrive. Linear dimming to 1% min.	NLTAIRER2 ^{2,10,13} nLight [®] AIR Dimming Pack Wireless Controls. Controls fixtures on emergency circuit	EL ⁹ Emergency battery pack, 10W, with integral test switch
EZB eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%.	NLTAIREM2 ^{2,13} nLight [®] AIR Dimming Pack Wireless Controls. Controls fixtures on emergency circuit with battery pack options.	ELR ⁹ Emergency battery pack, 10W, with remote test switch
EDAB ⁴ eldoLED SOLOdrive DALI. Logarithmic dimming to <1%.		ELSD ⁹ Emergency battery pack, 10W, with self-diagnostics, integral test switch
EDXB ⁴ eldoLED POWERdrive DMX with RDM (remote device management). Square Law dimming to <1%. Minimum 1000 lumens. Includes termination resistor. Refer to DMXR Manual .	EXA1 XPoint Wireless, eldoLED 0-10V ECOdrive. Linear dimming to 1%. Refer to XPoint tech sheet.	ELRSD ⁹ Emergency battery pack, 10W, with self-diagnostics, remote test switch
ECOS2 ⁵ Lutron [®] Hi-Lume [®] 2-wire forward-phase driver. 120V only. Minimum dimming level 1%. Min: 1000LM; Max: 2500LM	EXAB XPoint Wireless, eldoLED 0-10V SOLOdrive. Logarithmic dimming to <1%. Refer to XPoint tech sheet.	E10WCPR ⁹ Emergency battery pack, 10W Constant Power, CA Title 20 compliant with integral test switch
ECOD ⁵ Lutron Ecosystem digital Hi-Lume 1% soft-on, fade to black. Min: 2500LM; Max: 4000LM.		E10WCPR ⁹ Emergency battery pack, 10W Constant Power, CA Title 20 compliant with remote test switch
		N80 ¹¹ nLight [®] Lumen Compensation
		BGTD Bodine generator transfer device. Specify 120V or 277V.
		90CRI High CRI (90+)
		CP ¹² Chicago Plenum. Specify 120V or 277V for 5000lm and above.
		RRL RELOC [®] -ready luminaire connectors enable a simple and consistent factory installed option across all ABL luminaire brands. Refer to RRL for complete nomenclature.

ACCESSORIES — order as separate catalog numbers (shipped separately)	
SCA4	Sloped ceiling adapter. Degree of slope must be specified (5D, 10D, 15D, 20D, 25D, 30D). Ex: SCA4 10D. Refer to TECH-190 .
CTA4-8 YK	Ceiling thickness adapter (extends mounting frame to accommodate ceiling thickness up to 5"). Adds ~4" to fixture height.
ISD BC	0-10V wallbox dimmer. Refer to ISD-BC .

ORDERING NOTES	
1. Not available with finishes.	9. 11" of plenum depth or top access required for battery pack maintenance.
2. Not available with emergency battery pack options.	10. ER for use as UL924 Emergency Operation via power sense lead. Will require an emergency hot feed and normal hot feed. EM for use as UL924 Emergency Operation via power interrupt detection.
3. Supplied with factory installed step down transformer.	11. Fixture begins at 80% light level. Must be specified with NLT or NLTER. Only available with EZ10 and EZ1 drivers.
4. Refer to TECH-240 for compatible dimmers.	12. Not available with ELR, HAO, EXA1, or EXAB options.
5. Not available with nLight [®] and XPoint options.	13. Not available DALI or DMX drivers. Not available with CP or N80 options. Not recommended for metal ceiling installations.
6. Must specify voltage.	
7. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with WR (white reflector) or FL (flangeless) option.	
8. For use with different reflector finish only (i.e. AR, PR, WTR, GR options). Not applicable with BR (black reflector) or FL (flangeless) option.	

Optical Assembly

Fully serviceable and upgradeable lensed LED light engine suitable for field maintenance or service from below the ceiling. Optical design is a Bounding Ray™ design with 45° cutoff to source and source image. Top-down flash characteristic for superior glare control. Unitized optics shall have mechanical attachment of the light engine to the lower reflector for complete optical alignment.

Electrical

The luminaire shall operate from a 50 or 60 Hz ±3 Hz AC line over a voltage ranging from 120 VAC to 277 VAC. The fluctuations of line voltage shall have no visible effect on the luminous output. The luminaire shall have a power factor of 90% or greater at all standard operating voltages and full luminaire output. Sound Rated A+. Driver shall be >80% efficient at full load across all input voltages. Input wires shall be 18AWG, 300V minimum, solid copper.

Controls

Luminaire shall be equipped with interface for nLight wired or wireless network with integral power supply as per specification.

Dimming

The luminaire shall be capable of continuous dimming without perceivable stroboscopic flicker as measured by flicker index (ANSI/IES RP-16-10) over a range of 100 – 10%, 100 – 1.0% or 100 – 0.1% of rated lumen output with a smooth shut off function to step to 0%. eldoLED LED drivers shall conform to IEEE P1789 standards. Alternatively, manufacturers must demonstrate conformance with product literature and testing which demonstrates this performance. Systems that do not meet IEEE P1789 will not be considered. Driver is inaudible in 24dB environment, and stable when input voltage conditions fluctuate over what is typically experienced in a commercial environment.

Construction

Luminaire housing shall be constructed of 16-gauge galvanized steel and have preinstalled telescopic mounting bars with maximum 32" and minimum 15" extension and 4" vertical adjustment. Luminaires shall be suitable for installation in ceilings up to 1½" thick. (specify ceiling thickness adapter to extend frame to accommodate ceiling thickness up to 2"). Tool-less adjustments shall be possible after installation. The assembly and manufacturing process for the luminaire shall be designed to assure all internal components are adequately supported to withstand mechanical shock and vibration. 25°C ambient temperature standard (1/2" clearance on all sides from non-combustible materials in non-IC applications, unless marked spacing noted otherwise). For use in insulated ceilings, a 3" clearance on all sides from insulation is required (unless marked spacing noted otherwise).

Listings

Fixtures are CSA certified to meet US and Canadian Standards: All fixtures manufactured in strict accordance with the appropriate and current requirements of the "Standards for Safety" to UL, wet location covered ceiling. Luminaire configurations are Energy Star certified through testing in EPA-recognized laboratories, with the results reviewed by an independent, accredited certification organization. Visit www.energystar.gov for specific configurations listed.

Photometrics

LEDs tested to LM-80 standards. Measured by IESNA Standard LM-79-08 in an accredited lab. Lumen output shall not decrease by more than 30% over the minimum operational life of 60,000 hours. Color appearance from luminaire to luminaire of the same type and in all configurations, shall be consistent both initially and at 6,000 hours and operate within a tolerance of <2.5 MacAdam ellipse as defined by a point at the intersection of the CCT line and the black body locus line in CIE chromaticity space.

Warranty

5-year limited warranty. Complete warranty terms located at: www.acuitybrands.com/support/warranty/terms-and-conditions

Note:

Actual performance may differ as a result of end user environment and application. All values are design or typical values, measured under laboratory conditions at 25 °C.

A+ Capable Luminaire

This item is an A+ capable luminaire, which has been designed and tested to provide consistent color appearance and out-of-the-box control compatibility with simple commissioning.

- All configurations of this luminaire meet the Acuity Brands' specification for chromatic consistency
- This luminaire is part of an A+ Certified solution for nLight® control networks when ordered with drivers marked by a shaded background*
- This luminaire is part of an A+ Certified solution for nLight® control networks, providing advanced control functionality at the luminaire level, when selection includes driver and control options marked by a shaded background*

To learn more about A+, visit www.acuitybrands.com/aplus.

*See ordering tree for details

EVO - eldoLED Driver Default Dimming Curve			
Nomenclature	Min Dimming	Driver Dim Curve	Control Dim Curve
EZ10	10%	Linear	Linear/Logarithmic
EZ1	1%	Linear	Linear/Logarithmic
EXA1	1%	Linear	Linear/Logarithmic
EZB	<1%	Logarithmic	Linear
EDAB	<1%	Logarithmic	Linear
EXAB	<1%	Logarithmic	Linear
EDXB	<1%	Logarithmic	Linear

Distributions	
Distribution	Beam
MD	51
MWD	57
WD	73

CCT/CRI Multiplier Table		
CRI	CCT	Multiplier
80	2700K	0.96
	3000K	1.00
	3500K	1.00
	4000K	1.01
	5000K	1.07
90	2700K	0.80
	3000K	0.83
	3500K	0.85
	4000K	0.87
	5000K	0.91

Reflector Finish Multiplier	
Reflector Finish	Multiplier
LS - Specular	1
LSS - Semi Specular	0.956
WR - White	0.87
LD - Matte Diffuse	0.85
BR - Black	0.73

Driver		Control Provided (note: 347V/UVOLT versions provided with 347 option selected)				
Nomenclature	Description	NLT	NLTER	NLTAIR2	NLTAIR2ER	NLTAIREM2
GZ10	0-10V driver dims to 10%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2	RPP20 D 24V ER G2
GZ1	0-10V driver dims to 1%	nPP16 D EFP	nPP16 D ER EFP	RPP20 D 24V G2	RPP20 D 24V ER G2	RPP20 D 24V ER G2
EZ10	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2	RPP20 D 24V ER G2
EZ1	eldoLED 0-10V ECOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2	RPP20 D 24V ER G2
EZB	eldoLED 0-10V SOLOdrive	nPS 80 EZ	nPS 80 EZ ER	RPP20 D 24V G2	RPP20 D 24V ER G2	RPP20 D 24V ER G2

How to Estimate Delivered Lumens in Emergency Mode

Delivered Lumens = 1.25 x P x LPW

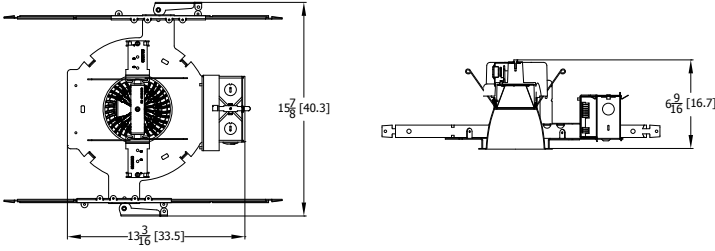
P = Output power of emergency driver. P = 10W for PS1055CP

LPW = Lumen per watt rating of the luminaire. This information is available on the ABL luminaire spec sheet.

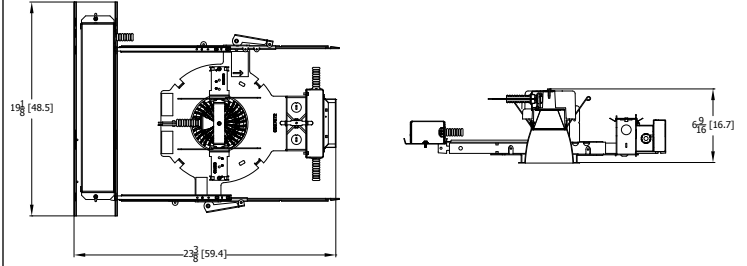
DIMENSIONAL DATA

Aperture: 4-5/16" (11) Ceiling Opening: 5-1/8" (13) self-flanged
 Overlap trim: 5-7/16" (13.8) 5-1/4" (13.3) flangeless

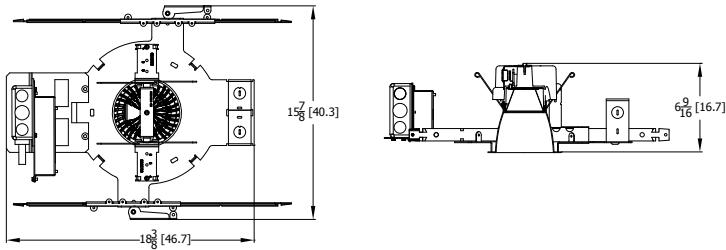
Standard



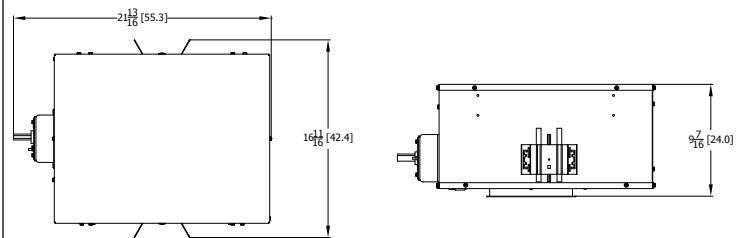
Battery Pack



CP Standard

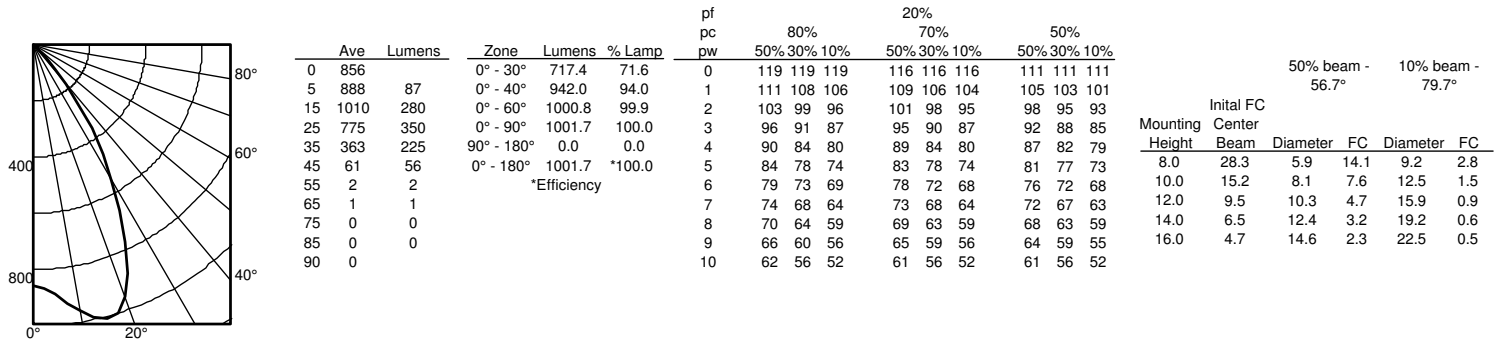


CP Enclosed For Use With Battery Pack & nLight

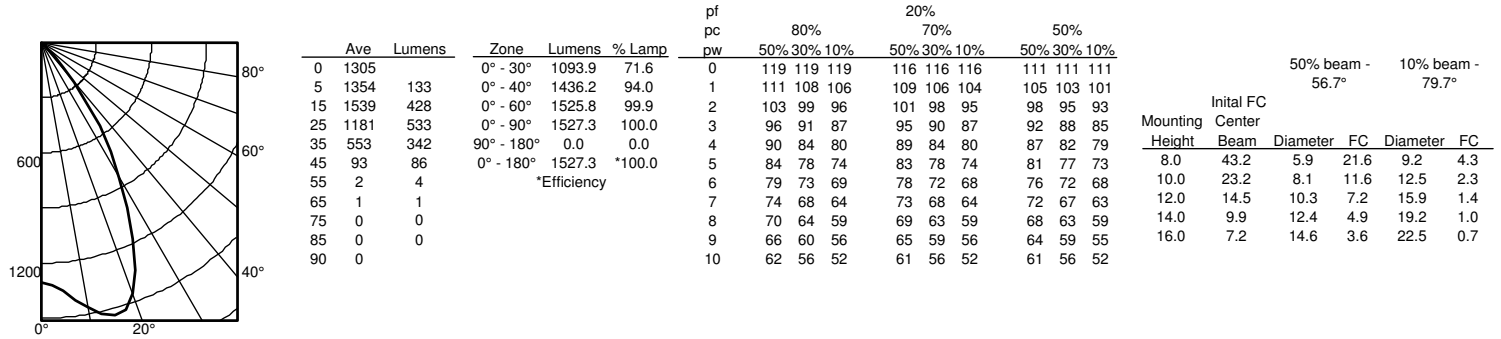


Photometry

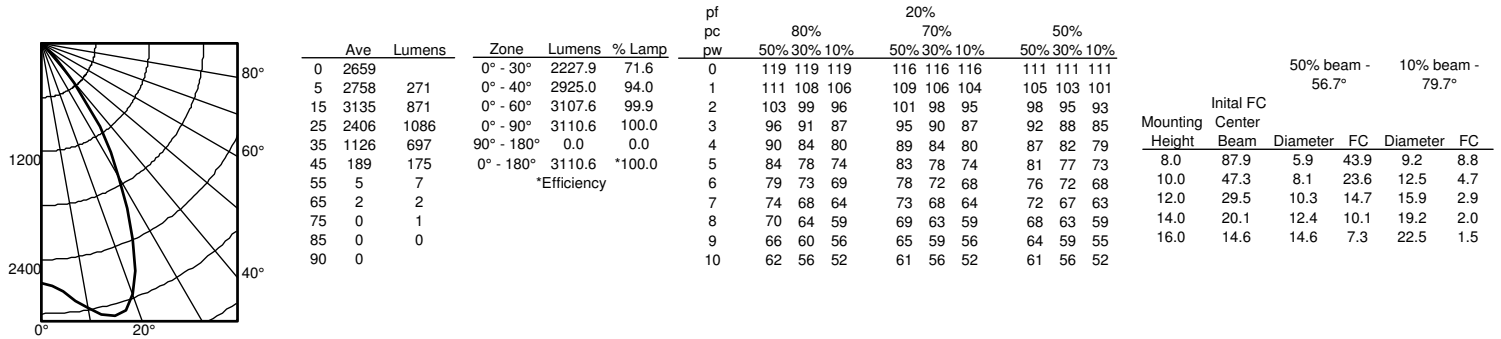
EVO4 35/10 MWD LS INPUT WATTS: 8.8W, DELIVERED LUMENS: 1001.7LM, LPW = 113.8, 1.08 S/MH, TEST NO. LTL27786P131



EVO4 35/15 MWD LSS INPUT WATTS: 13.7W, DELIVERED LUMENS: 1527.3LM, LPW = 111.4, 1.08 S/MH, TEST NO. LTL27786P137



EVO4 35/30 MWD LSS INPUT WATTS: 31.2W, DELIVERED LUMENS: 3110.6LM, LPW = 99.6, 1.08 S/MH, TEST NO. LTL27786P155





Collection of multi-lamps directional LED downlights. Multiple Large is most suitable for large scale retail and architectural lighting applications where scalable lighting solutions are required. Highly reliable thermal design ensures long lasting performance and color consistency.

Luminaire characteristic:

Power input: 22 or 28.5W (per lamp)
Lumens: 2400 or 3100lm per lamp (for 3000K, 80CRI)
Luminaire efficacy: Up to 112lm/W

Source: BRIDGELUX VERO18 LED module, (LM-80 tested).
2700K: 90CRI or 97CRI
3000K: 80CRI, 90CRI or 97CRI
3500K: 80CRI or 90CRI
4000K: 80CRI
Lumen maintenance: 90% of initial lumens at 132 000 hours (L90), (LM-79 tested).

Optic: Spot, Narrow Flood or Flood. Each optical assembly is adjustable 45° on all axes.

Material: Optical assembly: Die-cast aluminum
Heatsink: Extruded aluminum
Reflector: High bright anodized aluminum
Housing: Black oxide steel
Connection box and hardware: Galvanized steel

Mounting: New construction plaster frame or remodeling.
No plaster frame needed for remodeling option.
See page 4 for details.

Electrical: Integral high efficiency ~~electronic power supply~~, rated 50 000 hours, 120V, 277V or 120-277V.

Dimming: Standard power supply compatible with 0-10V dimming. Optional power supply available for Lutron Hi Lume® 1% EcoSystem™ (Soft-on, Fade to Black) or Lutron Hi Lume® 1% 2-wire (120V forward phase only).

Finish: White RAL9003, Black RAL9004, or Gray RAL9006 painted finish.

Weight: TBC.

Warranty: 5 year limited warranty.

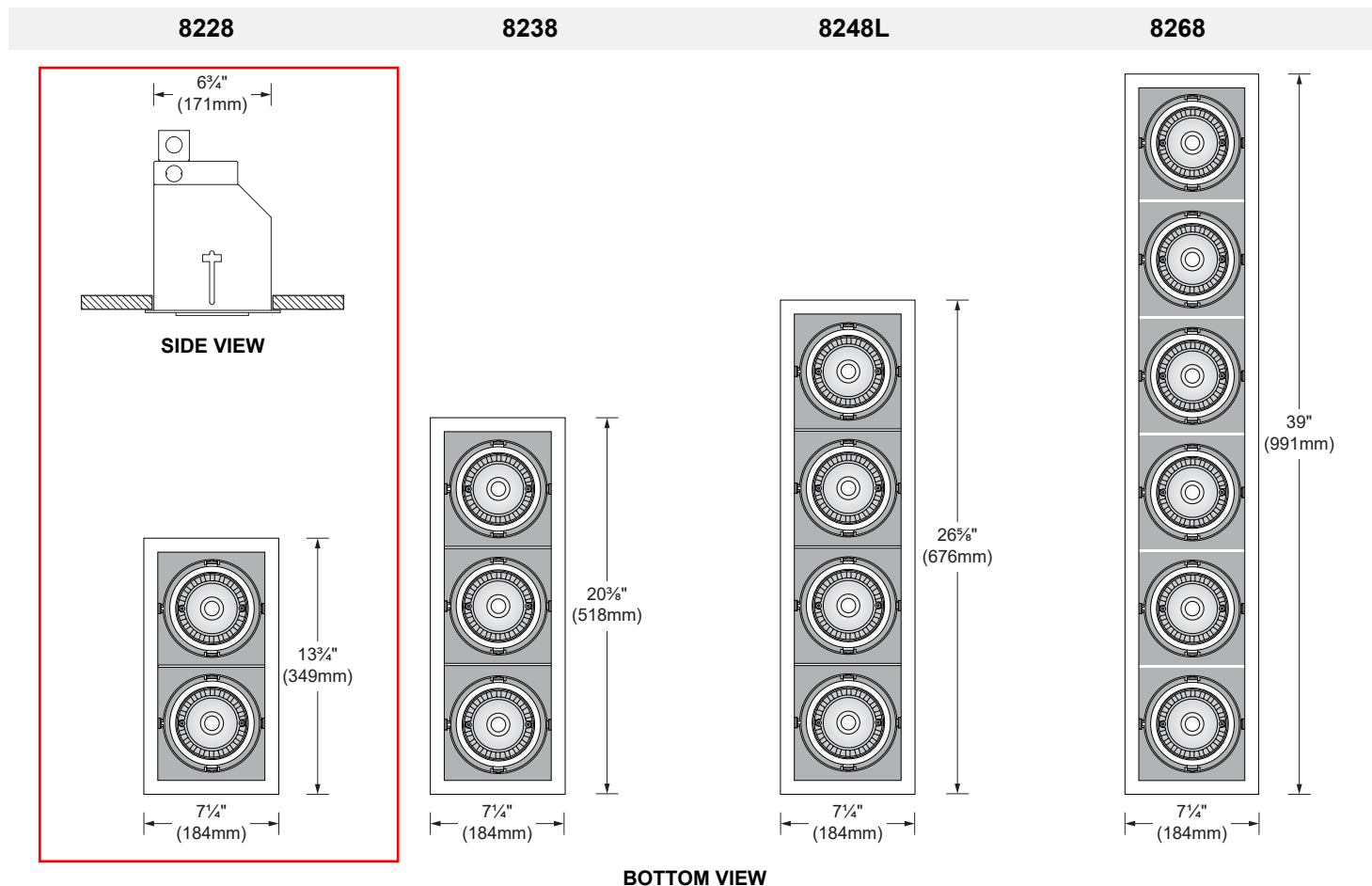
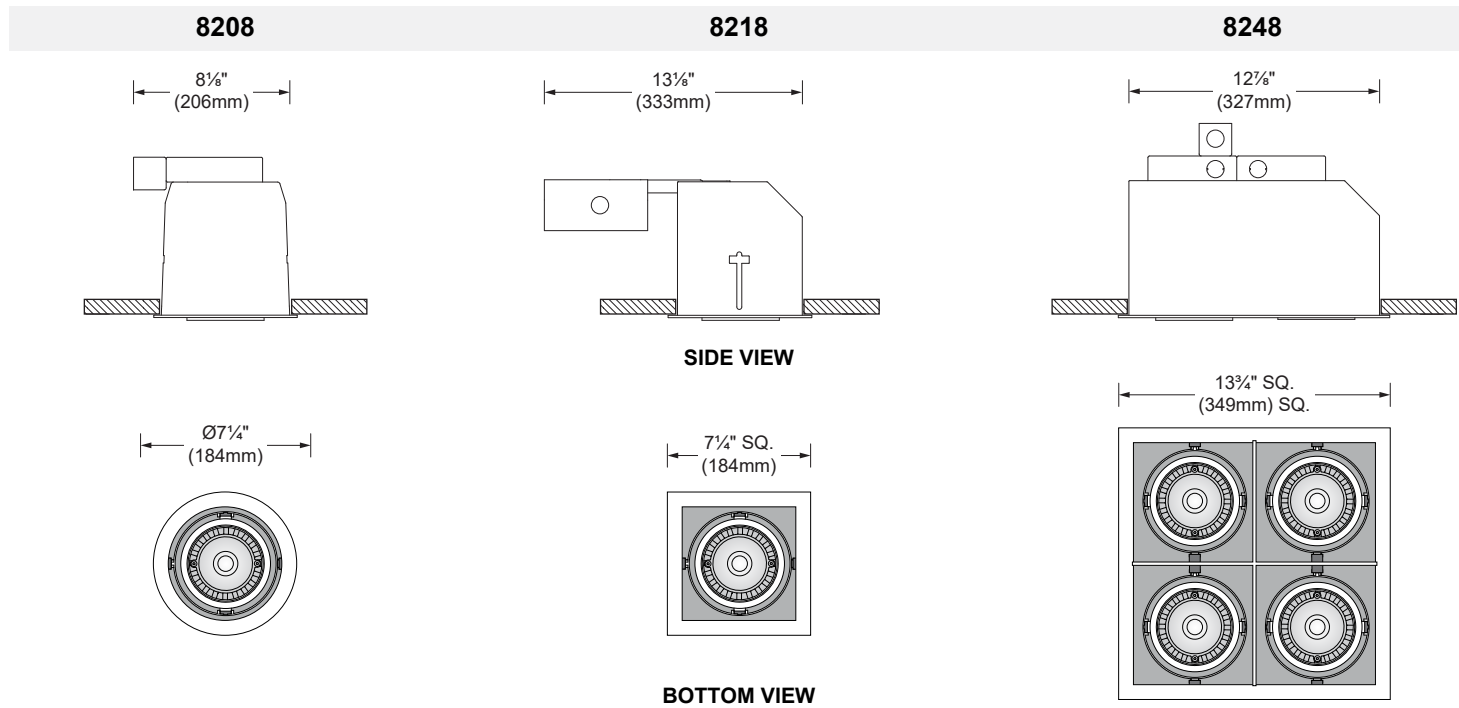
Rating: IP20.

Certification: cULus listed for Damp location.



Energy star certified product. To confirm which versions are certified, please consult the product list: www.energystar.gov/productfinder

MODEL



LED COLOR FIDELITY DATA

CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
80	3000K	82	92	97	83	83	90	84	61	12	81	82	75	85	99	75	86	96	0.52
	3500K	81	89	95	80	80	84	85	63	9	73	78	61	82	97	75	83	97	0.58
	4000K	80	88	93	81	80	83	87	66	10	71	79	56	82	96	74	83	95	0.67
90	2700K	91	94	93	90	89	91	93	82	60	83	89	74	91	95	88	89	101	0.44
	3000K	94	96	96	91	92	94	93	85	66	89	90	77	94	97	92	90	100	0.51
97	3500K	95	98	96	92	93	94	94	88	74	91	91	74	96	97	94	90	99	0.65
	2700K	99	99	98	98	99	97	95	92	84	98	97	89	99	98	98	94	102	0.50
	3000K	99	99	97	99	99	97	98	98	95	98	97	85	99	97	99	95	101	0.58

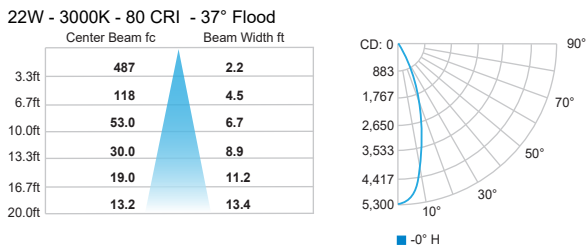
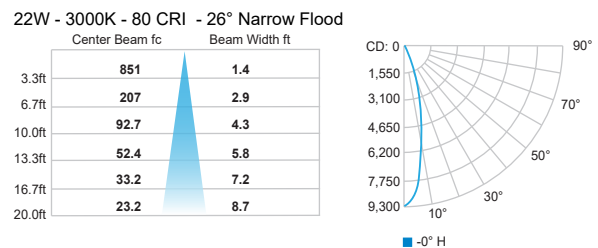
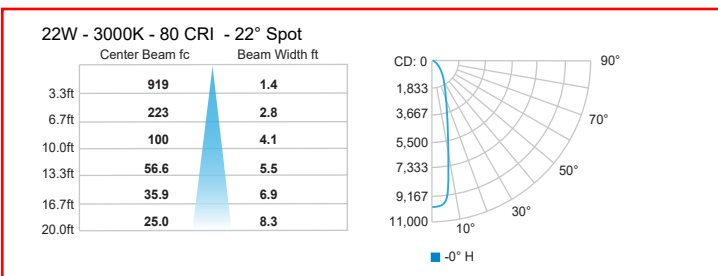
PHOTOMETRIC DATA

Photometric performance is measured at an accredited independent laboratory in accordance with IESNA LM-79. Visit sistemalux.com for complete photometric data.

REFER TO ONE LAMP

CCT (K)	CRI	OUTPUT (W)	LOAD (W)	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODEL
3000K	80	BO	22W	Spot	2465	112	10 000	8218-830-20
				Narrow Flood	2455	111	9270	8218-830-30
				Flood	2430	110	5295	8218-830-40
		HO	28.5W	Spot	3155	110	12 800	8218-HO-830-20
				Narrow Flood	3140	110	11 865	8218-HO-830-30
				Flood	3110	109	6775	8218-HO-830-40

*USE MULTIPLIER TABLE BELOW FOR OTHER CCT AND CRI OUTPUT DATA



MULTIPLIER TABLE

CCT options	2700K	2700K	3000K	3000K	3000K	3500K	3500K	4000K
CRI options	90CRI	97CRI	80CRI	90CRI	97CRI	80CRI	90CRI	80CRI
Multiplier	0.80	0.69	1	0.83	0.74	1.03	0.86	1.04

INSTALLATION

Remodel

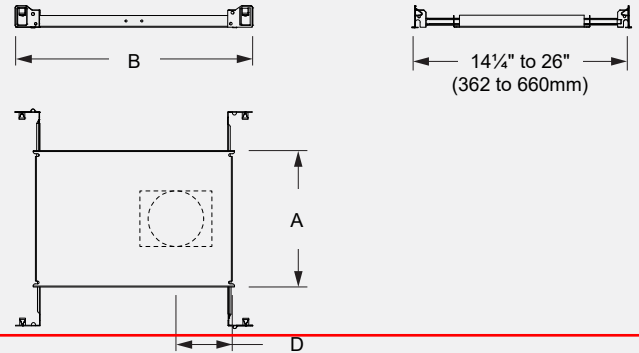
Versatile housing for new or existing ceiling structure. Suitable for non-insulated ceiling assemblies, like sheetrock, or paneling. Fixture is ready for remodeling installation. See page 2 for dimensions.

New construction with plaster frame

Plaster frame with hanger bars system to be installed during rough-in phase. Suitable for non-insulated new construction ceiling assemblies, like sheetrock, acoustic tiles, or paneling. Housing and trim can be shipped separately.

Ceiling thickness: 1/8" to 1 3/8" (3mm - 35mm)

push rigid insulation away from fixture



Model	Plaster frame	Overall dimensions (AxB)	Cut-out position (D)	Cut-out dimensions	Clearance
Single round	MUL-210R-KIT	9 1/2" x 14 1/8" (241mm x 359mm)	4 3/4" (121mm)	Ø 6 3/4" (171mm)	8 3/4" (222mm)
Single square	MUL-210C-KIT	9 1/2" x 14 1/8" (241mm x 359mm)	4 3/4" (121mm)	6 1/2" x 6 1/2" (165mm x 165mm)	6 7/8" (175mm)
Double	MUL-220C-KIT	9 1/2" x 20 5/8" (241mm x 524mm)	8" (203mm)	13" x 6 1/2" (330mm x 165mm)	9 5/8" (251mm)
Triple	MUL-230C-KIT	9 1/2" x 27 1/8" (241mm x 689mm)	11 1/4" (286mm)	19 1/2" x 6 1/2" (495mm x 165mm)	9 5/8" (251mm)
Four square	MUL-240C-KIT	15 5/8" x 20 1/4" (391mm x 514mm)	8 5/8" (219mm)	13 1/8" x 13 1/8" (333mm x 333mm)	10" (254mm)
Four long	MUL-240-L-C-KIT	9 1/2" x 33 3/8" (241mm x 848mm)	14 3/8" (365mm)	25 3/4" x 6 1/2" (654mm x 165mm)	9 5/8" (251mm)
Six	MUL-260C-KIT	9 1/2" x 45 1/8" (241mm x 1165mm)	20 5/8" (524mm)	38 1/4" x 6 1/2" (971mm x 165mm)	9 5/8" (251mm)

MULTIPLE LARGE

RECESSED

Type:
Project :

SPECIFICATION SHEET

Page: 5 of 5

ORDERING INFO

- HO - - - -

FIXTURE

RESET

MODEL

- 8208 - Single, round
 8218 - Single
 8228 - Double
 8238 - Triple
 8248 - Four, Square
 8248L - Four, long
 8268 - Six

INSTALLATION

- Remodel
 New construction

OUTPUT

- Base output, 22W
 HO - High output, 28.5W

LED

- 927 - 2700K, 90 CRI
 830 - 3000K, 80 CRI
 835 - 3500K, 80 CRI
 840 - 4000K, 80 CRI⁽¹⁾
 027 - 2700K, 97 CRI⁽¹⁾
 930 - 3000K, 90 CRI
 935 - 3500K, 90 CRI
 030 - 3000K, 97 CRI⁽¹⁾

OPTIC

- 20 - Spot 22°
 30 - Narrow Flood 26°
 40 - Flood 37°

VOLTAGE

- 120 - 120V⁽²⁾
 277 - 277V⁽²⁾
 UNV - 120-277V

FINISH

- 01 - White
 02 - Black
 10 - Gray

OPTIONAL DIMMING


- D3 - Lutron Hi Lume® 1% 2-wire (120V forward phase only)
 D2B - Lutron Hi Lume® 1% EcoSystem™ (Soft-on, Fade to Black)

⁽¹⁾LED options may require a longer lead time than standard. Please contact factory for details.

⁽²⁾120V or 277V is only available for model 8218 (single).

ACCESSORIES (TO BE ORDERED SEPARATELY)

*Maximum of 3 accessories per optical assembly.

- | | | |
|---|--|---|
| <input type="checkbox"/> 1701A - Frosted lens | <input type="checkbox"/> 1695A-52 - Black cross baffle
Length: 7/8" (22.5mm) |  |
| <input type="checkbox"/> 1702A - Elliptic lens  | <input type="checkbox"/> 1705A-52 - Black snoot
Length: 1 1/4" (44mm) |  |
| <input type="checkbox"/> 1703A - Soft focus lens | <input type="checkbox"/> 1706A-52 - Black visor wall washer
Length: 1 1/4" (44mm) |  |
| <input type="checkbox"/> 1704A-52 - Black hex cell louver  | | |
| <input type="checkbox"/> 8212-24 - Clear glass lens  | | |

Date _____ Project _____

Notes _____

AT11 CHANNEL FIXTURE

Our AT11 Channel Fixture is a surface-mounted channel with a 120-degree beam angle. We offer a variety of mounting options as well as a choice of clear, frosted and milky lenses to create a full range of light output and design. Custom design a fixture for nearly any application with our AT11 Channel and RibbonLyte products.



- Beam Angle 120°
- Wattage Range from 0.75 W/ft (2.46 W/m) to 8.8 W/ft (28.9 W/m)
- Static White delivered lumen range from 85 lm/ft (279 lm/m) up to 729 lm/ft (2391 lm/m)
- Assembled in USA

Applications:

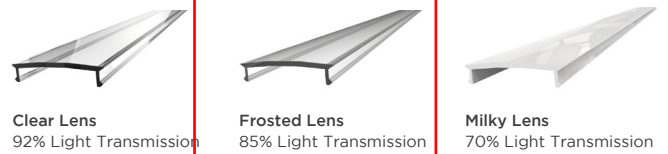
Commercial Entertainment Healthcare
Hospitality Museums Public Spaces
Residential Retail



AVAILABLE HOUSING FINISHES



AVAILABLE LENS FINISHES



ORDERING GUIDE

CATEGORY	LENS	CRI	RIBBON TYPE & IP RATING		
CHAT11					
CHAT11 - AT11 Channel	C - Clear* F - Frosted M - Milky	0 - Static Color, Color Changing 90 - 90+ CRI Static White	SWS220 - Static White Series 2 IP20 SWS265 - Static White Series 2 IP65 SWS268 - Static White Series 2 IP68 SCS220 - Static Color Series 2 IP20 SCS265 - Static Color Series 2 IP65 SCS268 - Static Color Series 2 IP68	VWS220 - VW Series 2 IP20 VWS265 - VW Series 2 IP65 VWS268 - VW Series 2 IP68 RGB20 - RGB IP20 RGB65 - RGB IP65 RGBWA20 - RGBW/A IP20	RGBWA65 - RGBW/A IP65 WD20 - Warm Dim IP20 WD65 - Warm Dim IP65

WATTAGE	COLOR	CONNECTION OPTIONS
0.75 - 0.75 W/ft (2.46 W/m - Static White, Static Color)	18 - 1800K	1 - End Feed Hard Wire Connection
1.0 - 1.0 W/ft (3.3 W/m - Variable White)	20 - 2000K	2 - Back Feed Hard Wire Connection
1.5 - 1.5 W/ft (4.9 W/m - Static White, Static Color)	22 - 2200K	3 - Side Feed Hard Wire Connection
2.2 - 2.2 W/ft (7.2 W/m - Static White, Static Color, RGB)	24 - 2400K	4 - IP67 Connector Input
3.0 - 3.0 W/ft (9.8 W/m - Static White, Static Color, Variable White)	27 - 2700K	5 - Soldered Daisy Chain
4.4 - 4.4 W/ft (14.4 W/m - Static White, Static Color, RGB, RGBW/RGBA)	30 - 3000K	6 - Daisy Chain With IP67 Connectors
5.0 - 5.0 W/ft (16.4 W/m - Static White, Static Color)	35 - 3500K	(See last page for connection diagram)
5.2 - 5.2 W/ft (17.1 W/m - Warm Dim)	40 - 4000K	
5.5 - 5.5 W/ft (18.0 W/m - RGBW/RGBA)	2920 - Warm Dim 2900K - 2000K (IP20)	
6.0 - 6.0 W/ft (19.7 W/m - Static White, Static Color, Variable White)	40 - 4000K	
8.8 - 8.8 W/ft (28.9 W/m - RGB)	2721 - Warm Dim 2700K - 2100K (IP65+IP68)	
	60 - 6000K	
	Z - Undecided**	
	R - Red	
	A - Amber	
	G - Green	
	B - Blue	

** For quotes only. Must be chosen before final order.

Included Accessories:
1. Mounting Clip

Optional Accessories:
1. Tilttable Stand (Part No.: TILTSTANDST)
2. Magnetic Mount (Part No.: CHMAG0.5)

AVAILABLE COLORS AND COLOR TEMPERATURES

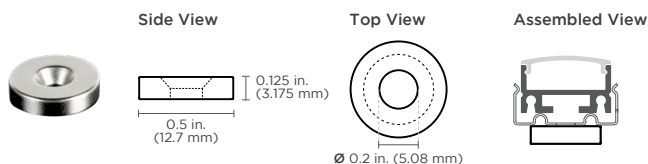


SPECIFICATIONS

AT11 CHANNEL	Mounting Clip (Included Accessory)		Tiltable Stand (Optional Accessory)	
	<p>Side View</p>	<p>Assembled View</p>	<p>Side Views</p>	<p>Assembled View</p>
	<p>Top View</p>			
	<p>* Each section of channel includes 3 mounting clips. * Magnetic mounting option available (see below)</p>		<p>* Height does not include height of mounting clip, channel and lens. Part Number: TILTSTAND</p>	

Beam Angle	120°		
Lens Type	Clear, Frosted, Milky		
Width	0.77 in. (19.6 mm)	0.8 in. (20.3 mm)	Base: 1.02 in. (26 mm) / Tabletop: 0.75 in. (19 mm)
Height	0.59 in. (15 mm)	0.34 in. (8.6 mm)	0.86 in. (21.8 mm)
Internal	0.67 in. (17 mm)	--	Screw hole: Size #4-40
Length	Channel is sold by the foot and cut to your exact desired length. Required amount of mounting clips included. Tiltable stands are sold separately.		
Operating Voltage	24V		
Dimming	MLV / 0-10 Volt / Lutron Hi-Lume 1% dimming LED drivers / Lutron VIVE code compliance available / ELV / DALI / DMX		
Operating Temperature	-40° F to 158° F (-40° C to 70° C)		
Colors	1800K, 2000K, 2200K, 2400K, 2700K, 3000K, 3500K, 4000K, 6000K, Red, Amber, Green, Blue, RGB, RGBW, RGBA, VW, Warm Dim (1800K, 2000K, 2200K only available in IP20)		
CRI	90+ CRI (Static White only)		
Lamp Life	L70 at 50,000 Hours		
MacAdam Ellipses (SDCM)	2-Step Binning (For Static White LEDs only)		
Certifications	ETL Listed: UL 2108 Issued: 2004/02/27 Ed: 1 Rev: 2014/02/24 Low Voltage Lighting Systems CSA C22.2#9.0 Issued: 1996/06/01 Ed: 1 (R2011) General Requirements for Luminaires; with Gen. Inst. 1: 1997, Gen Inst. 2: 1998. ROHS compliant UL 2108 - Low Voltage Lighting Systems UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products UL 1598 / CSA 250.0-08 - Luminaires		

Magnetic Mount (Part #: CHMAG0.5)



Features:

- High-energy neodymium magnets come attached to mounting clips with countersink hex nuts
- Create easy-mount magnetic channels with minimal surface gaps; no tools or drilling necessary
- Magnets rated for 8 lbs. of pull force with static load

Applications:

- Industrial lighting retrofits for troffers and other metal fixtures
- Metal retail shelf lighting
- Temporary light fixture installations

ASSEMBLY OPTIONS

ON-SITE ASSEMBLY
Cut to length with soldered leads, assembled on-site

BENEFITS:

- Run Lengths can be trimmed in the field
- Last-minute adjustments
- Shorter lead time

FACTORY ASSEMBLY
Pre-assembled factory-finished fixtures (Max assembled length is 78 in.)

BENEFITS:

- Easy and quick installation
- Shipped as a complete unit
- Plug-and-play installation

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SPECIFICATIONS

Available Wattages	Cuttable Length	LED Pitch	Color Temp.	lm/W without Lens	Delivered Lumens with Clear Lens	Delivered Lumens with Frosted Lens	Delivered Lumens with Milky Lens	Standard Cable Length	Compatible with Channel		
									IP20	IP65	IP68
6.0 Static White Series 2	1.4 in. (35.7 mm)	68 LEDs/ft (224 LEDs/m)	2400K	109	601.6 lm/ft (1973.2 lm/m)	555.9 lm/ft (1823.4 lm/m)	457.8 lm/ft (1501.6 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			2700K	122	674.2 lm/ft (2211.3 lm/m)	622.2 lm/ft (2040.8 lm/m)	512.4 lm/ft (1680.7 lm/m)				
			3000K	129	712.9 lm/ft (2338.2 lm/m)	657.9 lm/ft (2157.9 lm/m)	541.8 lm/ft (1777.1 lm/m)				
			3500K	132	729.4 lm/ft (2392.5 lm/m)	673.2 lm/ft (2208.1 lm/m)	554.4 lm/ft (1818.4 lm/m)				
			4000K	132	612.5 lm/ft (2008.9 lm/m)	673.2 lm/ft (2208.1 lm/m)	554.4 lm/ft (1818.4 lm/m)				
			6000K	126	696.3 lm/ft (2283.8 lm/m)	642.6 lm/ft (2107.7 lm/m)	529.2 lm/ft (1735.8 lm/m)				
0.75 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	41	28 lm/ft (93 lm/m)	26 lm/ft (86 lm/m)	22 lm/ft (70.6 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	175	121 lm/ft (396 lm/m)	112 lm/ft (366 lm/m)	92 lm/ft (301.4 lm/m)				
			Blue	19	13 lm/ft (43 lm/m)	12 lm/ft (40 lm/m)	10 lm/ft (32.7 lm/m)				
			Amber	34	23 lm/ft (77 lm/m)	22 lm/ft (71 lm/m)	18 lm/ft (58.6 lm/m)				
1.5 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	42	58 lm/ft (190 lm/m)	54 lm/ft (176 lm/m)	44 lm/ft (144.7 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	160	221 lm/ft (724 lm/m)	204 lm/ft (669 lm/m)	168 lm/ft (551.1 lm/m)				
			Blue	18	25 lm/ft (81 lm/m)	23 lm/ft (75 lm/m)	19 lm/ft (62 lm/m)				
			Amber	34	47 lm/ft (154 lm/m)	43 lm/ft (142 lm/m)	36 lm/ft (117.1 lm/m)				
2.2 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	42	85 lm/ft (279 lm/m)	79 lm/ft (258 lm/m)	65 lm/ft (212.2 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	145	293 lm/ft (963 lm/m)	271 lm/ft (889 lm/m)	223 lm/ft (732.4 lm/m)				
			Blue	18	36 lm/ft (119 lm/m)	34 lm/ft (110 lm/m)	28 lm/ft (90.9 lm/m)				
			Amber	33	67 lm/ft (219 lm/m)	62 lm/ft (202 lm/m)	51 lm/ft (166.7 lm/m)				
3.0 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	40.0	110.4 lm/ft (362.1 lm/m)	102.0 lm/ft (334.6 lm/m)	84.0 lm/ft (275.52 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	127.0	350.9 lm/ft (1151.0 lm/m)	323.9 lm/ft (1062.2 lm/m)	266.7 lm/ft (874.776 lm/m)				
			Blue	25.0	69.1 lm/ft (226.6 lm/m)	63.8 lm/ft (209.1 lm/m)	52.5 lm/ft (172.2 lm/m)				
			Amber	29.0	80.1 lm/ft (262.8 lm/m)	74.0 lm/ft (242.6 lm/m)	60.9 lm/ft (199.752 lm/m)				
4.4 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	38.0	153.8 lm/ft (504.5 lm/m)	142.1 lm/ft (466.2 lm/m)	117.0 lm/ft (383.8912 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	117.0	474.1 lm/ft (1555.1 lm/m)	437.6 lm/ft (1435.3 lm/m)	360.4 lm/ft (1181.981 lm/m)				
			Blue	24.0	97.3 lm/ft (319.0 lm/m)	89.8 lm/ft (294.4 lm/m)	73.9 lm/ft (242.4576 lm/m)				
			Amber	25.0	101.3 lm/ft (332.2 lm/m)	93.5 lm/ft (306.7 lm/m)	77.0 lm/ft (252.56 lm/m)				
5.0 Static Color Series 2	1.4 in. (35.7 mm)	68 LEDs/ft (224 LEDs/m)	Red	37.0	170.2 lm/ft (558.2 lm/m)	157.3 lm/ft (515.8 lm/m)	129.5 lm/ft (424.76 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	116.0	534.2 lm/ft (1752.1 lm/m)	493.0 lm/ft (1617.0 lm/m)	406.0 lm/ft (1331.68 lm/m)				
			Blue	24.0	110.5 lm/ft (362.5 lm/m)	102.0 lm/ft (334.6 lm/m)	84.0 lm/ft (275.52 lm/m)				
			Amber	26.0	119.7 lm/ft (392.7 lm/m)	110.5 lm/ft (362.4 lm/m)	91.0 lm/ft (298.48 lm/m)				
6.0 Static Color Series 2	1.4 in. (35.7 mm)	68 LEDs/ft (224 LEDs/m)	Red	37.0	204.2 lm/ft (669.8 lm/m)	188.7 lm/ft (618.9 lm/m)	155.4 lm/ft (509.712 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	113.0	624.4 lm/ft (2048.2 lm/m)	576.3 lm/ft (1890.3 lm/m)	474.6 lm/ft (1556.688 lm/m)				
			Blue	23.0	127.1 lm/ft (416.9 lm/m)	117.3 lm/ft (384.8 lm/m)	96.6 lm/ft (316.9 lm/m)				
			Amber	24.0	132.6 lm/ft (435.0 lm/m)	122.4 lm/ft (401.6 lm/m)	100.8 lm/ft (330.7 lm/m)				
1.0 Variable White Series 2	1.97 in. (50 mm)	42 LEDs/ft (140 LEDs/m)	2000K + 6500K	85.0	78.2 lm/ft (257 lm/m)	72.3 lm/ft (237 lm/m)	60 lm/ft (200 lm/m)	12 in. (30.5 cm)	✓	✓	✓
3.0 Variable White Series 2	1.97 in. (50 mm)	42 LEDs/ft (140 LEDs/m)	2000K + 6500K	80.0	220.8 lm/ft (725 lm/m)	205.0 lm/ft (670 lm/m)	168.0 lm/ft (551.2 lm/m)	12 in. (30.5 cm)	✓	✓	✓
6.0 Variable White Series 2	1.97 in. (50 mm)	42 LEDs/ft (140 LEDs/m)	2000K + 6500K	75.0	415 lm/ft (1,362 lm/m)	382.5 lm/ft (1255 lm/m)	315.0 lm/ft (1033.5 lm/m)	12 in. (30.5 cm)	✓	✓	✓

AVAILABLE DRIVERS

NON-DIMMING ELECTRONIC DRIVERS



**30W, 60W, 96W
Non-Dimming Electronic
Class 2 Drivers**

- Part No.:
- DRVW2430 (30 Watt)
 - DRVW2460 (60 Watt)
 - DRVW2496 (96 Watt)

Output Voltage: 24 V
Voltage Range: 120-277 VAC
IP Rating: Dry or Damp
UL Listed



**240W, 320W
Non-Dimming
Electronic Drivers**

- Part No.:
- DRVW24240 (240 Watt)
 - DRVW24320 (320 Watt)

Output Voltage: 24 V
Voltage Range: 90-305 VAC
IP Rating: Dry or Damp
UL Recognized



**40W
Lutron Hi-Lume 1% Dimming
Class 2 Drivers**

- Part No.:
- DRVLUT24403W (40 Watt, 3-wire)
 - DRVLUT24402W (40 Watt, 2-wire)

Output Voltage: 24 V
Voltage Range: 120-277 VAC (3-wire model)
or 120V (2-wire model)
IP Rating: Dry or Damp
Dimmable using 2-wire forward phase,
3-wire+G or digital EcoSystem
UL Listed



**96W
Lutron Hi-Lume Premier 0.1% Dimming
Class 2 Driver**

- Part No.:
- DRVLUT24963W (96 Watt, 3-wire)

Output Voltage: 24 V
Voltage Range: 120-277 VAC
IP Rating: Dry or Damp
Dimmable using 3-wire+G or digital EcoSystem
0.1% dimming SoftOn/FadeToBlack
with EcoSystem
UL Listed

MAGNETIC, ELV & MLV DRIVERS WITH COMPATIBLE DIMMERS



120 VAC

**60W, 96W, 200W, 300W
Class 1 & 2 Magnetic Drivers**

- Part No.:
- DRVWDIM2460 (60 Watt)
 - DRVWDIM24100 (96 Watt)
 - DRVWDIM24200 (200 Watt)
 - DRVWDIM24300 (300 Watt)

Magnetic Driver
Output Voltage: 24 V
Voltage Range: 120 VAC
IP Rating: Dry or Damp
Forward Phase Dimming
ETL Listed



277 VAC

**60W, 96W, 200W, 300W
Class 1 & 2 Magnetic Drivers**

- Part No.:
- DRVWDIM2460277 (60 Watt)
 - DRVWDIM24100277 (96 Watt)
 - DRVWDIM24200277 (200 Watt)
 - DRVWDIM24300277 (300 Watt)

Magnetic Driver
Output Voltage: 24 V
Voltage Range: 277 VAC
IP Rating: Dry or Damp
Forward Phase Dimming
ETL Listed



**60W, 96W, 150W, 200W
ELV & MLV Drivers**

- Part No.:
- DRVW2460ELV (60 Watt)
 - DRVW2496ELV (96 Watt)
 - DRVW24150ELV (150 Watt)
 - DRVW24200ELV (200 Watt)

Line Voltage Dimmable Drivers
Output Voltage: 24 V
Voltage Range: 100-130 VAC
IP Rating: Dry or Damp
Dimmable
ETL, UL and CSA Listed



LUTRON Skylark Contour Dimmer

Part No.: TRIDIMSKY
Width: 2.94 in (75 mm)
Length: 4.69 in (120 mm)
Depth: 0.30 in (7.6 mm)

- Single pole and 3-way versions
- Compatible with GENLED Acolyte MLV drivers
- Slide adjusts brightness and On/Off control
- 30 mA max control current
- Available in white finish



LUTRON NOVA-T Dimmer

Part No.: TRIDIMNOVA
Width: 2.75 in (70 mm)
Length: 4.56 in (116 mm)
Depth: 0.30 in (7.6 mm)

- Slide adjusts brightness and On/Off control
- 30 mA max control current
- Available in white finish



LUTRON DIVA Dimmer

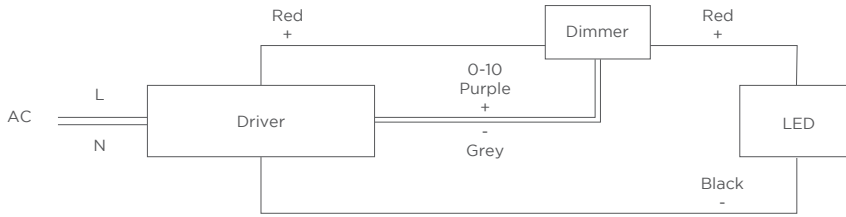
Part No.: TRIDIMDIVA
(With Locator Light) TRIDIMDIVAL
Width: 2.94 in (75 mm)
Length: 4.69 in (120 mm)
Depth: 0.30 in (7.6 mm)

- Large paddle switch with a captive linear-slide dimmer
- 30 mA max control current
- Available in white finish
- Available with locator light which glows green when the switch is off

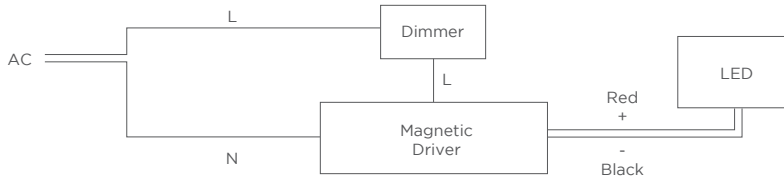
Note: For more options, please reference the Optional Dimmer List on GENLED Acolyte® product website page.

WIRING DIAGRAMS

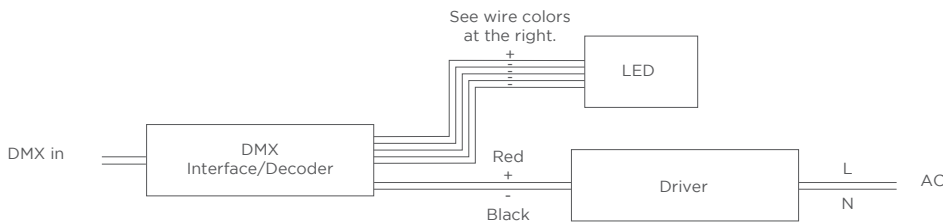
0-10V



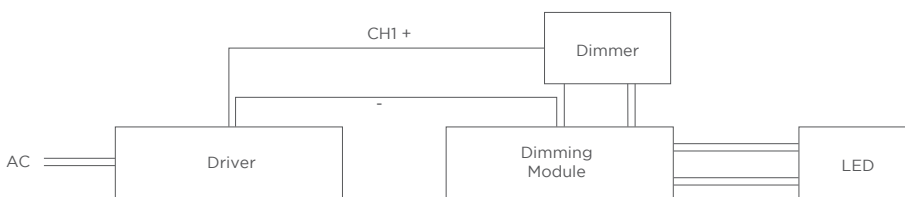
MAGNETIC + ELV



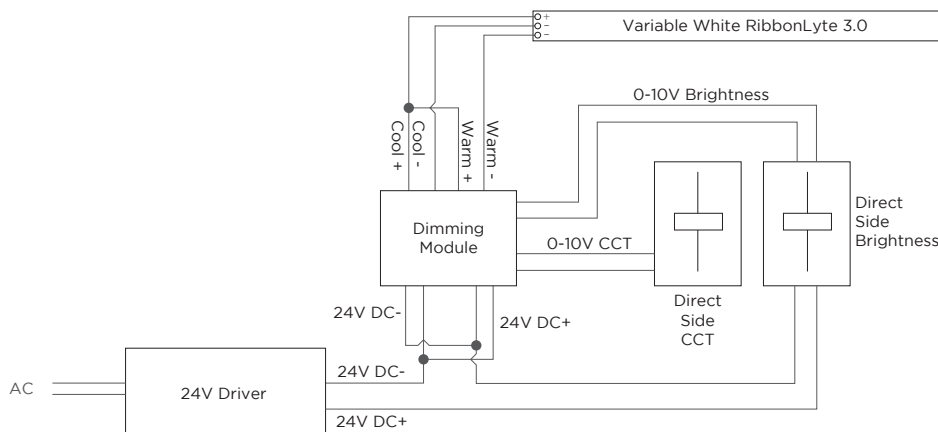
DMX



WARM DIM



2-CHANNEL VARIABLE WHITE DIMMING



WIRE COLORS PER RIBBONLYTE COLOR

STATIC WHITE + STATIC COLOR

Red Wire (+) Positive
Black Wire (-) Negative

RGB

Black Wire (+) Positive
Red Wire (-) Goes To Red Channel
Green Wire (-) Goes To Green Channel
Blue Wire (-) Goes To Blue Channel

RGBW/A

Black Wire (+) Positive
Red Wire (-) goes to Red Channel
Green Wire (-) goes to Green Channel
Blue Wire (-) goes to Blue Channel
White Wire (-) goes to White Channel

VARIABLE WHITE

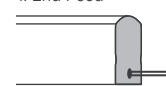
Black Wire (+) Positive
Red Wire (-) goes to Warm White Channel
Green Wire (-) goes to Cool White Channel

WARM DIM

Red Wire (-) goes to Warm White Channel
Blue Wire (-) goes to Cool White Channel
Black Wire (+) goes to Warm White Channel
Green Wire (+) goes to Cool White Channel

CONNECTION OPTIONS

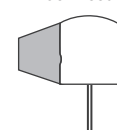
1. End Feed



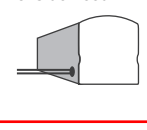
Default Option

Please specify if using a different connector type. Default option comes with 12 in. cable with bare wire if not specified.

2. Back Feed



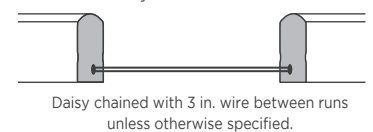
3. Side Feed



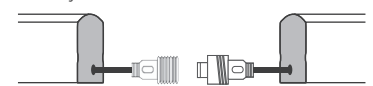
4. IP67 Connector Input



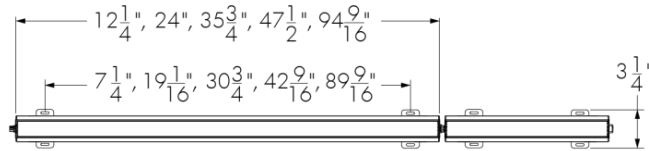
5. Soldered Daisy Chain



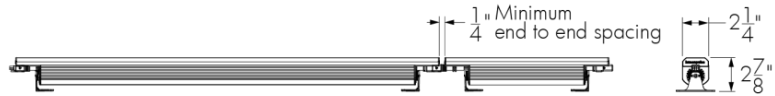
6. Daisy Chain with IP67 Connectors



Project Name _____ Qty _____
 Type _____ Catalog / Part Number _____



Top view



Front and side views

Photometric Summary

CCT	Delivered Output [lm]	Power [W]
RGB RO [2] [4]	660	22
RGB HO [2] [4]	1023	38
RGBW [2] [4]	806	22
RGBA [2] [4]	558	22

Photometric performance is measured in compliance with IESNA LM-79-08.
 (1) Use 0.25 multiplier for each 12in [305mm] section.
 (2) Frosted lens option ratio = x0.85.
 (3) Estimated. Consult website for the latest photometric files.
 (4) Tested at full output.

Colors and Color Temperatures



Controls



Optic



Rating

IP20

Certifications



Description

The Lumencove 2.0 Color Changing is a modular and adjustable system for even cove illumination in color. The system is available in 12 in, 24 in, 36 in, 48 in and 96 in sections enabling both curved and linear layouts. The longer 96 in sections help decrease installation costs by reducing the number of connections. Additional options include RGB, RGBW or RGBA color mixing for a more nuanced color palette, and dimming control via DMX/RDM.

Features

Color and Color Temperature	Additive RGB Regular Output, Additive RGB High Output, Additive RGB + 4000K, Additive RGB + amber
Length (nominal)	12 in, 24 in, 36 in, 48 in, 96 in
Optics	110° x 110°
Power Consumption	5 W/ft RGBW and RGBA version, 6 W/ft RO RGB version, 9 W/ft HO RGB version
Adjustability	+/- 90° tilt angle
Warranty	5-year limited warranty

Performance

Maximum Delivered Output	1023 lm (RGB full output, 48 in fixture)
Lumen Maintenance	L70 88,000 hrs (Ta 25 °C and Ta 40 °C), L95 72,000 hrs (Ta 25 °C and Ta 40 °C)

Physical

Housing Material	Low copper content extruded aluminum
Lens Material	Extruded polycarbonate, clear or frosted
Finish	White
Surface Finish	Electrostatically applied polyester powder coat
Weight	12 in : 1.25 lbs, 24 in : 2.5 lbs, 36 in : 3.75 lbs, 48 in : 5 lbs, 96 in : 10 lbs

Electrical and control

Voltage	120-277V (neutral connection required)
Fixture Cable	Power and data in one cable
Leader Cable Conductor	5C #16-5
Connector Type	Thumb latch connectors, breakable under load
Fixture Cable and Connector Color	White
Maximum Cable and Fixture Run Length	Up to 170 ft (DMX/RDM, 240-277V, RGB RO version), Up to 128 ft (DMX/RDM, 120-277V, RGBW version)
Control	Lumentalk, DMX/RDM enabled
Resolution (DMX/RDM)	Per foot or per fixture (configured with LumenID V3 software), 8-bit or 16-bit
RGB Color Mixing	18 LEDs per 12 in (tri-color LEDs RGB RO), 24 LEDs per 12 in (tri-color LEDs RGB HO)
RGBW Color Mixing	36 LEDs per 12 in (18x tri-color LEDs, 18x LEDs 4000K)
RGBA Color Mixing	36 LEDs per 12 in (18x tri-color LEDs, 18x amber LEDs)

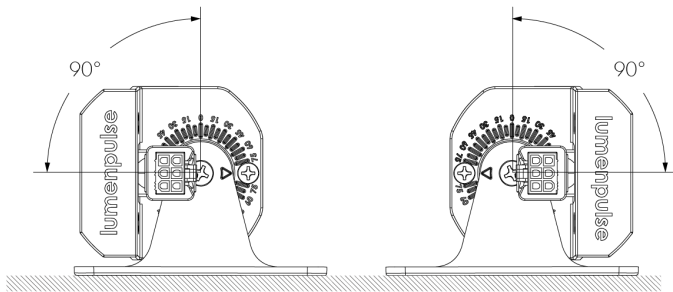
Environmental

Storage Temperature	-40 °F to 122 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-13 °F to 122 °F
Environment	Indoor applications only
Ingress Protection Rating	IP20

Accessories (order separately)

Cables	Leader Cable, Jumper Cable
Control Boxes	DMX/RDM enabled (daisy chain or star configuration), Ethernet enabled (daisy chain or star configuration), Lumentalk Data Bridge
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID, LumentalkID

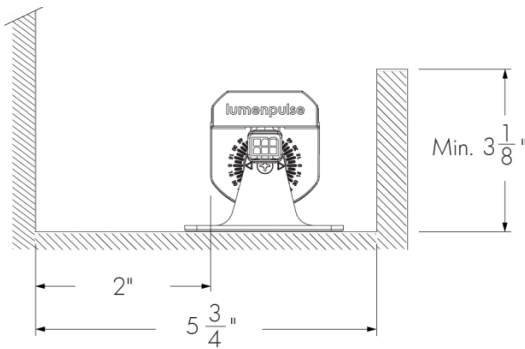
Maximum pivot limits



SIDE VIEW

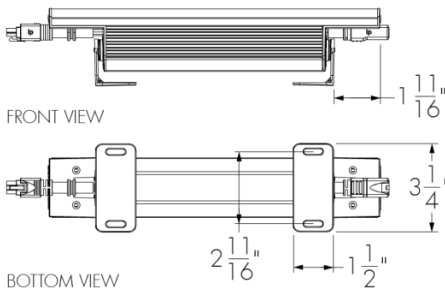
Mounting details

Suggested cove dimensions



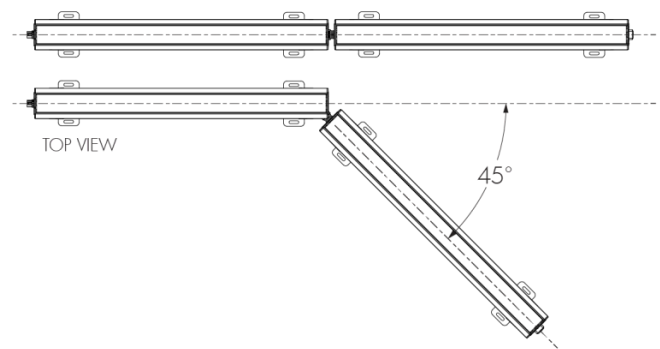
Minimum cove height depends on sight line.

Mounting bracket dimensions



12 in fixture shown.

Maximum angle adjustment



A jumper cable is required for angles greater than 45°.

Cables (order separately)

LCS2LC - Leader cable for Lumencove 2.0



LCS2LC-CERTIFICATION-CONTROL-LENGTH-WH

Please specify:

CERTIFICATION: UL or CE; **CONTROL:** NO or DATA; **LENGTH:** 10 ft or 25 ft

- Suitable for dimming/data and on/off applications.
- Consult Lumencove 2.0 leader or jumper cable specification sheets for details.

LCS2JC - Jumper cable for Lumencove 2.0



LCS2JC-CERTIFICATION-CONTROL-LENGTH-WH

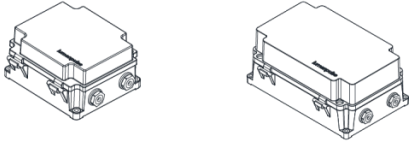
Please specify:

CERTIFICATION: UL or CE; **CONTROL:** NO or DATA; **LENGTH:** 2 ft or 4 ft

end to end connection

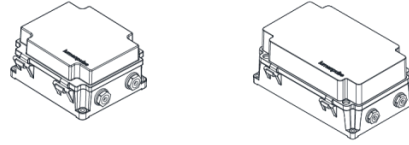
Control boxes (order separately)

CBX-DMX/RDM - DMX/RDM enabled (daisy chain or star configuration)



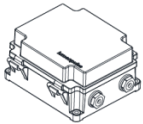
DMX/RDM control box. Up to six power and data outputs to fixtures or fixture runs. Consult CBX specification sheet and installation instructions for details. Lumenterminators provided with CBX (2x for daisy chain configuration, 6x for star configuration), consult factory to order spares.

CBX-ENET - Ethernet enabled (daisy chain or star configuration)



Ethernet control box. Up to four power and data outputs to fixture or fixture runs. Consult Ethernet CBX specification sheet and installation instructions for details.

LDB - Lumentalk Data Bridge



The Lumentalk Data Bridge is a digital interface that connects non-Lumentalk luminaires to the Lumentalk network, 0-10V or DMX output. Consult LDB specification sheet for details.

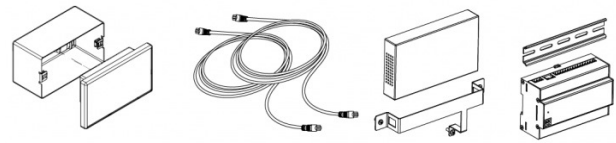
Control systems (order separately)

LTN2 - Lumentone™ 2



Lumentone 2 is a simple pre-programmed DMX 512 controller with a push button rotary dial and live feedback.

PHAROS - Pharos® kit



The Pharos kit, available for 1 or 2 DMX universes, allows for complete control of large lighting installations. 2 DMX universes kit shown.

Diagnostic and addressing tools (order separately)

LID - LumenID



LumenID is a diagnostic and addressing DMX/RDM tool. It must be specified on all DMX applications. Consult LID specification sheet for details.

LID-LT - LumentalkID

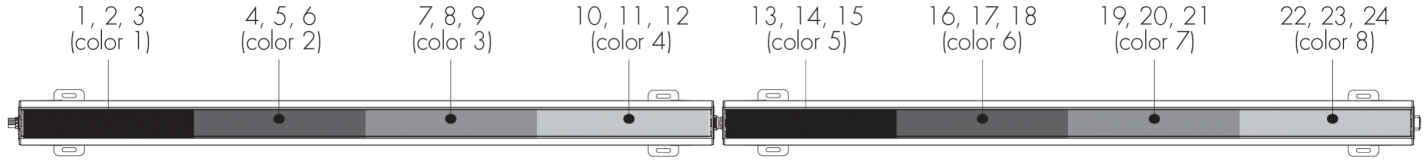


LumentalkID is a diagnostic and addressing tool. It must be specified for all Lumentalk (LT) applications. Consult LID-LT specification sheet for details.

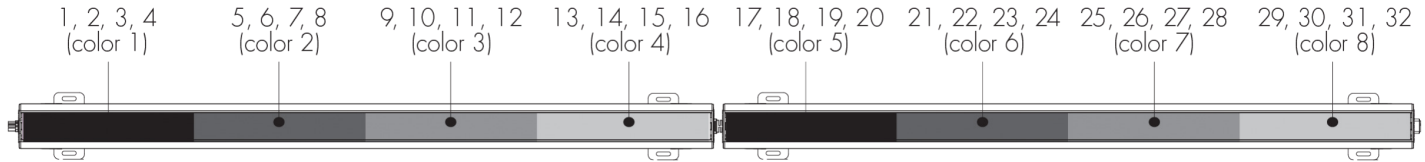
Resolution details

DMX/RDM control, resolution per foot: each 12 in section is addressed independently

DMX addresses:



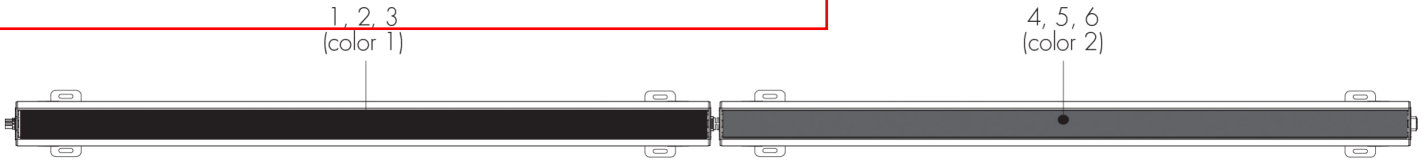
RGB color mixing option



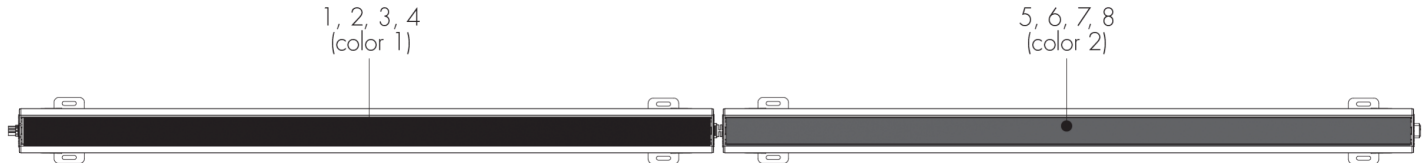
RGBW and RGBA color mixing options

DMX/RDM control, resolution per fixture: each fixture is addressed independently

DMX addresses:



RGB color mixing option



RGBW and RGBA color mixing options

- 48 in fixtures shown.
- Applicable for DMX/RDM control option only. Fixture resolution can be configured on-site within the LumenID V3 software. A DMX/RDM enabled CBX is required.

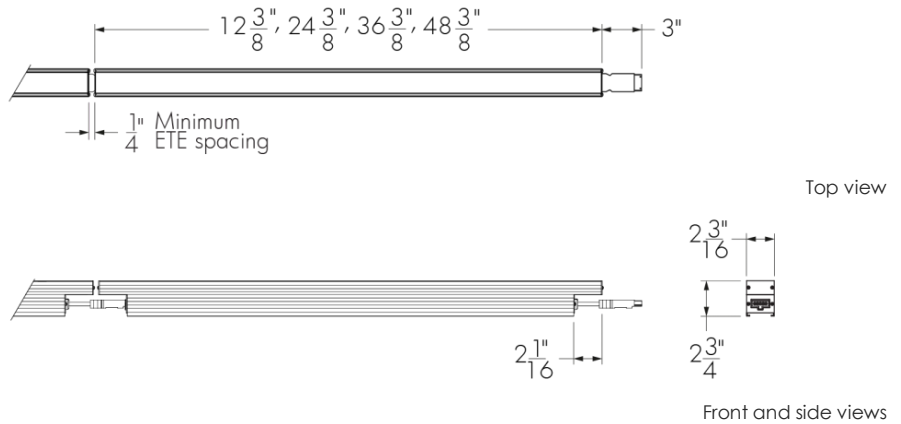
How to order

Housing	Voltage	Length	Color and Color Temperature	Lens	Finish	Control
LCS2 Lumencove@ 2.0	120 120 volts	12 12 1/4 in (1.25 lbs) ⁽¹⁾	RGB RO Additive RGB Regular Output, 6 W/ft	CL Clear lens	WH Smooth white	LT Lumentalk ⁽¹⁾ ⁽⁵⁾
	208 208 volts	24 24 in (2.5 lbs)	RGB HO Additive RGB High Output, 9 W/ft	FR Frosted lens	CC Custom color and finish (please specify RAL color) ⁽²⁾ ⁽³⁾ ⁽⁴⁾	DMX/RDM DMX/RDM enabled ⁽⁶⁾
	220 220 volts	36 35 3/4 in (3.75 lbs)	RGBW Additive RGB + 4000K 5 W/ft			
	240 240 volts	48 47 1/2 in (5 lbs)	RGBA Additive RGB + amber 5 W/ft	3,000K		
	277 277 volts	96 94 9/16 in (10 lbs)				

Notes:

- To connect 12 in fixture lengths to the Lumentalk system, DMX/RDM must be specified as the control option, and a Lumentalk Data Bridge (LDB-DMX) is required. See the typical wiring diagrams in the specification sheet for details.
- Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
- Setup charges apply for RAL colors. Consult factory for details.
- Longer lead times can be expected for custom RAL color finishes.
- A Lumentranslator 2 (LTL2) and LumentalkID (LIDL2) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
- A control box (CBX) and LumenID (LID) must be specified.

Project Name _____ Qty _____
 Type _____ Catalog / Part Number _____

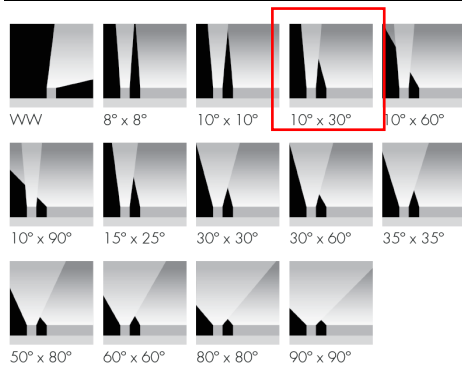


Photometric Summary

	Delivered output (lm)	Intensity (peak cd)
WW	3,515	5,040
8°x8°	4,042*	64,112*
10°x10°	4,394	40,976
10°x30°	3,752*	25,721*
10°x60°	3,459	13,078
10°x90°	3,503*	7,349*
15°x25°	3,801*	22,667*
30°x30°	3,689*	13,982*
30°x60°	3,425	4,625
35°x35°	3,842*	9,856*
50°x80°	3,691*	3,456*
60°x60°	3,638	3,145
80°x80°	3,807*	2,541*
90°x90°	3,518*	1,890*

Based on HO 4000K, 4ft [1219mm] configuration.
 Photometric performance is measured in compliance with IESNA LM-79-08.
 *Estimated. Consult website for the latest photometric files.

Optics



Description

The Lumenfacade Interior is a high-performance interior LED luminaire for grazing or wall washing applications. Featuring second generation LED technology, the luminaire is available in 12 in, 24 in, 36 in or 48 in sections, and can be configured with a number of options including: optics for grazing or flood lighting; a choice of outputs (RO 8.5 W/ft or HO 15.25 W/ft); various color temperatures or static colors; various mounting options, finishes, accessories and controls. The Lumenfacade is also available with a unique asymmetric wallwash distribution, providing exceptional uniformity and brightness for walls and signage.

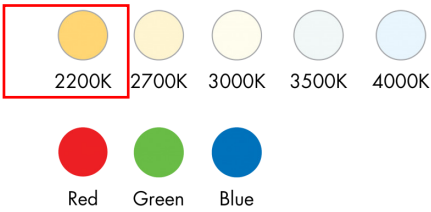
Features

Color and Color Temperature	2200K, 2700K, 3000K, 3500K, 4000K, Red, Green, Blue
Length (nominal)	12 in, 24 in, 36 in, 48 in
Optics	Asymmetric Wallwash, 8° x 8°, 10° x 10°, 10° x 30°, 10° x 60°, 10° x 90°, 15° x 25°, 30° x 30°, 30° x 60°, 35° x 35°, 50° x 80°, 60° x 60°, 80° x 80°, 90° x 90°
Power Consumption	5 W/ft (meets ASHRAE standards for linear lighting on building facades - not available for 12 in fixture lengths), 8.5 W/ft (RO version), 15.25 W/ft (HO version), Typically 20% higher for 12 in fixture lengths
Warranty	5-year limited warranty
Performance	
Illuminance at Distance	Minimum 1 fc at 114 ft (HO 4000K, 48 in fixture, 10° x 60°, DMX/RDM)
Color Consistency	2 SDCM, 3 SDCM (2200K)
Color Rendering	Minimum CRI 80
Lumen Maintenance	L70 280,000 hrs, L95 35,000 hrs

Physical

Housing Material Low copper content extruded aluminum

Colors and Color Temperatures



Controls

ON/OFF 0-10V DALI



Certifications



Lens Material	Clear acrylic
Hardware Material	Stainless steel
End Cap Material	Aluminum
Surface Finish	Electrostatically applied polyester powder coat
Weight	12 in: 2.1 lbs, 24 in: 3.7 lbs, 36 in: 5.3 lbs, 48 in: 6.8 lbs

Electrical and control

Voltage	100 to 277 volts, 347 volts available (consult factory for details)
Fixture Cable	Power and data in one cable, End-to-end configuration standard (factory installed input cable - no jumper cable needed for minimum spacing between two fixtures)
Fixture Cable and Connector Color	Black for Black Sandtex, Bronze Sandtex and Silver Sandtex finishes, White for Smooth white finish
Leader Cable Conductor	3C #16-3 (NO, LT control), 5C #16-5 (DIM, DALI, ES, DMX/RDM control)
Maximum Cable and Fixture Run Length	252 ft (On/Off, 277V, RO version), 164 ft (On/Off, 277V, HO version)
Control	On/Off control, Lumentalk, 0-10V dimming, DALI dimming, Lutron® EcoSystem® Enabled dimming, DMX/RDM enabled
Resolution (DMX/RDM)	Per foot or per fixture (configured with LumenID V3 software), 8-bit or 16-bit

Environmental

Environment	Indoor applications only
Storage Temperature	-40 °F to 185 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-40 °F to 122 °F

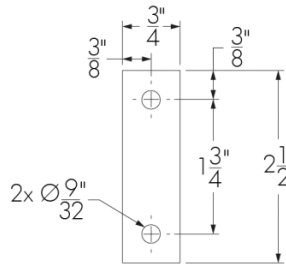
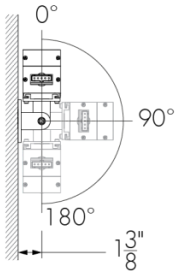
Accessories (order separately)

Optical Accessories	Lumenfacade Interior Radial Louver
Cables	Lumenfacade Interior Leader Cable, Lumenfacade Interior Jumper Cable
Control Boxes	DMX/RDM enabled (daisy chain or star configuration), Ethernet enabled (daisy chain or star configuration), Lumentalk Data Bridge
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID, LumentalkID

Wall Mount

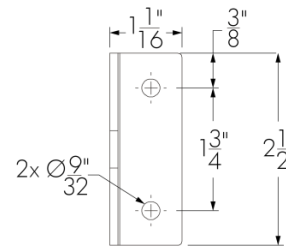
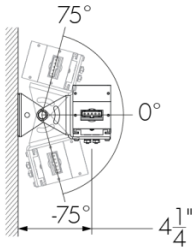
UMAS - Universal Adjustable Mounting

UMAS - Mounting hole pattern



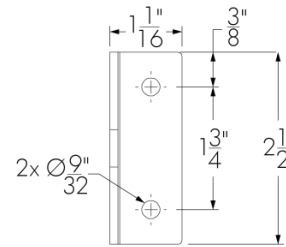
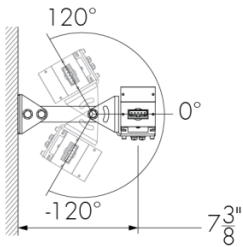
WAM2 - Adjustable Wall Mounting 2 in

WAM2 - Mounting hole pattern



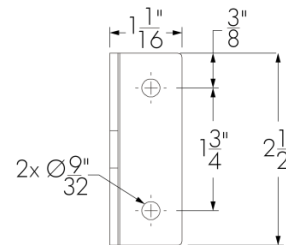
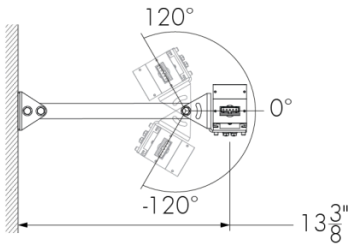
WAM6 - Adjustable Extended Arm Mounting 6 in

WAM6 - Mounting hole pattern



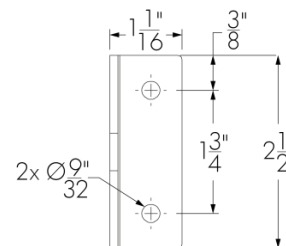
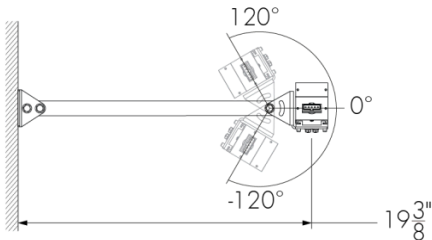
WAM12 - Adjustable Extended Arm Mounting 12 in

WAM12 - Mounting hole pattern



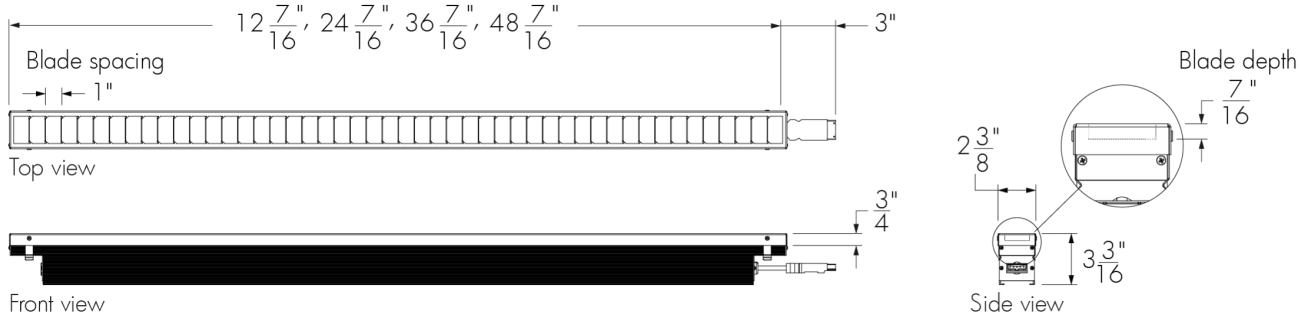
WAM18 - Adjustable Extended Arm Mounting 18 in

WAM18 - Mounting hole pattern



Optical accessories (order separately)

LOGIRD - Radial louver for Lumenfacade Interior



LOGIRD-LENGTH-FINISH

Please specify:

LENGTH: 12 in, 24 in, 36 in or 48 in; **FINISH:** BK - Black Sandtex®, BRZ - Bronze Sandtex®, SI - Silver Sandtex®, WH - Smooth white or CC - custom color and finish (please specify RAL color)

- The addition of a louver will affect beam distribution. Consult factory for application support.
- Not suitable for asymmetric wallwash optic.

Cables (order separately)

LOGiLC - Leader cable for Lumenfacade Interior



LOGiLC-CERTIFICATION-CONTROL-LENGTH-CABLE COLOR

Please specify:

CERTIFICATION: UL or CE; **CONTROL:** NO - non-dimming or DATA - dimming/data; **LENGTH:** 10 ft, 25 ft, 50 ft, 100 ft, 150 ft or 200 ft; **CABLE COLOR:** black or white (connectors are the same color as the specified cable color)

- Consult Lumenfacade Interior leader cable specification sheet for details.

LOGiJC - Jumper cable for Lumenfacade Interior



LOGiJC-CERTIFICATION-CONTROL-LENGTH-CABLE COLOR

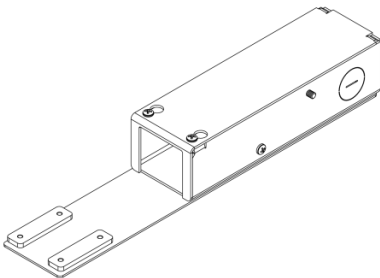
Please specify:

CERTIFICATION: UL or CE; **CONTROL:** NO - non-dimming or DATA - dimming/data; **LENGTH:** 1 ft to 30 ft (available in 1 ft increments) or 50 ft; **CABLE COLOR:** black or white (connectors are the same color as the specified cable color)

- Consult Lumenfacade Interior jumper cable specification sheet for details.

Wiring compartment (order separately)

WC-120/277-LOGI-WH - Wiring compartment



The Wiring Compartment is pre-wired with a leader cable, allowing the quick connection of conduits. Consult WC specification sheet for details.

How to order

Housing ⁽²⁾	Voltage ⁽³⁾	Length	Color and Color Temperature ⁽⁵⁾	Optics	Mounting Options	Finish	Control
LOGI ASHRAE Lumenfacade™ Interior, 5 W/ft, ASHRAE compliant ⁽¹⁾ LOGI RO Lumenfacade™ Interior Regular Output, 8.5 W/ft LOGI HO Lumenfacade™ Interior High Output, 15.25 W/ft	100 100 volts	12 12 3/8 in (2.1 lbs) ^{(2) (4)}	22K 2200K	WWLF Asymmetric Wallwash, left feed	SAM Slim Adjustable Mounting	BK Black Sandtex®	NO On/Off control
	120 120 volts	24 24 3/8 in (3.7 lbs)	27K 2700K	WWRF Asymmetric Wallwash, right feed	UMP Fixed Mounting	BRZ Bronze Sandtex®	LT Lumentalk ⁽⁴⁾ ^{(11) (12)}
	208 208 volts	36 36 3/8 in (5.3 lbs)	30K 3000K	8x8 8° x 8° ⁽⁷⁾	UMAS Universal Adjustable Mounting	SI Silver Sandtex®	DIM 0-10V dimming
	220 220 volts	48 48 3/8 in (6.8 lbs)	35K 3500K	10x10 10° x 10° ⁽⁷⁾	WAM2 Adjustable Wall Mounting 2 in	WH Smooth white	DALI DALI dimming
	240 240 volts		40K 4000K	10x30 10° x 30°	WAM6 Adjustable Extended Arm Mounting 6 in	CC Custom color and finish (please specify RAL color) ^{(8) (9) (10)}	ES Lutron® EcoSystem® Enabled dimming ⁽¹¹⁾
	277 277 volts		RD Red ⁽⁶⁾	10x60 10° x 60°	WAM12 Adjustable Extended Arm Mounting 12 in		DMX/RDM DMX/RDM enabled ⁽¹³⁾
			GR Green ⁽⁶⁾	10x90 10° x 90°	WAM18 Adjustable Extended Arm Mounting 18 in		
			BL Blue ⁽⁶⁾	15x25 15° x 25°			
				30x30 30° x 30°			
				30x60 30° x 60°			
				35x35 35° x 35°			
				50x80 50° x 80°			
				60x60 60° x 60°			
			80x80 80° x 80°				
			90x90 90° x 90°				

Notes:

- ASHRAE version not available for 12 in fixture lengths.
- Power consumption is typically 20% higher for 12 in fixture lengths.
- 347 volts available, consult factory for details.
- To connect 12 in fixture lengths to the Lumentalk system, DIM or DMX/RDM must be specified as the control option, and a Lumentalk Data Bridge (LDB) is required. See the typical wiring diagrams in the specification sheet for details.
- Consult factory for availability of static Royal Blue, 6500K and 90+ CRI.
- Static colors made to order 8-10 weeks.
- For best results use with HO fixtures at a 6 in setback from surface. Contact factory for application support.
- Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
- Setup charges apply for RAL colors. Consult factory for details.
- Longer lead times can be expected for custom RAL color finishes.
- Available for 24 in, 36 in and 48 in fixture lengths only.
- A Lumentranslator 2 (LTL2) and LumentalkID (LIDL) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
- A control box (CBX) and LumenID (LID) must be specified.

Date _____ Project _____

Notes _____

AT11 CHANNEL FIXTURE

Our AT11 Channel Fixture is a surface-mounted channel with a 120-degree beam angle. We offer a variety of mounting options as well as a choice of clear, frosted and milky lenses to create a full range of light output and design. Custom design a fixture for nearly any application with our AT11 Channel and RibbonLyte products.



- Beam Angle 120°
- Wattage Range from 0.75 W/ft (2.46 W/m) to 8.8 W/ft (28.9 W/m)
- Static White delivered lumen range from 85 lm/ft (279 lm/m) up to 729 lm/ft (2391 lm/m)
- Assembled in USA

Applications:

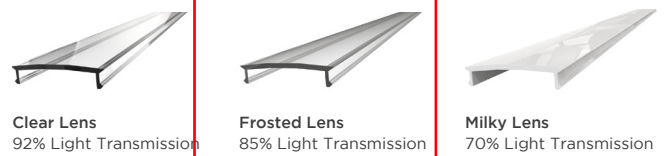
Commercial Hospitality Residential
Entertainment Museums Retail
Healthcare Public Spaces



AVAILABLE HOUSING FINISHES



AVAILABLE LENS FINISHES



ORDERING GUIDE

CATEGORY	LENS	CRI	RIBBON TYPE & IP RATING		
CHAT11					
CHAT11 - AT11 Channel	C - Clear* F - Frosted M - Milky	0 - Static Color, Color Changing 90 - 90+ CRI Static White	SWS220 - Static White Series 2 IP20 SWS265 - Static White Series 2 IP65 SWS268 - Static White Series 2 IP68 SCS220 - Static Color Series 2 IP20 SCS265 - Static Color Series 2 IP65 SCS268 - Static Color Series 2 IP68	VWS220 - VW Series 2 IP20 VWS265 - VW Series 2 IP65 VWS268 - VW Series 2 IP68 RGB20 - RGB IP20 RGB65 - RGB IP65 RGBWA20 - RGBW/A IP20	RGBWA65 - RGBW/A IP65 WD20 - Warm Dim IP20 WD65 - Warm Dim IP65

* Clear lens is the default option if not specified.

WATTAGE	COLOR	CONNECTION OPTIONS
0.75 - 0.75 W/ft (2.46 W/m - Static White, Static Color)	18 - 1800K VW - Variable White	1 - End Feed Hard Wire Connection
1.0 - 1.0 W/ft (3.3 W/m - Variable White)	20 - 2000K RGB - Red, Green, Blue	2 - Back Feed Hard Wire Connection
1.5 - 1.5 W/ft (4.9 W/m - Static White, Static Color)	22 - 2200K RGB30 - Red, Green, Blue + 3000K	3 - Side Feed Hard Wire Connection
2.2 - 2.2 W/ft (7.2 W/m - Static White, Static Color, RGB)	24 - 2400K RGB40 - Red, Green, Blue + 4000K (5.5W only)	4 - IP67 Connector Input
3.0 - 3.0 W/ft (9.8 W/m - Static White, Static Color, Variable White)	27 - 2700K RGB60 - Red, Green, Blue + 6000K	5 - Soldered Daisy Chain
4.4 - 4.4 W/ft (14.4 W/m - Static White, Static Color, RGB, RGBW/RGBA)	30 - 3000K RGBA - Red, Green, Blue + Amber	6 - Daisy Chain With IP67 Connectors
5.0 - 5.0 W/ft (16.4 W/m - Static White, Static Color)	35 - 3500K 2920 - Warm Dim 2900K - 2000K (IP20)	(See last page for connection diagram)
5.2 - 5.2 W/ft (17.1 W/m - Warm Dim)	40 - 4000K 2721 - Warm Dim 2700K - 2100K (IP65+IP68)	
5.5 - 5.5 W/ft (18.0 W/m - RGBW/RGBA)	60 - 6000K Z - Undecided**	
6.0 - 6.0 W/ft (19.7 W/m - Static White, Static Color, Variable White)	R - Red	
8.8 - 8.8 W/ft (28.9 W/m - RGB)	A - Amber G - Green B - Blue	

** For quotes only. Must be chosen before final order.

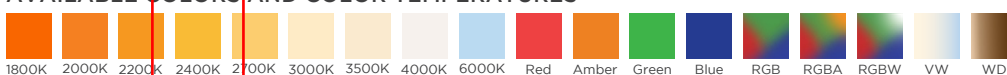
Included Accessories:

1. Mounting Clip

Optional Accessories:

1. Tilttable Stand (Part No.: TILTSTANDST)
2. Magnetic Mount (Part No.: CHMAG0.5)

AVAILABLE COLORS AND COLOR TEMPERATURES

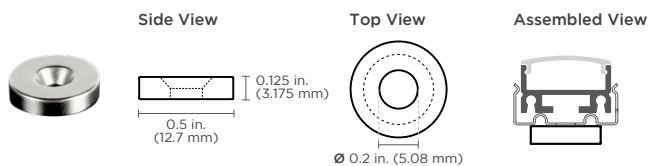


SPECIFICATIONS

AT11 CHANNEL	Mounting Clip (Included Accessory)		Tiltable Stand (Optional Accessory)	
	<p>Side View</p>	<p>Assembled View</p>	<p>Side Views</p>	<p>Assembled View</p>
	<p>Top View</p>			
	<p>* Each section of channel includes 3 mounting clips. * Magnetic mounting option available (see below)</p>		<p>* Height does not include height of mounting clip, channel and lens. Part Number: TILTSTAND</p>	

Beam Angle	120°			
Lens Type	Clear, Frosted, Milky			
Width	0.77 in. (19.6 mm)	0.8 in. (20.3 mm)	Base: 1.02 in. (26 mm) / Tabletop: 0.75 in. (19 mm)	
Height	0.59 in. (15 mm)	0.34 in. (8.6 mm)	0.86 in. (21.8 mm)	
Internal	0.67 in. (17 mm)	--	Screw hole: Size #4-40	
Length	Channel is sold by the foot and cut to your exact desired length. Required amount of mounting clips included. Tiltable stands are sold separately.			
Operating Voltage	24V			
Dimming	MLV / 0-10 Volt / Lutron Hi-Lume 1% dimming LED drivers / Lutron VIVE code compliance available / ELV / DALI / DMX			
Operating Temperature	-40° F to 158° F (-40° C to 70° C)			
Colors	1800K, 2000K, 2200K, 2400K, 2700K, 3000K, 3500K, 4000K, 6000K, Red, Amber, Green, Blue, RGB, RGBW, RGBA, VW, Warm Dim (1800K, 2000K, 2200K only available in IP20)			
CRI	90+ CRI (Static White only)			
Lamp Life	L70 at 50,000 Hours			
MacAdam Ellipses (SDCM)	2-Step Binning (For Static White LEDs only)			
Certifications	ETL Listed: UL 2108 Issued: 2004/02/27 Ed: 1 Rev: 2014/02/24 Low Voltage Lighting Systems CSA C22.2#9.0 Issued: 1996/06/01 Ed: 1 (R2011) General Requirements for Luminaires; with Gen. Inst. 1: 1997, Gen Inst. 2: 1998. ROHS compliant UL 2108 - Low Voltage Lighting Systems UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products UL 1598 / CSA 250.0-08 - Luminaires			

Magnetic Mount (Part #: CHMAG0.5)



Features:

- High-energy neodymium magnets come attached to mounting clips with countersink hex nuts
- Create easy-mount magnetic channels with minimal surface gaps; no tools or drilling necessary
- Magnets rated for 8 lbs. of pull force with static load

Applications:

- Industrial lighting retrofits for troffers and other metal fixtures
- Metal retail shelf lighting
- Temporary light fixture installations

ASSEMBLY OPTIONS

ON-SITE ASSEMBLY
Cut to length with soldered leads, assembled on-site

BENEFITS:

- Run Lengths can be trimmed in the field
- Last-minute adjustments
- Shorter lead time

FACTORY ASSEMBLY
Pre-assembled factory-finished fixtures (Max assembled length is 78 in.)

BENEFITS:

- Easy and quick installation
- Shipped as a complete unit
- Plug-and-play installation

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SPECIFICATIONS

Available Wattages	Cuttable Length	LED Pitch	Color Temp.	lm/W without Lens	Delivered Lumens with Clear Lens	Delivered Lumens with Frosted Lens	Delivered Lumens with Milky Lens	Standard Cable Length	Compatible with Channel		
									IP20	IP65	IP68
6.0 Static White Series 2	1.4 in. (35.7 mm)	68 LEDs/ft (224 LEDs/m)	2400K	109	601.6 lm/ft (1973.2 lm/m)	555.9 lm/ft (1823.4 lm/m)	457.8 lm/ft (1501.6 lm/m)	12 in. (30.5 cm)	✓	✓	
			2700K	122	674.2 lm/ft (2211.3 lm/m)	622.2 lm/ft (2040.8 lm/m)	512.4 lm/ft (1680.7 lm/m)				
			3000K	129	712.9 lm/ft (2338.2 lm/m)	657.9 lm/ft (2157.9 lm/m)	541.8 lm/ft (1777.1 lm/m)				
			3500K	132	729.4 lm/ft (2392.5 lm/m)	673.2 lm/ft (2208.1 lm/m)	554.4 lm/ft (1818.4 lm/m)				
			4000K	132	612.5 lm/ft (2008.9 lm/m)	673.2 lm/ft (2208.1 lm/m)	554.4 lm/ft (1818.4 lm/m)				
			6000K	126	696.3 lm/ft (2283.8 lm/m)	642.6 lm/ft (2107.7 lm/m)	529.2 lm/ft (1735.8 lm/m)				
0.75 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	41	28 lm/ft (93 lm/m)	26 lm/ft (86 lm/m)	22 lm/ft (70.6 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	175	121 lm/ft (396 lm/m)	112 lm/ft (366 lm/m)	92 lm/ft (301.4 lm/m)				
			Blue	19	13 lm/ft (43 lm/m)	12 lm/ft (40 lm/m)	10 lm/ft (32.7 lm/m)				
			Amber	34	23 lm/ft (77 lm/m)	22 lm/ft (71 lm/m)	18 lm/ft (58.6 lm/m)				
1.5 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	42	58 lm/ft (190 lm/m)	54 lm/ft (176 lm/m)	44 lm/ft (144.7 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	160	221 lm/ft (724 lm/m)	204 lm/ft (669 lm/m)	168 lm/ft (551.1 lm/m)				
			Blue	18	25 lm/ft (81 lm/m)	23 lm/ft (75 lm/m)	19 lm/ft (62 lm/m)				
			Amber	34	47 lm/ft (154 lm/m)	43 lm/ft (142 lm/m)	36 lm/ft (117.1 lm/m)				
2.2 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	42	85 lm/ft (279 lm/m)	79 lm/ft (258 lm/m)	65 lm/ft (212.2 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	145	293 lm/ft (963 lm/m)	271 lm/ft (889 lm/m)	223 lm/ft (732.4 lm/m)				
			Blue	18	36 lm/ft (119 lm/m)	34 lm/ft (110 lm/m)	28 lm/ft (90.9 lm/m)				
			Amber	33	67 lm/ft (219 lm/m)	62 lm/ft (202 lm/m)	51 lm/ft (166.7 lm/m)				
3.0 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	40.0	110.4 lm/ft (362.1 lm/m)	102.0 lm/ft (334.6 lm/m)	84.0 lm/ft (275.52 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	127.0	350.9 lm/ft (1151.0 lm/m)	323.9 lm/ft (1062.2 lm/m)	266.7 lm/ft (874.776 lm/m)				
			Blue	25.0	69.1 lm/ft (226.6 lm/m)	63.8 lm/ft (209.1 lm/m)	52.5 lm/ft (172.2 lm/m)				
			Amber	29.0	80.1 lm/ft (262.8 lm/m)	74.0 lm/ft (242.6 lm/m)	60.9 lm/ft (199.752 lm/m)				
4.4 Static Color Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	Red	38.0	153.8 lm/ft (504.5 lm/m)	142.1 lm/ft (466.2 lm/m)	117.0 lm/ft (383.8912 lm/m)	12 in. (30.5 cm)	✓	✓	✓
			Green	117.0	474.1 lm/ft (1555.1 lm/m)	437.6 lm/ft (1435.3 lm/m)	360.4 lm/ft (1181.981 lm/m)				
			Blue	24.0	97.3 lm/ft (319.0 lm/m)	89.8 lm/ft (294.4 lm/m)	73.9 lm/ft (242.4576 lm/m)				
			Amber	25.0	101.3 lm/ft (332.2 lm/m)	93.5 lm/ft (306.7 lm/m)	77.0 lm/ft (252.56 lm/m)				
5.0 Static Color Series 2	1.4 in. (35.7 mm)	68 LEDs/ft (224 LEDs/m)	Red	37.0	170.2 lm/ft (558.2 lm/m)	157.3 lm/ft (515.8 lm/m)	129.5 lm/ft (424.76 lm/m)	12 in. (30.5 cm)	✓	✓	
			Green	116.0	534.2 lm/ft (1752.1 lm/m)	493.0 lm/ft (1617.0 lm/m)	406.0 lm/ft (1331.68 lm/m)				
			Blue	24.0	110.5 lm/ft (362.5 lm/m)	102.0 lm/ft (334.6 lm/m)	84.0 lm/ft (275.52 lm/m)				
			Amber	26.0	119.7 lm/ft (392.7 lm/m)	110.5 lm/ft (362.4 lm/m)	91.0 lm/ft (298.48 lm/m)				
6.0 Static Color Series 2	1.4 in. (35.7 mm)	68 LEDs/ft (224 LEDs/m)	Red	37.0	204.2 lm/ft (669.8 lm/m)	188.7 lm/ft (618.9 lm/m)	155.4 lm/ft (509.712 lm/m)	12 in. (30.5 cm)	✓	✓	
			Green	113.0	624.4 lm/ft (2048.2 lm/m)	576.3 lm/ft (1890.3 lm/m)	474.6 lm/ft (1556.688 lm/m)				
			Blue	23.0	127.1 lm/ft (416.9 lm/m)	117.3 lm/ft (384.8 lm/m)	96.6 lm/ft (316.9 lm/m)				
			Amber	24.0	132.6 lm/ft (435.0 lm/m)	122.4 lm/ft (401.6 lm/m)	100.8 lm/ft (330.7 lm/m)				
1.0 Variable White Series 2	1.97 in. (50 mm)	42 LEDs/ft (140 LEDs/m)	2000K + 6500K	85.0	78.2 lm/ft (257 lm/m)	72.3 lm/ft (237 lm/m)	60 lm/ft (200 lm/m)	12 in. (30.5 cm)	✓	✓	✓
3.0 Variable White Series 2	1.97 in. (50 mm)	42 LEDs/ft (140 LEDs/m)	2000K + 6500K	80.0	220.8 lm/ft (725 lm/m)	205.0 lm/ft (670 lm/m)	168.0 lm/ft (551.2 lm/m)	12 in. (30.5 cm)	✓	✓	✓
6.0 Variable White Series 2	1.97 in. (50 mm)	42 LEDs/ft (140 LEDs/m)	2000K + 6500K	75.0	415 lm/ft (1,362 lm/m)	382.5 lm/ft (1255 lm/m)	315.0 lm/ft (1033.5 lm/m)	12 in. (30.5 cm)	✓	✓	✓



AVAILABLE DRIVERS

NON-DIMMING ELECTRONIC DRIVERS



**30W, 60W, 96W
Non-Dimming Electronic
Class 2 Drivers**

- Part No.:
- DRVW2430 (30 Watt)
 - DRVW2460 (60 Watt)
 - DRVW2496 (96 Watt)

Output Voltage: 24 V
Voltage Range: 120-277 VAC
IP Rating: Dry or Damp
UL Listed



**240W, 320W
Non-Dimming
Electronic Drivers**

- Part No.:
- DRVW24240 (240 Watt)
 - DRVW24320 (320 Watt)

Output Voltage: 24 V
Voltage Range: 90-305 VAC
IP Rating: Dry or Damp
UL Recognized



**40W
Lutron Hi-Lume 1% Dimming
Class 2 Drivers**

- Part No.:
- DRVLUT24403W (40 Watt, 3-wire)
 - DRVLUT24402W (40 Watt, 2-wire)

Output Voltage: 24 V
Voltage Range: 120-277 VAC (3-wire model)
or 120V (2-wire model)
IP Rating: Dry or Damp
Dimmable using 2-wire forward phase,
3-wire+G or digital EcoSystem
UL Listed



**96W
Lutron Hi-Lume Premier 0.1% Dimming
Class 2 Driver**

- Part No.:
- DRVLUT24963W (96 Watt, 3-wire)

Output Voltage: 24 V
Voltage Range: 120-277 VAC
IP Rating: Dry or Damp
Dimmable using 3-wire+G or digital EcoSystem
0.1% dimming SoftOn/FadeToBlack
with EcoSystem
UL Listed

MAGNETIC, ELV & MLV DRIVERS WITH COMPATIBLE DIMMERS



120 VAC

**60W, 96W, 200W, 300W
Class 1 & 2 Magnetic Drivers**

- Part No.:
- DRVWDIM2460 (60 Watt)
 - DRVWDIM24100 (96 Watt)
 - DRVWDIM24200 (200 Watt)
 - DRVWDIM24300 (300 Watt)

Magnetic Driver
Output Voltage: 24 V
Voltage Range: 120 VAC
IP Rating: Dry or Damp
Forward Phase Dimming
ETL Listed



277 VAC

**60W, 96W, 200W, 300W
Class 1 & 2 Magnetic Drivers**

- Part No.:
- DRVWDIM2460277 (60 Watt)
 - DRVWDIM24100277 (96 Watt)
 - DRVWDIM24200277 (200 Watt)
 - DRVWDIM24300277 (300 Watt)

Magnetic Driver
Output Voltage: 24 V
Voltage Range: 277 VAC
IP Rating: Dry or Damp
Forward Phase Dimming
ETL Listed



**60W, 96W, 150W, 200W
ELV & MLV Drivers**

- Part No.:
- DRVW2460ELV (60 Watt)
 - DRVW2496ELV (96 Watt)
 - DRVW24150ELV (150 Watt)
 - DRVW24200ELV (200 Watt)

Line Voltage Dimmable Drivers
Output Voltage: 24 V
Voltage Range: 100-130 VAC
IP Rating: Dry or Damp
Dimmable
ETL, UL and CSA Listed



LUTRON Skylark Contour Dimmer

Part No.: TRIDIMSKY
Width: 2.94 in (75 mm)
Length: 4.69 in (120 mm)
Depth: 0.30 in (7.6 mm)

- Single pole and 3-way versions
- Compatible with GENLED Acolyte MLV drivers
- Slide adjusts brightness and On/Off control
- 30 mA max control current
- Available in white finish



LUTRON NOVA-T Dimmer

Part No.: TRIDIMNOVA
Width: 2.75 in (70 mm)
Length: 4.56 in (116 mm)
Depth: 0.30 in (7.6 mm)

- Slide adjusts brightness and On/Off control
- 30 mA max control current
- Available in white finish



LUTRON DIVA Dimmer

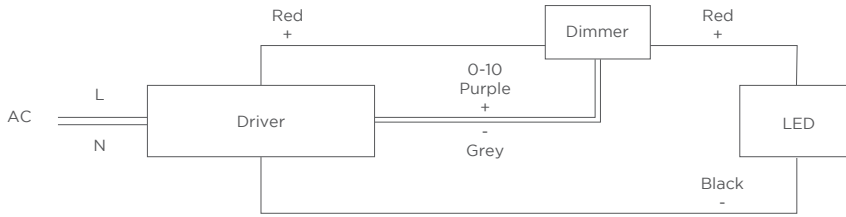
Part No.: TRIDIMDIVA
(With Locator Light) TRIDIMDIVAL
Width: 2.94 in (75 mm)
Length: 4.69 in (120 mm)
Depth: 0.30 in (7.6 mm)

- Large paddle switch with a captive linear-slide dimmer
- 30 mA max control current
- Available in white finish
- Available with locator light which glows green when the switch is off

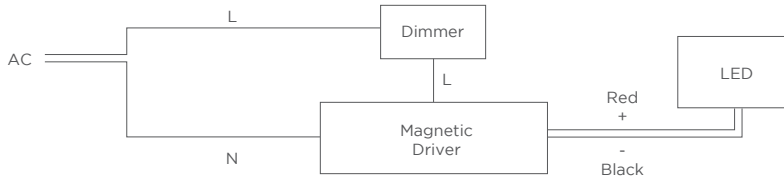
Note: For more options, please reference the Optional Dimmer List on GENLED Acolyte® product website page.

WIRING DIAGRAMS

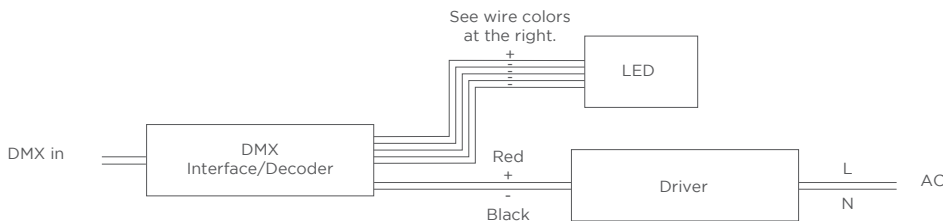
0-10V



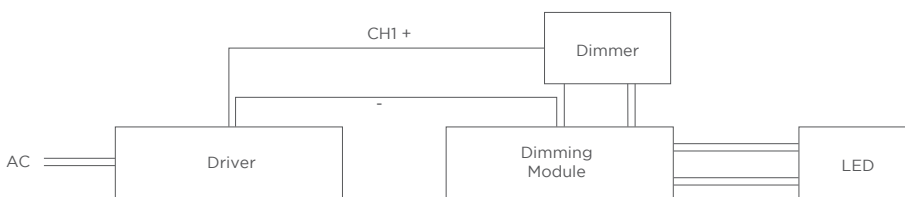
MAGNETIC + ELV



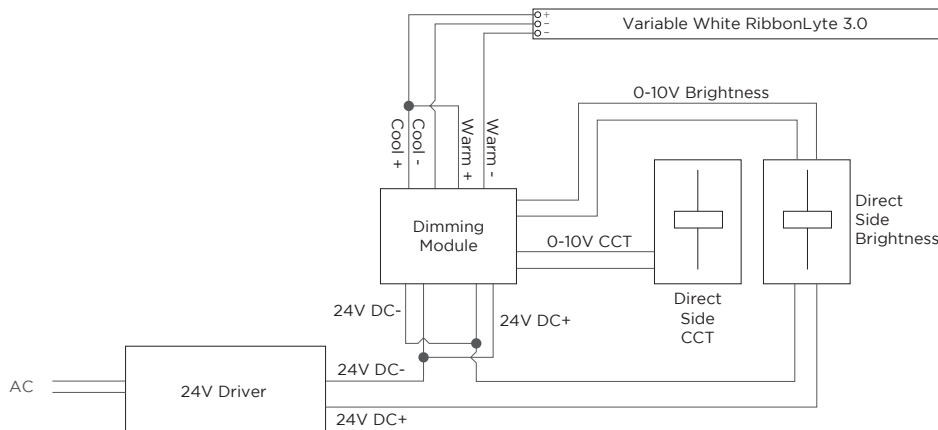
DMX



WARM DIM



2-CHANNEL VARIABLE WHITE DIMMING



WIRE COLORS PER RIBBONLYTE COLOR

STATIC WHITE + STATIC COLOR

Red Wire (+) Positive
Black Wire (-) Negative

RGB

Black Wire (+) Positive
Red Wire (-) Goes To Red Channel
Green Wire (-) Goes To Green Channel
Blue Wire (-) Goes To Blue Channel

RGBW/A

Black Wire (+) Positive
Red Wire (-) goes to Red Channel
Green Wire (-) goes to Green Channel
Blue Wire (-) goes to Blue Channel
White Wire (-) goes to White Channel

VARIABLE WHITE

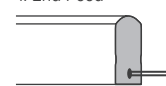
Black Wire (+) Positive
Red Wire (-) goes to Warm White Channel
Green Wire (-) goes to Cool White Channel

WARM DIM

Red Wire (-) goes to Warm White Channel
Blue Wire (-) goes to Cool White Channel
Black Wire (+) goes to Warm White Channel
Green Wire (+) goes to Cool White Channel

CONNECTION OPTIONS

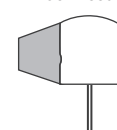
1. End Feed



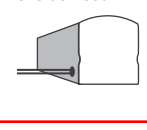
Default Option

Please specify if using a different connector type. Default option comes with 12 in. cable with bare wire if not specified.

2. Back Feed



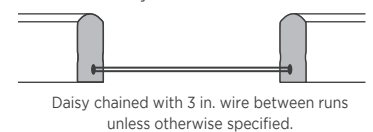
3. Side Feed



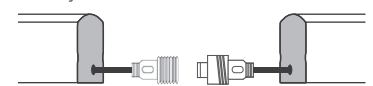
4. IP67 Connector Input



5. Soldered Daisy Chain



6. Daisy Chain with IP67 Connectors



MODEM SMALL PENDANT LED

SPECIFICATION SHEET

TYPE PL1-
Recruiting lounge

PAGE: 1 OF 4

Project name: _____

Type: _____



Pendant luminaire with direct light distribution that provides high efficacy lighting. Suitable for interior applications such as commercial spaces and display areas, where directional lighting is desired.

Luminaire characteristics:

Power input: 40.5W or 81W (13.5W per module)

Lumens: 895 to 1300 lm (per module)

Luminaire efficacy: 66 to 96 lm/W

Source: Bridgelux Vero 13 LED module, LM80 tested.

2700K: 90CRI, or 97CRI

3000K: 80CRI, 90CRI, or 97CRI

3500K: 80CRI, or 90CRI

4000K: 80CRI

Lumen maintenance: >90% of initial lumens at 123 000 hours (L90), (LM-79 tested).

Optics: Available in spot, narrow flood, flood, or wide flood (Field interchangeable optic). Each optical assembly is adjustable 45° in all axes.

Material:

Body: Aluminum extrusion.

Lamp holder: Die-cast aluminum.

Reflector: High-Bright anodized aluminum.

Suspension: Stainless steel aircraft cables.

Electrical: Integral high efficiency electronic power supply rated 50 000 hours, 120-277V.

Dimming: Available with 0-10V dimming (120-277V) or leading (TRIAC) and trailing edge (ELV) dimming (120V only).

Mounting: Supplied with 5' (1524mm) long aircraft suspension cables and a white painted canopy. To be installed on a standard 4" junction box.

For longer suspension cable, contact factory.

Finish: Gray RAL9006 painted finish.

Weight: TBC

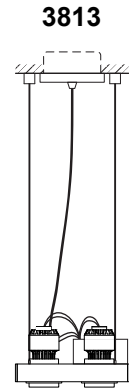
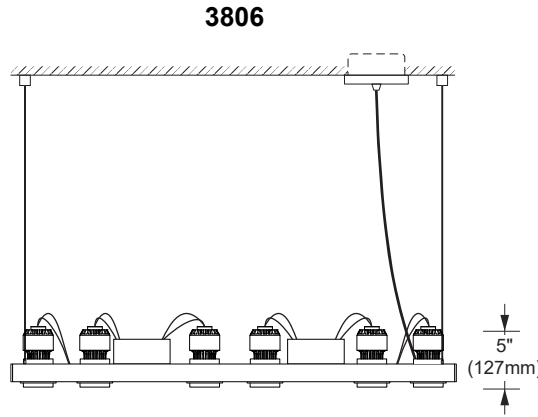
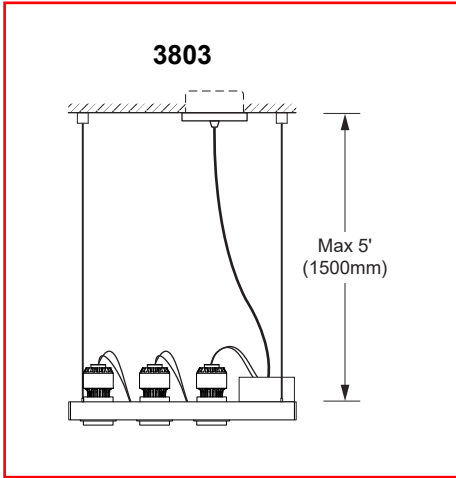
Warranty: 5 year limited warranty.

Certification: cULus listed for dry location.

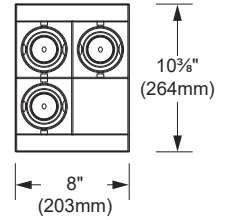
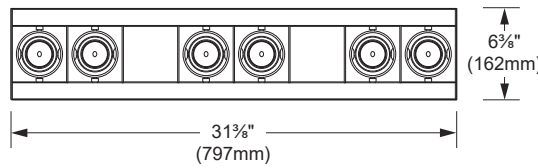
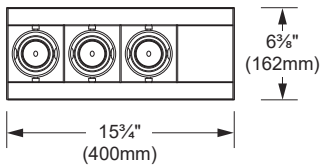
Project name: _____

Type: _____

MODELS

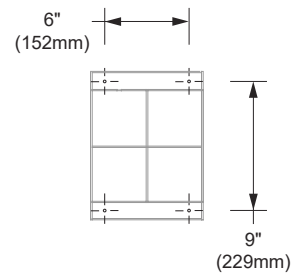
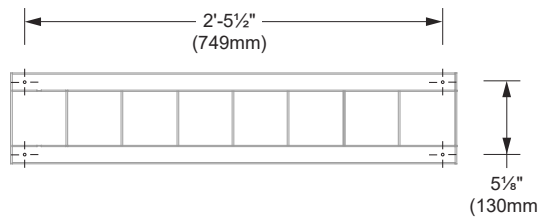
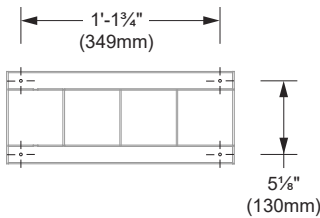


FRONT VIEW



BOTTOM VIEW

**MOUNTING
ANCHOR POINT LAYOUT**



MODEM SMALL PENDANT LED

TYPE PL1-
Recruiting lounge

SPECIFICATION SHEET

PAGE: 3 OF 4

Project name: _____

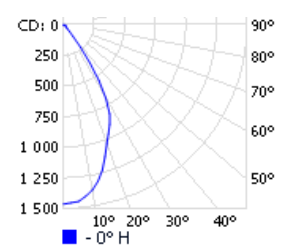
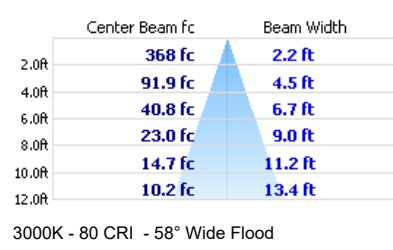
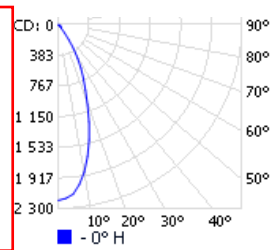
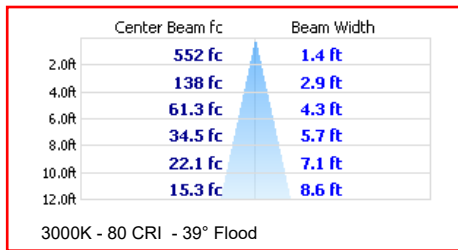
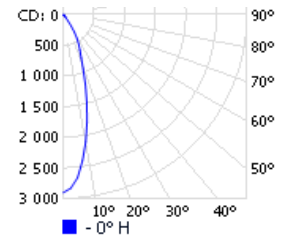
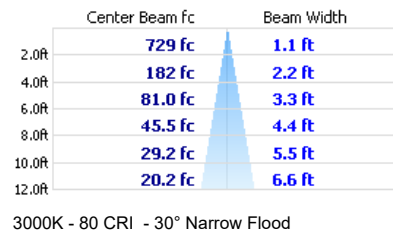
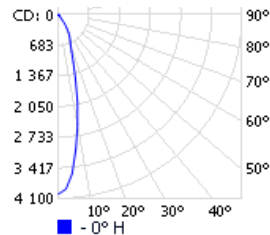
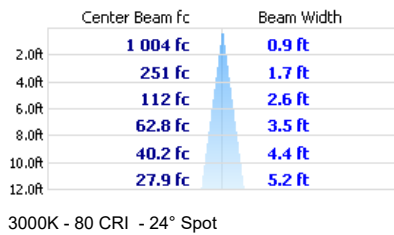
Type: _____

TECHNICAL DATA

Refer to one module only

Photometric performance is measured at an accredited independent laboratory in accordance with IESNA LM-79. Nominal data shown. Visit sistemalux.com for complete photometric data.

LOAD (W)	CCT (K)	CRI	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODEL
13.5W	3000K	80	Spot	1250	92	4015	38XX-W-830-20
			Narrow Flood	1195	88	2915	38XX-W-830-30
			Flood	1205	89	2205	38XX-W-830-40
			Wide Flood	1230	91	1470	38XX-W-830-60



*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

CCT options	2700K	2700K	3000K	3000K	3000K	3500K	3500K	4000K
CRI options	90CRI	97CRI	80CRI	90CRI	97CRI	80CRI	90CRI	80CRI
Multiplier	0.80	0.75	1	0.83	0.81	1.03	0.86	1.04

LED COLOR FIDELITY DATA

CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
80	3000K	82	92	97	83	83	90	84	61	12	81	82	75	85	99	75	86	96	0.52
	3500K	81	89	95	80	80	84	85	63	9	73	78	61	82	97	75	83	97	0.58
	4000K	80	88	93	81	80	83	87	66	10	71	79	56	82	96	74	83	95	0.67
90	2700K	91	94	93	90	89	91	93	82	60	83	89	74	91	95	88	89	101	0.44
	3000K	94	96	96	91	92	94	93	85	66	89	90	77	94	97	92	90	100	0.51
	3500K	95	98	96	92	93	94	94	88	74	91	91	74	96	97	94	90	99	0.65
97	2700K	99	99	98	98	99	97	95	92	84	98	97	89	99	98	98	94	102	0.50
	3000K	99	99	97	99	99	97	98	98	95	98	97	85	99	97	99	95	101	0.58


MODEM SMALL PENDANT LED


Project name: _____


Type: _____

ACCESSORIES (TO BE ORDERED SEPARATELY)

*Maximum of 1 accessory by optical assembly.


8050 - Frosted glass 

8675-02 - Black louver 

8111-02 - Black visor 

1740 - Interchangeable aluminum reflector, spot (20)

1741 - Interchangeable aluminum reflector, narrow flood (30)

1742 - Interchangeable aluminum reflector, flood (40) 

1743 - Interchangeable aluminum reflector, wide flood (60)

ORDERING INFO

MODEL	MOUNTING	LED	OPTIC	VOLTAGE	FINISH	DIMMING
<input checked="" type="radio"/> 3803 - 3 modules, line	H	<input type="radio"/> 927 - 2700K, 90CRI	<input type="radio"/> 20 - 24°	<input type="radio"/> UNV - 120-277V	<input checked="" type="radio"/> 10 - Gray	<input type="radio"/> D10 - 0-10V
<input type="radio"/> 3806 - 6 modules, line		<input type="radio"/> 027* - 2700K, 97CRI	<input type="radio"/> 30 - 30°	<input type="radio"/> 120 - 120V		<input type="radio"/> LTE - Leading and trailing edge dimming (120V only)
<input type="radio"/> 3813 - 3 modules, square		<input type="radio"/> 830 - 3000K, 80CRI	<input checked="" type="radio"/> 40 - 39°			
		<input type="radio"/> 930 - 3000K, 90CRI	<input type="radio"/> 60 - 58°			
		<input checked="" type="radio"/> 030* - 3000K, 97CRI				
		<input type="radio"/> 835 - 3500K, 80CRI				
		<input type="radio"/> 935 - 3500K, 90CRI				
		<input type="radio"/> 840* - 4000K, 80CRI				

* LED options not carried in our standard inventory and as such may require a longer lead time than standard. Please contact factory for details.

MODEM SMALL PENDANT LED

SPECIFICATION SHEET

TYPE PL2-
Recruiting lounge

PAGE: 1 OF 4

Project name: _____

Type: _____



Pendant luminaire with direct light distribution that provides high efficacy lighting. Suitable for interior applications such as commercial spaces and display areas, where directional lighting is desired.

Luminaire characteristics:

Power input: 40.5W or 81W (13.5W per module)

Lumens: 895 to 1300 lm (per module)

Luminaire efficacy: 66 to 96 lm/W

Source: Bridgelux Vero 13 LED module, LM80 tested.

2700K: 90CRI, or 97CRI

3000K: 80CRI, 90CRI, or 97CRI

3500K: 80CRI, or 90CRI

4000K: 80CRI

Lumen maintenance: >90% of initial lumens at 123 000 hours (L90), (LM-79 tested).

Optics: Available in spot, narrow flood, flood, or wide flood (Field interchangeable optic). Each optical assembly is adjustable 45° in all axes.

Material:

Body: Aluminum extrusion.

Lamp holder: Die-cast aluminum.

Reflector: High-Bright anodized aluminum.

Suspension: Stainless steel aircraft cables.

Electrical: Integral high efficiency electronic power supply rated 50 000 hours, 120-277V.

Dimming: Available with 0-10V dimming (120-277V) or leading (TRIAC) and trailing edge (ELV) dimming (120V only).

Mounting: Supplied with 5' (1524mm) long aircraft suspension cables and a white painted canopy. To be installed on a standard 4" junction box.

For longer suspension cable, contact factory.

Finish: Gray RAL9006 painted finish.

Weight: TBC

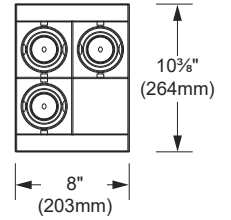
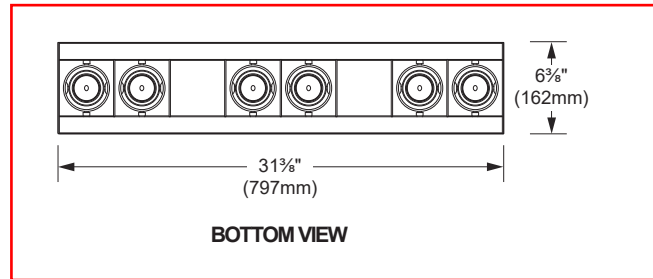
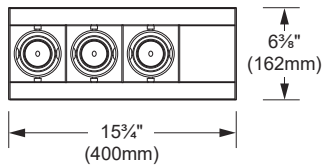
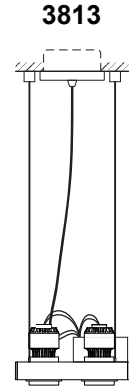
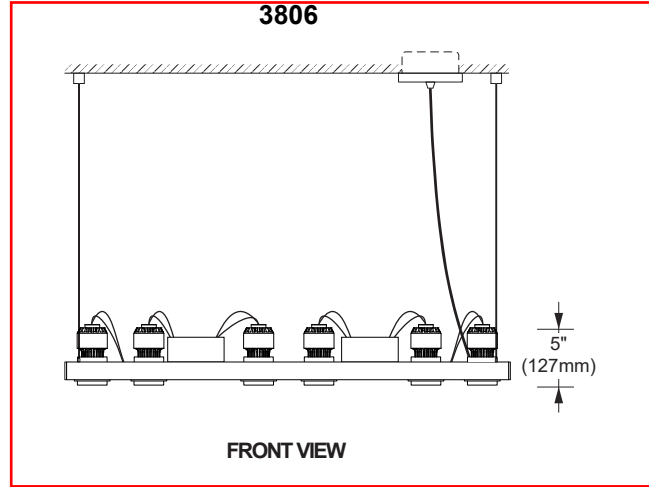
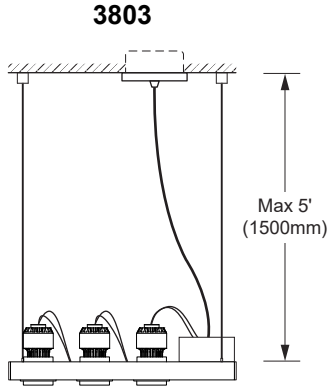
Warranty: 5 year limited warranty.

Certification: cULus listed for dry location.

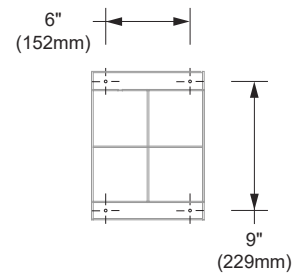
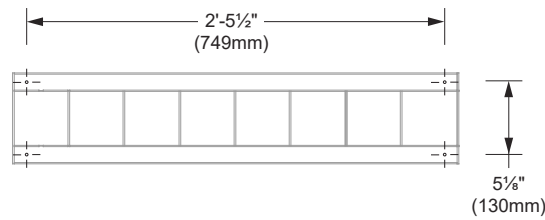
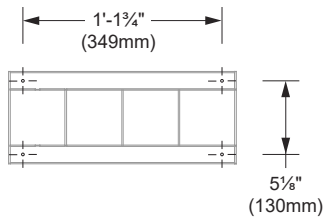
Project name: _____

Type: _____

MODELS



**MOUNTING
ANCHOR POINT LAYOUT**



MODEM SMALL PENDANT LED

Project name: _____

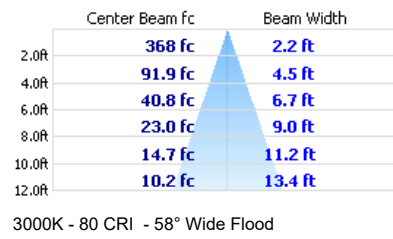
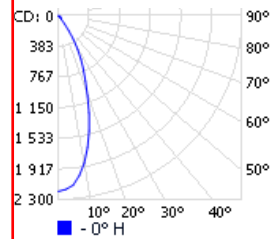
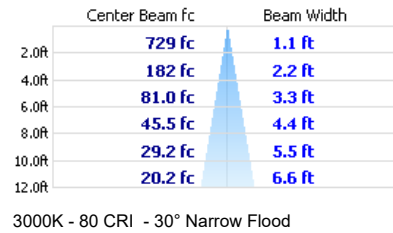
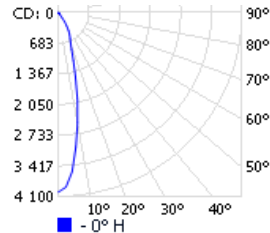
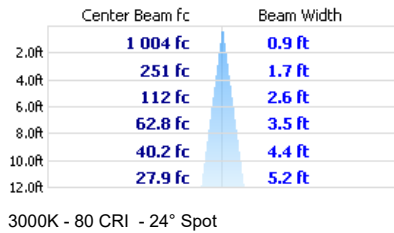
Type: _____

TECHNICAL DATA

Refer to one module only

Photometric performance is measured at an accredited independent laboratory in accordance with IESNA LM-79. Nominal data shown. Visit sistemalux.com for complete photometric data.

LOAD (W)	CCT (K)	CRI	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODEL
13.5W	3000K	80	Spot	1250	92	4015	38XX-W-830-20
			Narrow Flood	1195	88	2915	38XX-W-830-30
			Flood	1205	89	2205	38XX-W-830-40
			Wide Flood	1230	91	1470	38XX-W-830-60



*USE MULTIPLIER TABLE FOR OTHER CCT AND CRI OUTPUT DATA

CCT options	2700K	2700K	3000K	3000K	3000K	3500K	3500K	4000K
CRI options	90CRI	97CRI	80CRI	90CRI	97CRI	80CRI	90CRI	80CRI
Multiplier	0.80	0.75	1	0.83	0.81	1.03	0.86	1.04

LED COLOR FIDELITY DATA

CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
80	3000K	82	92	97	83	83	90	84	61	12	81	82	75	85	99	75	86	96	0.52
	3500K	81	89	95	80	80	84	85	63	9	73	78	61	82	97	75	83	97	0.58
	4000K	80	88	93	81	80	83	87	66	10	71	79	56	82	96	74	83	95	0.67
90	2700K	91	94	93	90	89	91	93	82	60	83	89	74	91	95	88	89	101	0.44
	3000K	94	96	96	91	92	94	93	85	66	89	90	77	94	97	92	90	100	0.51
	3500K	95	98	96	92	93	94	94	88	74	91	91	74	96	97	94	90	99	0.65
97	2700K	99	99	98	98	99	97	95	92	84	98	97	89	99	98	98	94	102	0.50
	3000K	99	99	97	99	99	97	98	98	95	98	97	85	99	97	99	95	101	0.58


MODEM SMALL PENDANT LED


Project name: _____


Type: _____

ACCESSORIES (TO BE ORDERED SEPARATELY)

*Maximum of 1 accessory by optical assembly.


8050 - Frosted glass 

8675-02 - Black louver 

8111-02 - Black visor 

1740 - Interchangeable aluminum reflector, spot (20)

1741 - Interchangeable aluminum reflector, narrow flood (30)

1742 - Interchangeable aluminum reflector, flood (40) 

1743 - Interchangeable aluminum reflector, wide flood (60)

ORDERING INFO

MODEL	MOUNTING	LED	OPTIC	VOLTAGE	FINISH	DIMMING
<input type="radio"/> 3803 - 3 modules, line	H	<input type="radio"/> 927 - 2700K, 90CRI	<input type="radio"/> 20 - 24°	<input type="radio"/> UNV - 120-277V	<input checked="" type="radio"/> 10 - Gray	<input type="radio"/> D10 - 0-10V
<input checked="" type="radio"/> 3806 - 6 modules, line		<input type="radio"/> 027* - 2700K, 97CRI	<input type="radio"/> 30 - 30°	<input type="radio"/> 120 - 120V		<input type="radio"/> LTE - Leading and trailing edge dimming (120V only)
<input type="radio"/> 3813 - 3 modules, square		<input type="radio"/> 830 - 3000K, 80CRI	<input checked="" type="radio"/> 40 - 39°			
		<input type="radio"/> 930 - 3000K, 90CRI	<input type="radio"/> 60 - 58°			
		<input checked="" type="radio"/> 030* - 3000K, 97CRI				
		<input type="radio"/> 835 - 3500K, 80CRI				
		<input type="radio"/> 935 - 3500K, 90CRI				
		<input type="radio"/> 840* - 4000K, 80CRI				

* LED options not carried in our standard inventory and as such may require a longer lead time than standard. Please contact factory for details.





GENERAL SPECIFICATION

Product Overview:

- Design Patent Pending Le Louvre features a stunning three-dimensional diagonal louver structure that gives the profile a closed appearance when the light is switched off and an open appearance when the light source is on.
- Compared to basic diffuser-based downlight solutions, Le Louvre also has the advantage of offering improved visual comfort with a Unified Glare Rating (UGR) less than 9.
- Indirect batwing optics are offered as standard.
- Industry-leading 141 Lumens Per Watt.
- Choose from five different louvre finishes, Frosted, for high performance, Black for dark light, or Satin Chrome, Satin Gold or Satin Champagne for high-end interiors.
- Available in four lengths, 4, 6, 8 and 12ft, either stand-alone or continuous runs.
- Our robust connection mechanism delivers seamless joints with zero light leak.
- Numerous decorative finishes including wood grain options.

Body: Aluminum.

Finish: Powder coated

Suspension: Steel cables.

Power cable: Silver braided.

Diffuser: Opal acrylic.

Drivers: HPF electronic drivers for 120-277V, 347V (EU-240V).

Integral Emergency system: Emergency option provides a 1.5 hour (3 hours for EU) emergency lighting facility. The self contained system includes the inverter module, NiCad batteries, LED charge indicator and test switch (NA only). Not available with a 347V supply.

PoE: Can be integrated into your data network via Power over Ethernet (PoE) connectivity.

Mechanical: Luminaires mount directly over J box (by others).

Reported L70 @25deg C (77deg F): > 60,000 hrs @ 2000 lumens/ft (6000 lumens/m)

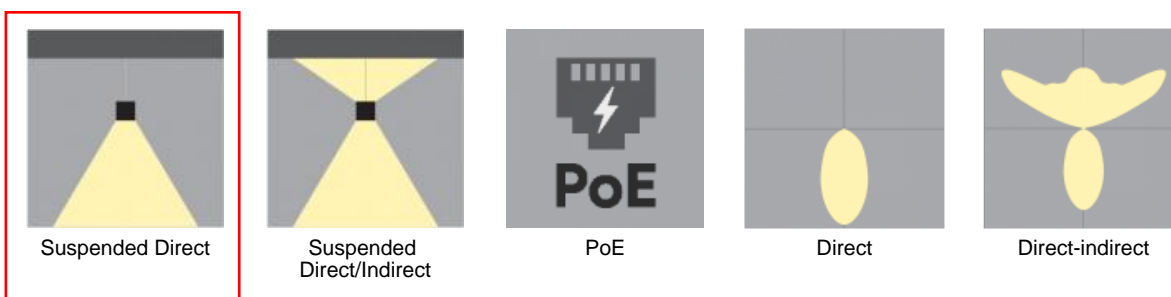
Estimated L70 @25deg C (77deg F): > 165,000 hrs @ 2000 lumens/ft (6000 lumens/m)

Delivered lumens: Delivered lumens & LPW based on 4000K CRI 80+

Approvals: Damp Location (Indoor use only).

Design: US Design Patent Pending.

MOUNTING & OPTICS



HOW TO ORDER

A SPECIFY LUMINAIRE

Code	Light Direction
LPL1P	Direct
LPL2P	Direct/Indirect

B SPECIFY LENGTH OF RUN

SFA -- various lengths

Additional Information

The minimum length of order is 4ft. Lengths are to be in 2ft increments.

- Example: 4ft = SFA400
- Example: 10ft = SFA100
- Example: 50ft = SFA500

C SPECIFY MAX LENGTH PER SECTION

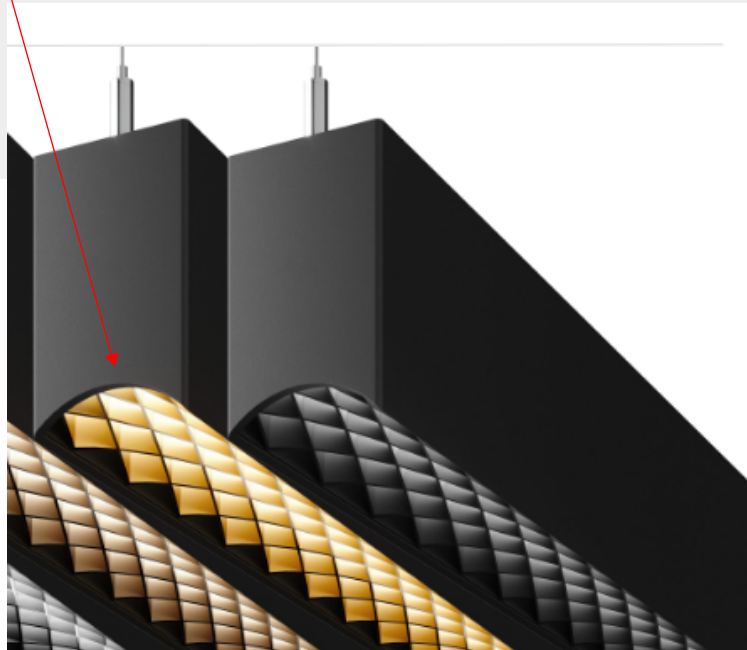
SL04	4ft
SL06	6ft
SL08	8ft
SL12	12ft

Additional Information

Maximum length an individual section can be in order to accommodate the size constraints within a building. Example: 40ft run required, however, the longest an individual section can be is 8ft.

D SPECIFY LOUVER

LV1	Frosted
LV2	Black
LV4	Satin Chrome
LV6	Satin Gold
LV9	Satin Champagne



E SPECIFY LM/FT (DIRECT)

LPF010	100 lm/ft
LPF020	200 lm/ft
LPF030	300 lm/ft
LPF040	400 lm/ft
LPF050	500 lm/ft
LPF060	600 lm/ft
LPF070	700 lm/ft
LPF080	800 lm/ft
LPF100	1000 lm/ft
LPF120	1200 lm/ft

Additional Information

Consult website for available lumens/ft.

F SPECIFY LM/FT (INDIRECT)

LPG000	Not required
LPG025	250 lm/ft
LPG050	500 lm/ft
LPG075	750 lm/ft
LPG100	1000 lm/ft
LPG120	1200 lm/ft
LPG160	1600 lm/ft

Additional Information

Consult website for available lumens/ft.

G SPECIFY CRI

CR80	CRI 80+
CR90	CRI 90+

H SPECIFY CCT (DIRECT)

CTA30	3000K
CTA35	3500K
CTA40	4000K

I SPECIFY CCT (INDIRECT)

CTB00	Not required
CTB30	3000K
CTB35	3500K
CTB40	4000K

J SPECIFY UPLIGHT DIFFUSER

UD0	Not required
UD1	Clear diffuser (Batwing)

Additional Information

¹ Available on a per/ft basis, consult factory

K SPECIFY UPLIGHT BLACKOUT PLATE

UB00	Not required
UB__	Blackout plate ¹

Additional Information

¹ Available on a per foot basis. May be required to prevent lighting up duct work in a loft type application.

L SPECIFY VOLTAGE

V1	120/277V
V2	240V ¹
V3	347V ²
V4	Low Voltage ³

Additional Information

¹ Not available in North America.

² Only available with DA01 dimming.

³ Only available with DA45 dimming.

M SPECIFY DIMMING

DA00	Not required
DA01	0-10V Dimming 1.0%
DA02	0-10V Dimming 0.1% ¹
DA20	DALI Dimming 0.1% ¹
DA21	DALI Dimming 1.0% ¹
DA30	DSI/switchDim ²
DA45	PoE ³

Additional Information

¹ Not available with 347V.

² Not available in North America.

N SPECIFY CEILING TYPE

G1	Grid ceiling ¹
H1	Hard ceiling ²

Additional Information

The cost for the canopies, power cables, connections mechanisms and endcaps for the fixture has been added to these items.

¹ Combo kit provided includes installation to T-bar and through tile mount.

² Consists of drywall and concrete ceilings.

O SPECIFY SUSPENSION

- HLA03 3ft cable suspension
- HLA06 6ft cable suspension
- HLA09 9ft cable suspension

P SPECIFY FIXTURE FINISH

- FA01 White
- FA02 Black Metallic - Textured
- FA20 Silver Metallic - Textured
- FA25 Gold Metallic
- FA27 Wood grain - Light Cherry ¹
- FA28 Wood grain - Dark Walnut ¹
- FA44 Midnight Blue Metallic - Textured
- FA45 Copper Metallic
- FA46 Charcoal Metallic - Textured
- FA47 Bronze Metallic - Textured
- FA52 Champagne Metallic
- FA53 Red Metallic - Textured

Additional Information

¹ Longer lead times may apply, consult factory.

Q SPECIFY CANOPY FINISH

- CF01 White
- CF02 Black Metallic - Textured
- CF20 Silver Metallic - Textured
- CF25 Gold Metallic
- CF44 Midnight Blue Metallic - Textured
- CF45 Copper Metallic
- CF46 Charcoal Metallic - Textured
- CF47 Bronze Metallic - Textured
- CF52 Champagne Metallic
- CF53 Red Metallic - Textured

R SPECIFY QUANTITY OF EMERGENCY SECTIONS

- EO Not required
- ES__ Emergency system - Integral ¹
- EG__ Emergency generator circuit ¹

Additional Information

¹ Specify quantity of emergency sections or emergency generator circuits required based off total length of run. Not available with 347V. A drawing will be required at time of ordering to determine the required location of the emergency sections or generator circuits.

S SPECIFY CIRCUITS

CS1 Single circuit
CS2 Dual circuit

Additional Information

¹ Independent control of uplight for LELP2P.

T SPECIFY SENSOR AND QUANTITY OF SENSOR SECTIONS

SR00 Not required

In Canopy Sensors *

SR__ Enlighted
ST__ Osram Encelium
SV__ Philips ¹

Additional Information

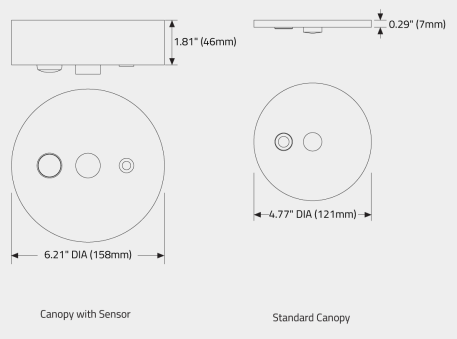
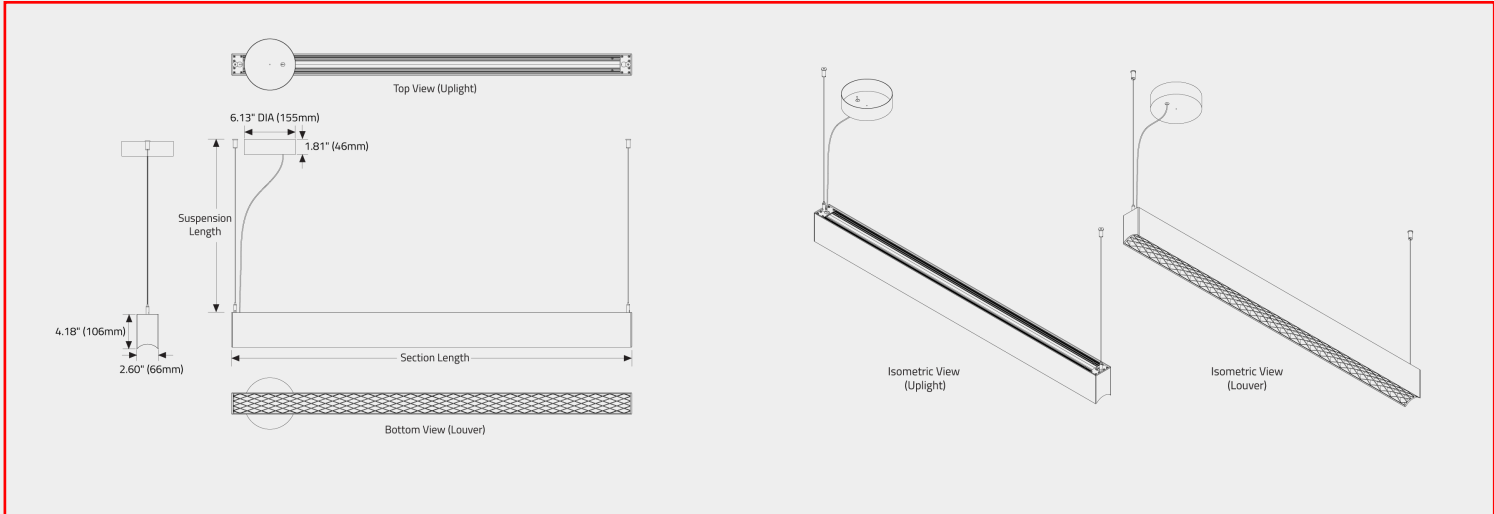
* Specify quantity of sensor sections required based off total length of run. A drawing will be required at time of ordering to determine the required location of the sensors.

¹ Not available with 347V.

EXAMPLE CODE

LELP2PSF0400/SL06/LV1/LPF070/LPG120/CR80/CTA35/CTB35/UD1/UB00/V1/DA01/H1/HLA06/FA27/CF01/EG04/CS2/SR00

DIMENSIONAL DIAGRAMS



APPROVALS



Project:

Location:

Fixture Type:

Catalog Number:



AVAILABLE FINISHES:



Marimba

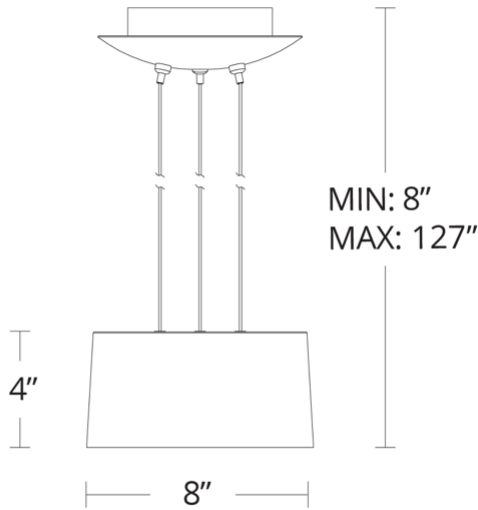
PD-52708

FEATURES

- Transformer concealed within the canopy
- Hand-leafed interior
- Thin powered aircraft cables provide an ultra clean look for adjustable suspension height
- Twist-lock opal glass diffuser for easy removal

SPECIFICATIONS

Rated Life	50000 Hours
Standards	ETL, cETL,Damp Location Listed
Input	120 VAC,50/60Hz
Dimming	ELV
Color Temp	3000K
CRI	90
Construction	Steel body and Opal glass diffuser



PD-52708

Model & Size	Color Temp	Finish	LED Watts	LED Lumens	Delivered Lumens
○ PD-52708 8"	3000K	○ GL Gold Leaf/Bronze	14W	753	278
	3000K	○ SL Silver Leaf/White	14W	753	278

Example: **PD-52708-SL**

For custom requests please contact customs@modernforms.com

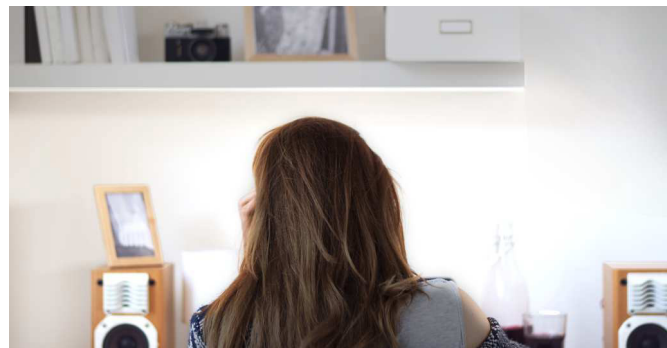
Date _____ Project _____

Notes _____

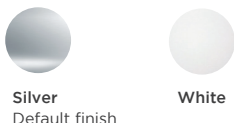
AR16 CHANNEL FIXTURE

Our AR16 Channel Fixture is a recessed fixture with a 110-degree beam angle. We offer choices of clear, milky and black lenses to create a full range of light output options. Design a custom fixture for walls, ceilings, cabinets and shelving with AR16 Channel Fixture and our RibbonLyte products.

- 1.1 in. (28 mm) wide by 0.73 in. (18.6 mm) deep
- 110-degree beam angle
- Wattage Range from 0.75 W/ft (2.46 W/m) to 8.8 W/ft (28.86 W/m)
- Static White delivered lumen range from 85 lm/ft (279 lm/m) up to 729 lm/ft (2391 lm/m)
- Available in silver, white or custom colors
- Clear Lens, Milky Lens or Black Lens



HOUSING FINISHES



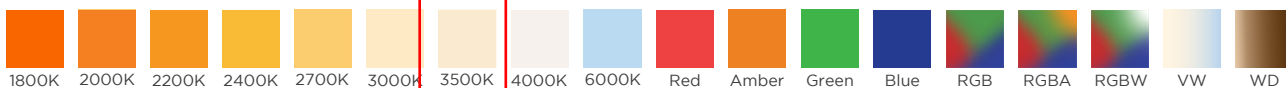
LENS FINISHES



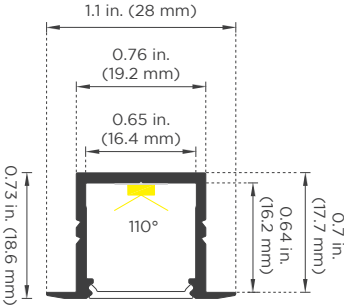
* Our black lens offers great diffusion and helps hide fixtures that aren't in use.



AVAILABLE COLORS & COLOR TEMPERATURES



DIMENSIONS

AR16 Channel	Mounting Clip		Spring Clip	
 <p>Width: 1.1 in. (28 mm) Height: 0.73 in. (18.6 mm) Internal Width: 0.65 in. (16.4 mm) Internal Height: 0.64 in. (16.2 mm)</p>	<p>Side View 0.79 in. (20 mm) 0.43 in. (11 mm)</p> <p>Top View 0.79 in. (20 mm) 0.98 in. (25 mm)</p> <p>Assembled View 0.83 in. (21 mm) 0.75 in. (19 mm)</p> <p>Width: 0.79 in. (20 mm) Length: 0.98 in. (25 mm)</p>	<p>Front View 0.79 in. (20 mm) 1.5 in. (38 mm)</p> <p>Side View 2.66 in. (67.5 mm) 0.55 in. (14 mm) 1.77 in. (45 mm) 0.42 in. (10.7 mm) 0.98 in. (25 mm)</p> <p>Width: 0.98 in. (25 mm) Height: 1.77 in. (45 mm)</p>		

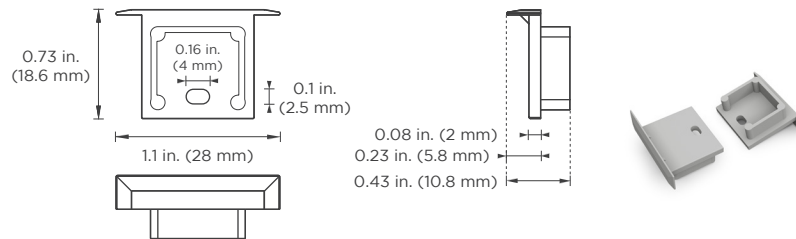
GENLED Acolyte[®] does not warrant or represent that the information is free from errors or omission. The information may change without notice and GENLED Acolyte[®] is not in any way liable for the accuracy of any information printed and stored or in any way interpreted or used.

SPECIFICATIONS

Beam Angle	110°
Lens Type	Clear Lens, Milky Lens, Black Lens
Length	Channel is sold by the foot and cut to your exact desired length. Required amount of mounting clips included.
Operating Voltage	24V
Dimming	MLV / 0-10 Volt / Lutron Hi-Lume 1% dimming LED drivers / Lutron VIVE code compliance available / ELV / DALI / DMX
Operating Temperature	-40° F to 158° F (-40° C to 70° C)
Colors	1800K, 2000K, 2200K, 2400K, 2700K, 3000K, 3500K, 4000K, 6000K, Red, Amber, Green, Blue, RGB, RGBA, RGBW, VW, Warm Dim (1800K, 2000K, 2200K only available in IP20)
CRI	90+ CRI (Static white only)
Lamp Life	L70 at 50,000 Hours
MacAdam Ellipses (SDCM)	2-Step Binning (For Static White LEDs only)
Certifications	ETL Listed: UL 2108 Issued: 2004/02/27 Ed: 1 Rev: 2014/02/24 Low Voltage Lighting Systems CSA C22.2#9.0 Issued: 1996/06/01 Ed: 1 (R2011) General Requirements for Luminaires; with Gen. Inst. 1: 1997, Gen Inst. 2: 1998. ROHS compliant UL 2108 - Low Voltage Lighting Systems UL 8750 - Light Emitting Diode (LED) Equipment for Use in Lighting Products UL 1598 / CSA 250.0-08 - Luminaires

ACCESSORIES

End Caps



ORDERING GUIDE

STEP 1 Complete Channel Part Number

CHANNEL	LENS	HOUSING COLOR	MOUNTING TYPE
CHAR16			
CHAR16 - AR16 Channel	C - Clear Lens M - Milky Lens BK - Black Lens	SV - Silver WH - White	C - Mounting Clips S - Spring Clips

STEP 2 Complete RibbonLyte Part Number

CATEGORY	CRI	RIBBON TYPE & IP RATING		
RB				
RB - RibbonLyte	0 - Static Color, Color Changing 90 - 90+ CRI Static White	SWS220 - Static White Series 2 IP20 SWS265 - Static White Series 2 IP65 SWS268 - Static White Series 2 IP68 SCS220 - Static Color Series 2 IP20 SCS265 - Static Color Series 2 IP65 SCS268 - Static Color Series 2 IP68	RGB20 - RGB IP20 RGB65 - RGB IP65 RGB68 - RGB IP68 RGBWA20 - RGBW/A IP20 RGBWA65 - RGBW/A IP65 VWS220 - VW Series 2 IP20	VWS265 - VW Series 2 IP65 VWS268 - VW Series 2 IP68 WD20 - Warm Dim IP20 WD65 - Warm Dim IP65 WD68 - Warm Dim IP68

WATTAGE

- 0.75 - 0.75 W/ft (2.46 W/m - Static White, Static Color)
- 1.0 - 1.0 W/ft (3.3 W/m - Variable White)
- 1.5 - 1.5 W/ft (4.9 W/m - Static White, Static Color)
- 2.2 - 2.2 W/ft (7.2 W/m - Static White, Static Color, RGB)
- 3.0 - 3.0 W/ft (9.8 W/m - Static White, Static Color, Variable White)
- 4.4 - 4.4 W/ft (14.4 W/m - Static White, Static Color, RGB, RGBW/RGBA)
- 5.2 - 5.2 W/ft (17.1 W/m - Warm Dim)
- 5.0 - 5.0 W/ft (16.4 W/m - Static White, Static Color)
- 5.5 - 5.5 W/ft (18.0 W/m - RGBW/RGBA)
- 6.0 - 6.0 W/ft (19.7 W/m - Static White, Static Color, Variable White)
- 8.8 - 8.8 W/ft (28.86 W/m - RGB)

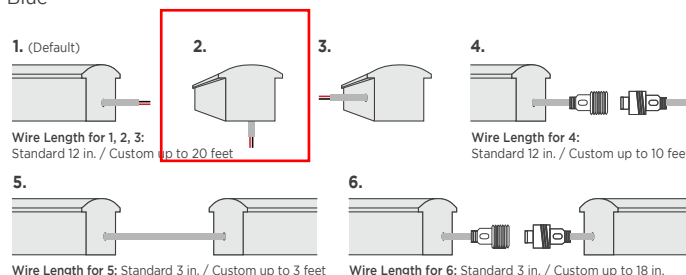
COLOR

- 18 - 1800K
 - 20 - 2000K
 - 22 - 2200K
 - 24 - 2400K
 - 27 - 2700K
 - 30 - 3000K
 - 35 - 3500K
 - 40 - 4000K
 - 60 - 6000K
 - R - Red
 - A - Amber
 - G - Green
 - B - Blue
 - RGB - Red, Green, Blue
 - RGB30 - Red, Green, Blue + 3000K
 - RGB40 - Red, Green, Blue + 4000K (5.5W only)
 - RGB60 - Red, Green, Blue + 6000K
 - RGBA - Red, Green, Blue + Amber
 - VW - Variable White
 - 2920 - Warm Dim 2900K-2000K (IP20)
 - 2721 - Warm Dim 2900K-2000K (IP65)
 - Z - Undecided**
- ** For quotes only. Must be chosen before final order.

CONNECTION OPTIONS (See diagrams on the right)

- 1 - End Feed Bare Wire Connection
- 2 - Back Feed Bare Wire Connection
- 3 - Side Feed Bare Wire Connection
- 4 - End Feed with IP67 Male Connector
- 5 - Soldered Daisy Chain
- 6 - Daisy Chain With IP67 Connectors

with 20 foot leads-
vertical to horizontal runs abut each other.
horizontal to horizontal 90 degree bends to be
mitered at 45 degrees



ASSEMBLY OPTIONS



ON-SITE ASSEMBLY

Cut to length with soldered leads, assembled on-site

BENEFITS:

- Run Lengths can be trimmed in the field
- Last-minute adjustments
- Shorter lead time



FACTORY ASSEMBLY

Pre-assembled factory-finished fixtures (Max assembled length is 78 in.)

BENEFITS:

- Easy and quick installation
- Shipped as a complete unit
- Plug-and-play installation

SPECIFICATIONS

Available Wattages	Cuttable Length	LED Pitch	Color Temp.	lm/W without Lens	Delivered Lumens with Clear Lens (lm/ft / lm/m)	Delivered Lumens with Milky Lens (lm/ft / lm/m)	Delivered Lumens with Black Lens (lm/ft / lm/m)	Standard Cable Length	Compatible with Channel		
									IP20	IP65	IP68
0.75 Static White Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	1800K	84	59 / 192	21 / 70	41 / 134	12 in. (30.5 cm)	✓	✓	✓
			2000K	99	69 / 227	25 / 83	69 / 227				
			2200K	109	76 / 249	28 / 91	76 / 249				
			2400K	113	79 / 259	29 / 95	79 / 259				
			2700K	123	86 / 281	31 / 103	86 / 281				
			3000K	123	86 / 281	31 / 103	86 / 281				
			3500K	130	91 / 297	33 / 109	91 / 297				
			4000K	134	93 / 307	34 / 112	93 / 307				
			6000K	131	91 / 300	33 / 110	91 / 300				
1.5 Static White Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	1800K	84	117 / 384	43 / 141	117 / 384	12 in. (30.5 cm)	✓	✓	✓
			2000K	98	137 / 384	50 / 164	137 / 449				
			2200K	109	152 / 499	56 / 182	152 / 499				
			2400K	113	158 / 517	58 / 189	158 / 517				
			2700K	123	172 / 563	63 / 206	172 / 563				
			3000K	123	172 / 563	63 / 206	172 / 563				
			3500K	129	180 / 590	66 / 216	180 / 590				
			4000K	134	187 / 613	68 / 224	187 / 613				
			6000K	131	183 / 600	67 / 219	183 / 600				
2.2 Static White Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	1800K	83	169.8 / 557	62 / 204	169.8 / 557	12 in. (30.5 cm)	✓	✓	✓
			2000K	96	196.4 / 644	72 / 236	196.4 / 644				
			2200K	106	216.9 / 712	79 / 260	216.9 / 712				
			2400K	111	227.1 / 745	83 / 272	227.1 / 745				
			2700K	120	245.5 / 806	90 / 294	245.5 / 806				
			3000K	122	249.6 / 819	91 / 299	249.6 / 819				
			3500K	127	259.8 / 852	95 / 312	259.8 / 852				
			4000K	133	272.1 / 893	99 / 326	272.1 / 893				
			6000K	128	261.9 / 859	96 / 314	261.9 / 859				
3.0 Static White Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	1800K	84	234 / 769	86 / 281	234 / 769	12 in. (30.5 cm)	✓	✓	✓
			2000K	98	273 / 897	100 / 328	273 / 897				
			2200K	108	301 / 989	110 / 361	301 / 989				
			2400K	109.8	306 / 1005	112 / 367	306 / 1005				
			2700K	122.9	343 / 1125	125 / 411	343 / 1125				
			3000K	130	363 / 1190	133 / 435	363 / 1190				
			3500K	133	371 / 1217	136 / 445	371 / 1217				
			4000K	133	371 / 1217	136 / 445	371 / 1217				
			6000K	127	357 / 1172	131 / 428	357 / 1172				
4.4 Static White Series 2	1.97 in. (50 mm)	48 LEDs/ft (160 LEDs/m)	1800K	121	331 / 1087	121 / 398	331 / 1087	12 in. (30.5 cm)	✓	✓	✓
			2000K	142	389 / 1275	142 / 466	389 / 1275				
			2200K	157	430 / 1410	157 / 515	430 / 1410				
			2400K	109	446 / 1463	163 / 535	446 / 1463				
			2700K	122	499 / 1638	183 / 599	499 / 1638				
			3000K	129	528 / 1732	193 / 633	528 / 1732				
			3500K	132	540 / 1772	197 / 648	540 / 1772				
			4000K	132	540 / 1772	197 / 648	540 / 1772				
			6000K	126	516 / 1692	188 / 618	516 / 1692				
5.0 Static White Series 2	1.4 in. (35.7 mm)	68 LEDs/ft (224 LEDs/m)	1800K	141	386 / 1266	141 / 462	386 / 1266	12 in. (30.5 cm)	✓	✓	✓
			2000K	167	456 / 1495	167 / 547	456 / 1495				
			2200K	182	498 / 1632	182 / 597	498 / 1632				
			2400K	109.8	511 / 1675	187 / 612	511 / 1675				
			2700K	122.9	571 / 1875	209 / 685	571 / 1875				
			3000K	130	605 / 1983	221 / 725	605 / 1983				
			3500K	133	618 / 2029	226 / 742	618 / 2029				
			4000K	133	618 / 2029	226 / 742	618 / 2029				
			6000K	127	591 / 1937	216 / 708	591 / 1937				

SPECIFICATIONS

Available Wattages	Cutttable Length	LED Pitch	Color Temp.	lm/W without Lens	Delivered Lumens with Clear Lens (lm/ft / lm/m)	Delivered Lumens with Milky Lens (lm/ft / lm/m)	Delivered Lumens with Black Lens (lm/ft / lm/m)	Standard Cable Length	Compatible with Channel		
									IP20	IP65	IP68
2.2 RGB	6.55 in. (166.4 mm)	9 LEDs/ft (30 LEDs/m)	RGB	37	75.7 / 248	27.7 / 91	75.7 / 248	12 in. (30.5 cm)	✓	✓	✓
4.4 RGB	3.94 in. (100 mm)	18 LEDs/ft (60 LEDs/m)	RGB	37	75.7 / 249	27.7 / 91	75.7 / 248	12 in. (30.5 cm)	✓	✓	✓
8.8 RGB	1.97 in. (50 mm)	18 LEDs/ft (60 LEDs/m)	RGB	37	302.8 / 993	97.2 / 319	302.8 / 993	12 in. (30.5 cm)	✓	✓	
4.4 RGBW	6.55 in. (166.4 mm)	18 LEDs/ft (60 LEDs/m)	RGBW	65	266 / 873	49.4 / 162	266 / 873	12 in. (30.5 cm)	✓	✓	✓
4.4 RGBA	6.55 in. (166.4 mm)	18 LEDs/ft (60 LEDs/m)	RGBA	33	135 / 443	95.4 / 313	135 / 443	12 in. (30.5 cm)	✓	✓	✓
5.5 4-in-1 RGBW	3.94 in. (100 mm)	18 LEDs/ft (60 LEDs/m)	RGBW	51	260.9 / 856	50.5 / 166	135 / 443	12 in. (30.5 cm)	✓	✓	✓
5.5 4-in-1 RGBA	3.94 in. (100 mm)	18 LEDs/ft (60 LEDs/m)	RGBA	27	138.1 / 453	110.7 / 363	260.9 / 856	12 in. (30.5 cm)	✓	✓	✓
5.2 Warm Dim	3.94 in. (100 mm)	36 LEDs/ft (120 LEDs/m)	WARM DIM	55	266 / 873	97.2 / 319	266 / 873	12 in. (30.5 cm)	✓	✓	✓

DIODE VISIBILITY CHART (Data below applies to installations with Milky lens only)



No Visible Diode = N



With Visible Diode = Y

Static White & Static Color RibbonLyte			Color Changing RibbonLyte						
0.75/1.5/2.2	3.0/4.4	5.0/6.0	2.2 RGB	4.4 RGB	8.8 RGB	4.4 RGBW/A	5.5 4-in-1 RGBW/A	Warm Dim	Variable White
IP20 IP65 IP68	IP20 IP65 IP68	IP20 IP65 IP68	IP20 IP65 IP68	IP20 IP65 IP68	IP20 IP65	IP20 IP65 IP68	IP20 IP65 IP68	IP20 IP65 IP68	IP20 IP65 IP68
N	N	N	Y	N	N	N	N	N	N



AVAILABLE DRIVERS

NON-DIMMING ELECTRONIC DRIVERS



**30W, 60W, 96W
Non-Dimming Electronic
Class 2 Drivers**

- Part No.:
- DRVW2430 (30 Watt)
 - DRVW2460 (60 Watt)
 - DRVW2496 (96 Watt)

Output Voltage: 24 V
Voltage Range: 120-277 VAC
IP Rating: Dry or Damp
UL Listed



**240W, 320W
Non-Dimming
Electronic Drivers**

- Part No.:
- DRVW24240 (240 Watt)
 - DRVW24320 (320 Watt)

Output Voltage: 24 V
Voltage Range: 90-305 VAC
IP Rating: Dry or Damp
UL Recognized



**40W
Lutron Hi-Lume 1% Dimming
Class 2 Drivers**

- Part No.:
- DRVLUT24403W (40 Watt, 3-wire)
 - DRVLUT24402W (40 Watt, 2-wire)

Output Voltage: 24 V
Voltage Range: 120-277 VAC (3-wire model)
or 120V (2-wire model)
IP Rating: Dry or Damp
Dimmable using 2-wire forward phase,
3-wire+G or digital EcoSystem
UL Listed



**96W
Lutron Hi-Lume Premier 0.1% Dimming
Class 2 Driver**

- Part No.:
- DRVLUT24963W (96 Watt, 3-wire)

Output Voltage: 24 V
Voltage Range: 120-277 VAC
IP Rating: Dry or Damp
Dimmable using 3-wire+G or digital EcoSystem
0.1% dimming SoftOn/FadeToBlack
with EcoSystem
UL Listed

MAGNETIC, ELV & MLV DRIVERS WITH COMPATIBLE DIMMERS



120 VAC

**60W, 96W, 200W, 300W
Class 1 & 2 Magnetic Drivers**

- Part No.:
- DRVWDIM2460 (60 Watt)
 - DRVWDIM24100 (96 Watt)
 - DRVWDIM24200 (200 Watt)
 - DRVWDIM24300 (300 Watt)

Magnetic Driver
Output Voltage: 24 V
Voltage Range: 120 VAC
IP Rating: Dry or Damp
Forward Phase Dimming
ETL Listed



277 VAC

**60W, 96W, 200W, 300W
Class 1 & 2 Magnetic Drivers**

- Part No.:
- DRVWDIM2460277 (60 Watt)
 - DRVWDIM24100277 (96 Watt)
 - DRVWDIM24200277 (200 Watt)
 - DRVWDIM24300277 (300 Watt)

Magnetic Driver
Output Voltage: 24 V
Voltage Range: 277 VAC
IP Rating: Dry or Damp
Forward Phase Dimming
ETL Listed



**60W, 96W, 150W, 200W
ELV & MLV Drivers**

- Part No.:
- DRVW2460ELV (60 Watt)
 - DRVW2496ELV (96 Watt)
 - DRVW24150ELV (150 Watt)
 - DRVW24200ELV (200 Watt)

Line Voltage Dimmable Drivers
Output Voltage: 24 V
Voltage Range: 100-130 VAC
IP Rating: Dry or Damp
Dimmable
ETL, UL and CSA Listed



LUTRON Skylark Contour Dimmer

Part No.: TRIDIMSKY
Width: 2.94 in (75 mm)
Length: 4.69 in (120 mm)
Depth: 0.30 in (7.6 mm)

- Single pole and 3-way versions
- Compatible with GENLED Acolyte MLV drivers
- Slide adjusts brightness and On/Off control
- 30 mA max control current
- Available in white finish



LUTRON NOVA-T Dimmer

Part No.: TRIDIMNOVA
Width: 2.75 in (70 mm)
Length: 4.56 in (116 mm)
Depth: 0.30 in (7.6 mm)

- Slide adjusts brightness and On/Off control
- 30 mA max control current
- Available in white finish



LUTRON DIVA Dimmer

Part No.: TRIDIMDIVA
(With Locator Light) TRIDIMDIVAL
Width: 2.94 in (75 mm)
Length: 4.69 in (120 mm)
Depth: 0.30 in (7.6 mm)

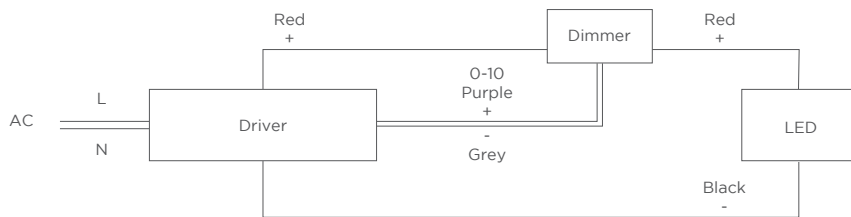
- Large paddle switch with a captive linear-slide dimmer
- 30 mA max control current
- Available in white finish
- Available with locator light which glows green when the switch is off

Note: For more options, please reference the Optional Dimmer List on GENLED Acolyte® product website page.

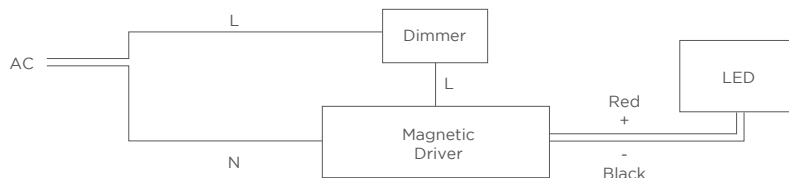


WIRING DIAGRAMS

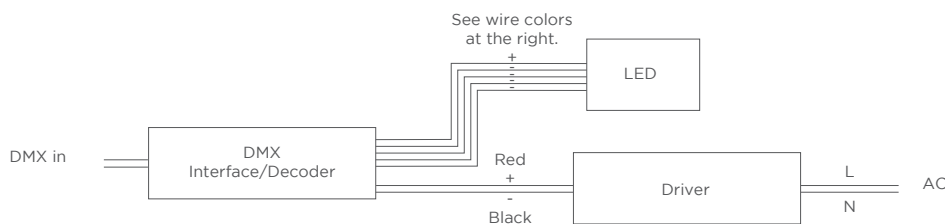
0-10V



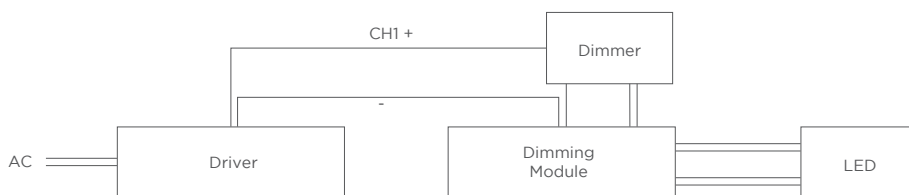
MAGNETIC + ELV



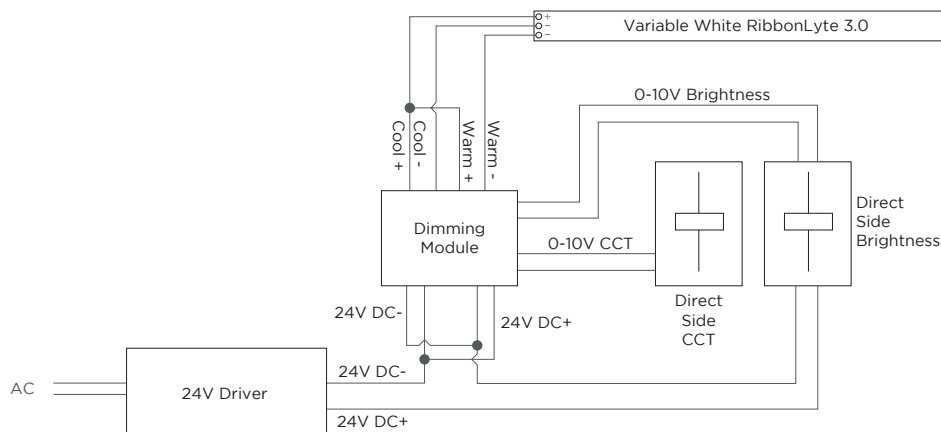
DMX



WARM DIM



2-CHANNEL VARIABLE WHITE DIMMING



WIRE COLORS PER RIBBONLYTE COLOR

STATIC WHITE + STATIC COLOR

Red Wire (+) Positive
Black Wire (-) Negative

RGB

Black Wire (+) Positive
Red Wire (-) Goes To Red Channel
Green Wire (-) Goes To Green Channel
Blue Wire (-) Goes To Blue Channel

RGBW/A

Black Wire (+) Positive
Red Wire (-) goes to Red Channel
Green Wire (-) goes to Green Channel
Blue Wire (-) goes to Blue Channel
White Wire (-) goes to White Channel

VARIABLE WHITE

Black Wire (+) Positive
Red Wire (-) goes to Warm White Channel
Green Wire (-) goes to Cool White Channel

WARM DIM

Red Wire (-) goes to Warm White Channel
Blue Wire (-) goes to Cool White Channel
Black Wire (+) goes to Warm White Channel
Green Wire (+) goes to Cool White Channel

FINELITE

High Performance Perimeter Slot (HP-WS)



Declare.

Third Party Verified

Date

Project

Type

Comments



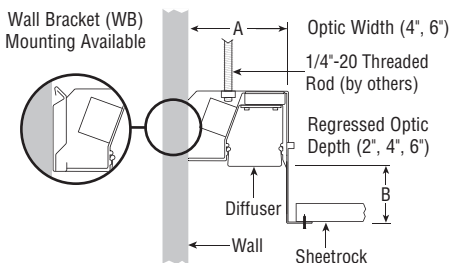
DESCRIPTION

The High Performance Perimeter Slot (HP-WS) creates a wash of ambient and vertical illumination at the transition between the wall and the ceiling plane. Available in 2', 3', 4', & 8' sections with telescoping options that can be combined to make longer runs, and 2", 4", and 6" regressed optic options.

This Product is enrolled in the International Living Future Institute (ILFI) Declare 2.0 Program and is third-party verified with options achieving Red List Approved and Declared status.

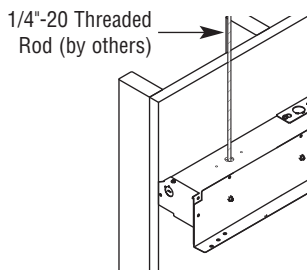


Scan QR Code to view video



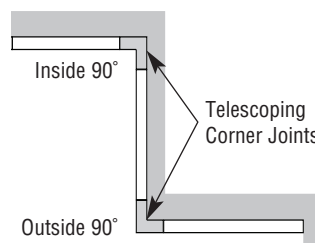
DIMENSIONS & LIGHT ENGINE

Distribution is attained with mid-power LEDs distributed evenly and paired with a precise regressed diffuser.



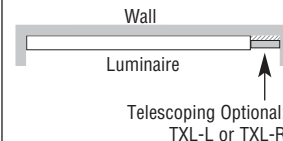
POST-CEILING THREADED-ROD (TR) MOUNTING INSTALLATION

Allows a luminaire to be installed after ceiling framing is complete.



FULLY ILLUMINATED 90° CORNERS

Fully illuminated 90° corners with telescoping standard. Refer to page 3 for telescoping lengths on inside and outside corners.



STRAIGHT RUNS WITH OPTIONAL TELESCOPING

Optional telescoping section adds up to 12 inches for a straight run. Telescope section mounts securely to wall.

ORDERING GUIDE – Sample Number: HP-WS - 4W - 4D - 8' - S - 830 - 120V - SC - TR - SW - FE-L - TXL-R - C1 - RLA

Finelite HP-WS	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>	<input type="checkbox"/>
Optic Width (4W - 4" Width, 6W - 6" Width)																			
Regressed Optic Depth (2D - 2" Depth, 4D - 4" Depth, 6D - 6" Depth)																			
Length (2' , 3' , 4' , 8' , multiples standard)																			
Light Output (S - Standard, B - Boosted Standard, H - High, V - Very High)																			
LED CRI/CC (830 - 80 CRI min, 3000K, 930 - 90 CRI min, 3000K, 835 - 80 CRI min, 3500K, 935 - 90 CRI min, 3500K, 840 - 80 CRI min, 4000K, 940 - 90 CRI min, 4000K)																			
Voltage (120V , 277V)																			
Circuiting (SC - Single Circuit) ¹																			
Mounting (TR - Threaded Rod ² (standard), WB - Wall Bracket ³)																			
Reflector (SW - Signal White)																			
End Condition Left (FE-L - Flat (standard), PE-L - Pocket Slot, TXL-L - Telescoping) ⁴																			
End Condition Right (FE-R - Flat (standard), PE-R - Pocket Slot, TXL-R - Telescoping) ⁴																			
Ceiling Type (C1 - 1" T-Bar, C2 - 9/16" T-Bar, C3 - screw slot, SF - Spackle Flange, C1T - 1" tegular, C2T - 9/16" tegular)																			
Special Options (RLA - Red List Approved, RLD - Declared Label)																			

¹ Contact factory for switching options.

⁴ The end condition on each side can be specified with different hardware options to accommodate different installation features.

² Pre- or post-ceiling.

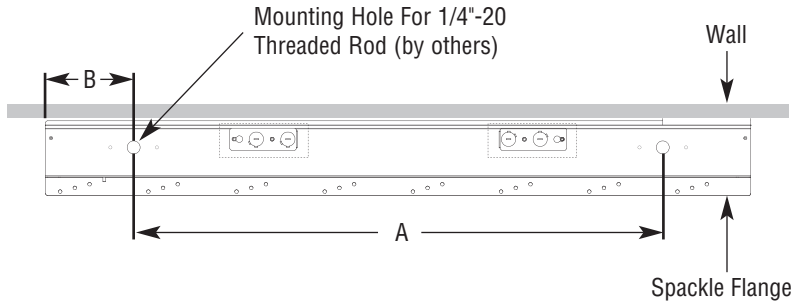
See page 3 for more information.

³ Pre-ceiling only.

FINELITE

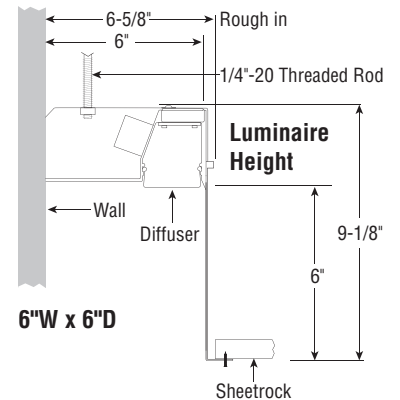
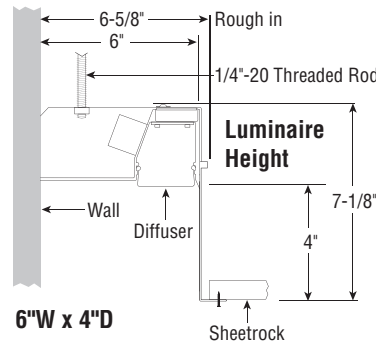
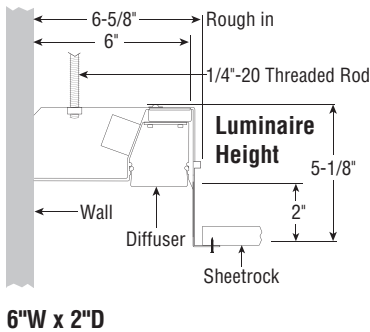
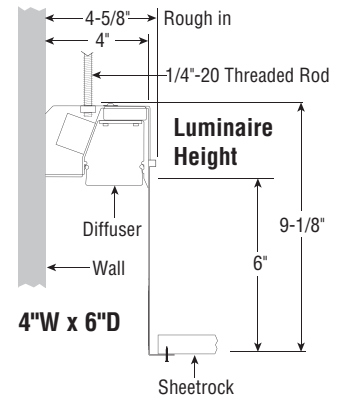
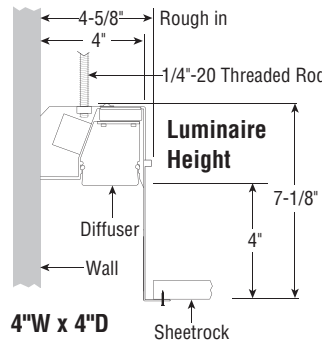
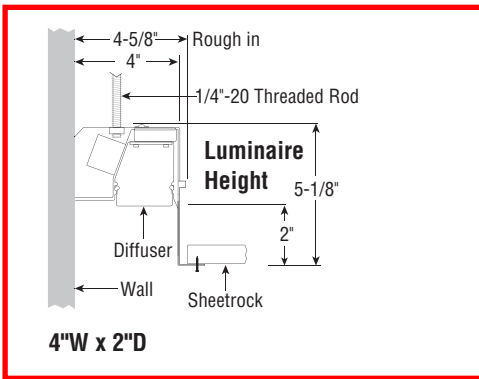
High Performance Perimeter Slot (HP-WS)

THREADED-ROD (TR) MOUNTING LOCATION

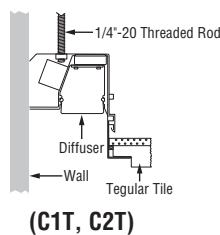
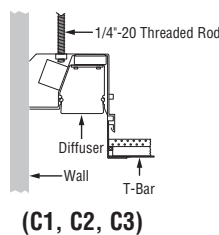
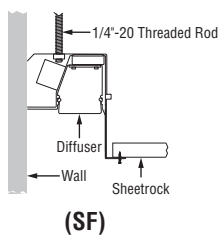


MOUNTING HOLE LOCATION TABLE		
LUMINAIRE LENGTH	A (in)	B (in)
2'	18	3
3'	30	3
4'	36	6
8'	84	6

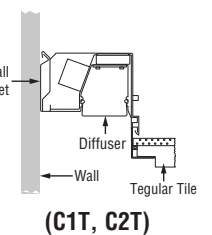
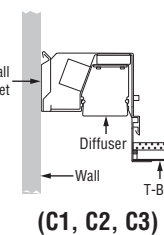
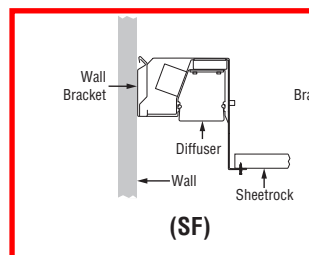
THREADED-ROD (TR) MOUNTING CROSS SECTIONS



CEILING TYPES — THREADED-ROD (TR) MOUNTING



WALL BRACKET (WB) MOUNTING

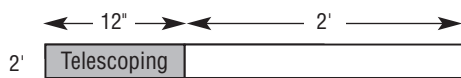


A brand of **legrand**

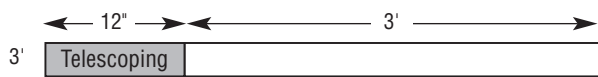
FINELITE

High Performance Perimeter Slot (HP-WS)

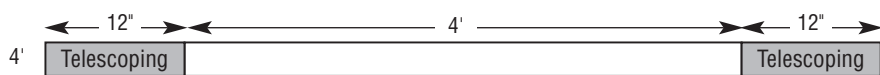
RUN LENGTHS



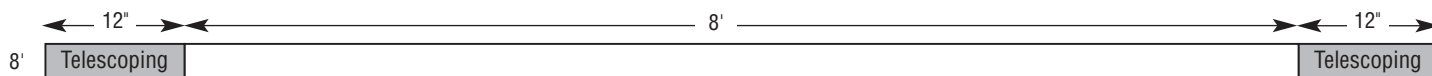
2' Telescoping Section (optional) adds a minimum of 2" and a maximum of 12". Only one end can be extended.



3' Telescoping Section (optional) adds a minimum of 1" and a maximum of 12". Only one end can be extended.



4' Telescoping Sections (optional) adds a minimum of 1" and a maximum of 12". Both ends can be extended.



8' Telescoping Sections (optional) adds a minimum of 1" and a maximum of 12". Both ends can be extended.
Standard 2', 3', 4', and 8' section can be combined to make longer runs.

Endcaps Information

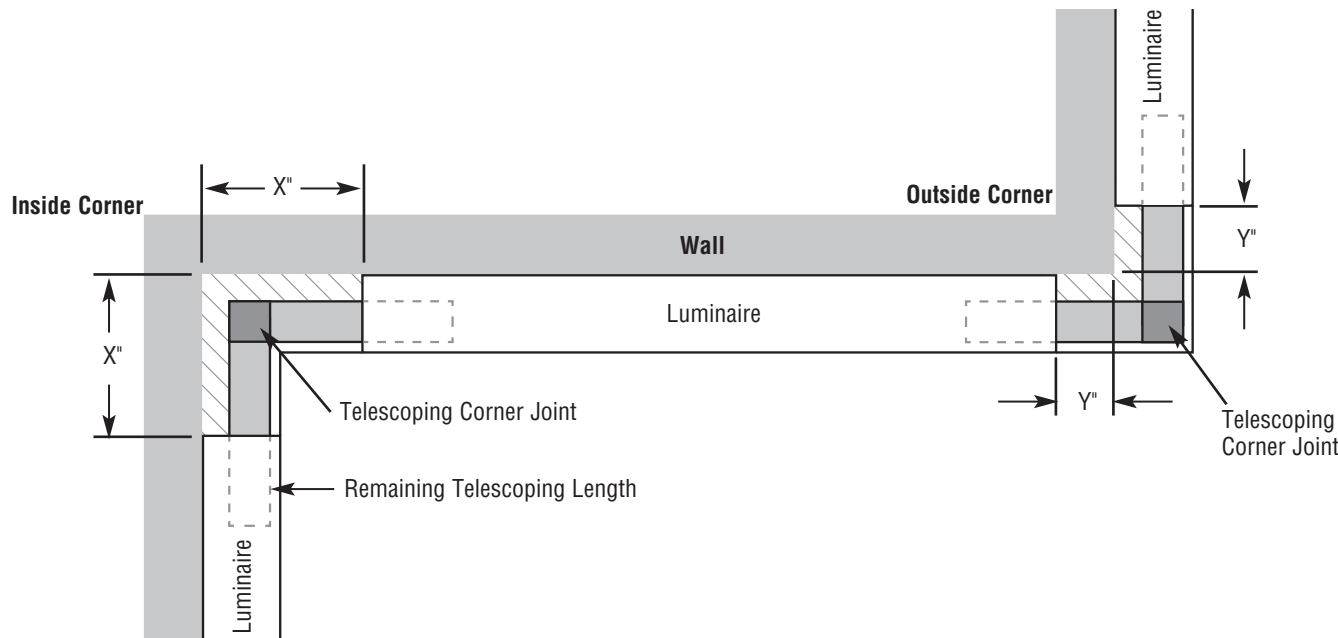
The **Flat Endcap** adds 1/8" per endcap to the section length.

The **Pocket Slot Endcap** adds 1-1/4" for Spackle Flange and 1" for T-Bar per endcap to the section length.

The **Telescoping Endcap** adds:

- A minimum of 2" to a 2' section
- A minimum of 1" to a 3' section
- A minimum of 1" to 4' and 8' sections

90° INSIDE AND OUTSIDE FULLY ILLUMINATED CORNER MEASURING DETAILS



Luminaire Width Configuration	Measurement From End of Luminaire to Wall			
	Inside Corner		Outside Corner	
	X" Min.	X" Max.	Y" Min.	Y" Max.
4W	8"	14"	1"	8"
6W	10"	16"	1"	7"

Notes

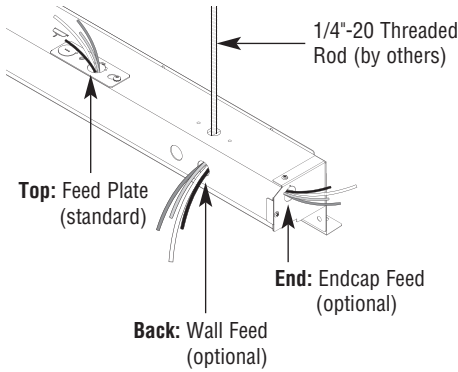
- Inside and outside corners ship standard with telescoping.
- Telescoping is optional for straight runs.

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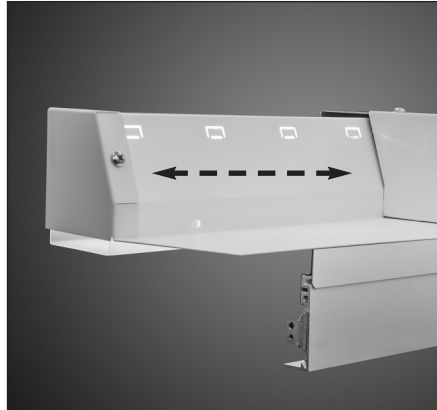
High Performance Perimeter Slot (HP-WS)

FEED OPTIONS



Refer to installation instructions for feed hole measurements.

TELESCOPING (TXL-L or TXL-R)

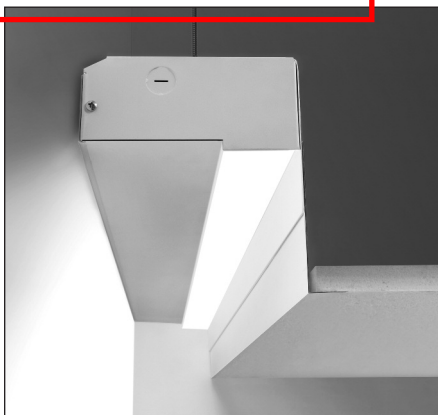


TAPERED OPTIC STANDARD WITH 90° INSIDE CORNERS

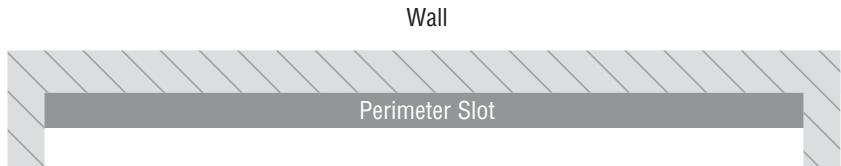


ENDCAP OPTIONS

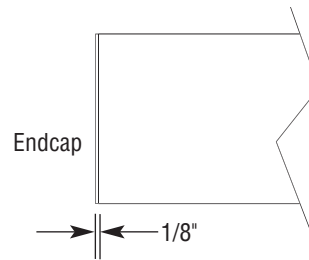
STANDARD FLAT (FE-L or FE-R)



Adds 1/8" per endcap to the section length. Spackle Flange version shown, T-Bar available.



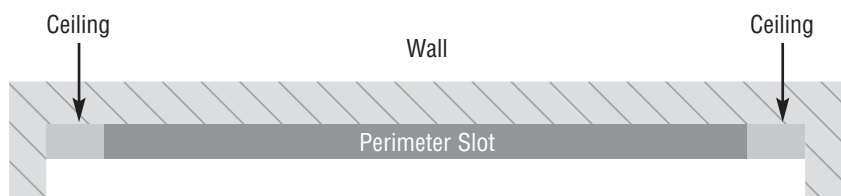
Flat end condition for when luminaire terminates at a vertical surface such as a wall.



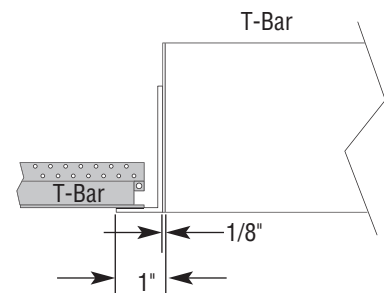
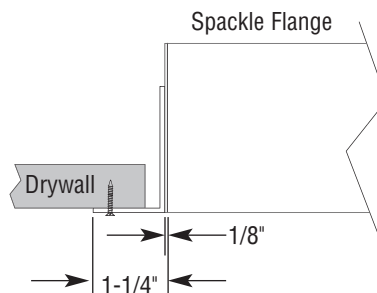
POCKET SLOT (PE-L or PE-R)



Adds 1-1/4" for Spackle Flange and 1" for T-Bar (includes endcap dimension 1/8") per endcap to the housing length on shop drawings. T-Bar version shown, Spackle Flange available.



Pocket slot end condition for when slot terminates before meeting additional vertical wall surface.



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High Performance Perimeter Slot (HP-WS)

PHOTOMETRY – 4' Luminaire

4"W x 2"D

Very High Output - 120V

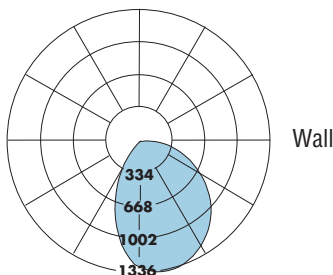
Efficacy: 84 lumens per watt

Total Luminaire Output: 3097 lumens (774 lumens/foot)

37 watts (9.3 watts/foot)

CCT: 3500K

ITL LM79 Report: 86712



CANDELA DISTRIBUTION						
	0.0	45	90	135	180	Flux
0	1235	1235	1235	1235	1235	
5	1280	1264	1229	1198	1168	116
15	1333	1280	1172	1002	903	321
25	1323	1241	1060	746	586	460
35	1258	1150	909	489	297	519
45	1144	1020	735	248	60	502
55	967	859	555	49	2	436
65	741	654	375	3	0	344
75	514	437	204	2	0	233
85	295	232	52	1	0	121
90	188	132	0	0	0	

	Total Light Output, 3500K, 80 CRI (Lumens) - 4' Luminaire				
	S*	B*	H*	V**	
4"W x 2"D	1268	1594	2409	3097	

Lumen Adjustment Factors - 80 CRI	
3000K	0.985
3500K	1.000
4000K	1.032

	Light Output, 3500K, 80 CRI (Lumens Per Foot)				
	S*	B*	H*	V**	
4"W x 2"D	317	398	602	774	

Lumen Adjustment Factors - 90 CRI	
3000K	0.746
3500K	0.760
4000K	0.789

	Power, 3500K, 80 CRI (Watts Per Foot)				
	S*	B*	H*	V**	
4"W x 2"D	3.6	4.6	7.1	9.3	

Apply a lumen adjustment factor to calculate lumens for the desired CCT and CRI.

	Efficacy, 3500K, 80 CRI (Lumens Per Watt)				
	S*	B*	H*	V**	
4"W x 2"D	88	87	85	84	

SAMPLE LUMEN ADJUSTMENT CALCULATION

High Output (H), 4000K, 90 CRI

Lumen Adjustment Factor = 0.789

$$\text{Total Light Output} = 2409 \text{ lm} \times 0.789 = 1901 \text{ lm}$$

$$\text{Total Light Output per Foot} = 602 \text{ lm/ft} \times 0.789 = 475 \text{ lm/ft}$$

$$\text{watts/foot} = 7.1 \text{ W/ft}$$

$$\text{Efficacy} = \frac{475 \frac{\text{lm}}{\text{ft}}}{7.1 \frac{\text{W}}{\text{ft}}} = 67 \text{ lm/W}$$

S - Standard Output, B - Boosted Standard Output, H - High Output, V - Very High Output

* Family Correlation based on 4' luminaire 3500K Very High Output (V) test - 120V.

** Based on ITL report: 86712

Notes

– Refer to LM-79 reports for other configurations.

FINELITE

High Performance Perimeter Slot (HP-WS)

SPECIFICATIONS

CONSTRUCTION: Precision cut 6061-T6 extruded aluminum visible flange. Internal joiner system, plug-together wiring standard. Steel sheet metal galvanized and powder coated body.

ENDCAPS: The luminaire can terminate in three different end conditions to accommodate project needs. Endcaps are made of 20-gauge die-formed powder-coated steel. Flat (standard) Endcap adds 1/8", Pocket Slot Endcap adds 1-1/4", and for Telescoping Endcap refer to telescoping section below.

END CONDITIONS:

FLAT (standard) (FE-L or FE-R): Is used when the luminaire terminates at a wall. Adds 1/8" per endcap to overall length of the luminaire.

POCKET SLOT (PE-L or PE-R): Includes the necessary hardware to accommodate ceiling materials when the luminaire doesn't terminate at a wall. Adds 1-1/4" for Spackle Flange and 1" for T-Bar per endcap to overall length of the luminaire.

TELESCOPING (TXL-L or TXL-R): Provides up to 12" of additional illuminated section to accommodate variances in the built-in wall slot. Telescoping available on both ends of 4' and 8' luminaire sections. Adds a minimum of 1" per end to overall section length. Telescoping only available at one end of 2' and 3' luminaire sections. Adds a minimum of 2" to overall length of 2' sections and a minimum of 1" to overall length of 3' sections. Telescoping is standard with corners. Telescoping section must end at wall and be secured with bracket (provided).

90° CORNER: Illuminated 90° inside and outside corners. Standard with telescoping sections. Tapered optics is standard with inside corners.

REFLECTORS: Finelite Signal White powder coat finish standard.

DIFFUSER: Frosted diffusers are 1/16". All diffusers are UV-stabilized and impact resistant virgin acrylic.

LIGHT OUTPUT: Four lumen packages available; Standard (**S**), Boosted Standard (**B**), High (**H**), and Very High (**V**). A separate chart summarizes lumen distribution and wattage. Light engines are replaceable.

LUMEN MAINTENANCE: 90% of initial light output (L90) at 100,000+ hours; 70% of initial light output (L70) at 200,000+ hours.

DRIVER: Replaceable 120V/277V Constant Current Reduction dimming driver standard. Can be wired dimming or non-dimming. 0-10V dimming controls with a range of 10% - 100%. Dimming to 1% available; consult factory. Driver is fully accessible from below the ceiling. Power Factor: ≥ 0.9 . Total Harmonic Distortion (THD): $< 20\%$. Step-dimming driver (limited programmable outputs. Contact Factory). Expected driver lifetime: 100,000 hours.

LUTRON DRIVER OPTIONS: **LUTES1** (Hi-lume 1% EcoSystem with Soft-On, Fade to Black dimming (LDE1 series)); **LUTES5** (5-Series 5% EcoSystem (LDE5 Series)), **LUT2W** (Hi-lume 1% 2-wire, 120V forward phase dimming (LTEA series)); Contact factory for availability of discontinued Lutron drivers, L3DA-3-wire and L3DA EcoSystem.

ELECTRICAL: Optional emergency to generator/inverter wiring, internal generator transfer switch, nightlight wiring, backup battery. Factory-choice low-profile backup battery available. Chicago Plenum Option available (includes telescoping luminaires). 8' minimum luminaire length for low profile battery pack. Backup batteries deliver 1519 lumens. Half of a 4' section will be illuminated in emergency mode. Optional fusing is available.

CIRCUITING: 3' sections with telescoping and 4' sections can be specified with up to 2 circuits. 8' sections can be specified with up to 4 circuits. All others are available with a single circuit. Contact factory for more information.

MOUNTING: The standard mounting (Threaded Rod - TR) option eliminates the need to install luminaires prior to the slot being framed. Luminaire mounts on threaded rods. Gasket runs length of luminaire ensuring a clean finish at the wall. Optional mounting includes a wall bracket that is attached to the wall. Luminaires are then snapped onto the bracket. Luminaire installation that uses the mounting bracket must be performed before the perimeter slot framing is built.

FINISH: Finelite Signal White powder coat finish standard. Optional adder: 185 colors available using RAL color chart. Custom color applies to the visible T-Bar flange.

FEED: Standard with one 18-gauge/5-conductor single-circuit feed. 14-gauge feed used when luminaire current exceeds 5 amps. Optional 6' flex conduit whips available. Dual knockouts (for dual flex conduit) are available at the top and rear feed locations. Endcaps have a single knockout and support a single flex conduit only.

LENGTHS: Standard 2', 3', 4', and 8' section lengths can be combined to make longer runs. Optional telescoping sections on straight runs add a minimum of 1" up to 12" at the end of the luminaire. Contact factory for corner details and availability. Telescoping sections are available on either or both ends of the luminaire.

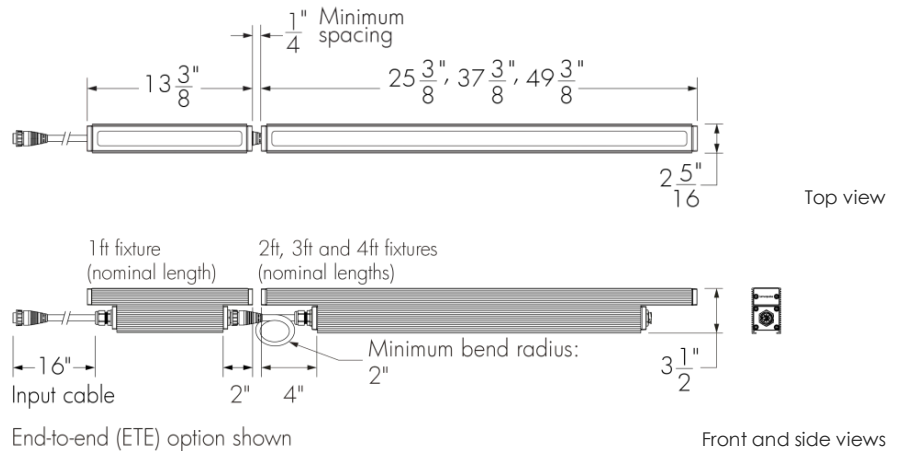
LABELS: Luminaire and electrical components are ETL-listed conforming to UL 1598 in the U.S.A. and CAN/CSA C22.2 No. 250.0 in Canada. In accordance with NEC Code 410.73 (G), this luminaire contains an internal driver disconnect. IC-Rated. Damp Location. Finelite products use electronic components that are RoHS compliant, and the mechanical components of the luminaire have been verified to not knowingly contain any restricted substances listed per RoHS Directive 2011/65/EU. Finelite makes the specification process easy when putting healthier products on your projects. Simply add – **RLA** (Red List Approved) or – **RLD** (Declared Label) to your part number.

WEIGHT: 5.6 lb/ft.

WARRANTY: 10-year performance-based warranty on all standard components. Optional accessories such as emergency battery packs are covered by their individual manufacturer warranties.

Project Name _____ Qty _____

Type _____ Catalog / Part Number _____

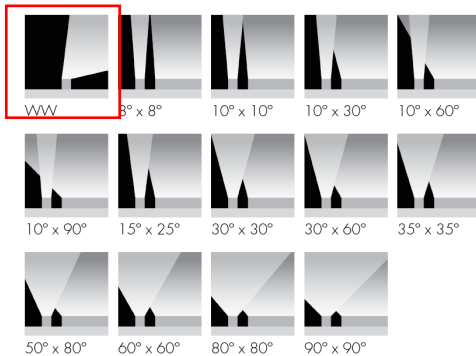


Photometric Summary

	Delivered output (lm)	Intensity (peak cd)
WW	3,592	5,159
8°x8°	4,045	77,896
10°x10°	3,830	38,346
10°x30°	3,885	30,056
10°x60°	3,984	17,736
10°x90°	3,576	7,897
15°x25°	3,880	24,730
30°x30°	3,765	14,726
30°x60°	3,848	5,106
35°x35°	3,921	9,999
50°x80°	3,767	3,449
60°x60°	3,435	3,007
80°x80°	3,881	2,530
90°x90°	3,588	1,886

Based on HO 4000K, 4ft [1219mm] configuration. Photometric performance is measured in compliance with IESNA LM-79-08.

Optics



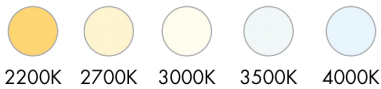
Description

The Lumenfacade is a high-performance linear LED luminaire for grazing or floodlighting exterior walls and facades. Featuring second generation LED technology, the luminaire is available in 12 in, 24 in, 36 in or 48 in sections, and can be configured with a wide number of options, including: optics for grazing or flood lighting; a choice of outputs (ASHRAE 5 W/ft, RO 8.5 W/ft or HO 15.25 W/ft); various color temperatures or static colors; various mounting options, finishes, accessories and controls. The Lumenfacade is also available with a unique asymmetric wallwash distribution, providing exceptional uniformity and brightness for walls and signage.

Features

Color and Color Temperature	2200K, 2700K, 3000K, 3500K, 4000K, Red, Green, Blue
Length (nominal)	12 in, 24 in, 36 in, 48 in
Optics	Asymmetric Wallwash, 8° x 8°, 10° x 10°, 10° x 30°, 10° x 60°, 10° x 90°, 15° x 25°, 30° x 30°, 30° x 60°, 35° x 35°, 50° x 80°, 60° x 60°, 80° x 80°, 90° x 90°
Options	End-to-end configuration (factory installed 16 in black input cable included), Corrosion-resistant coating for hostile environments, 3G ANSI C136.31-2010 Vibration Rating for bridge applications, CE (certification covers European Economic Area)
Power Consumption	5 W/ft (meets ASHRAE standards for linear lighting on building facades - not available for 12 in fixture lengths), 8.5 W/ft (RO version), 15.25 W/ft (HO version), Typically 20% higher for 12 in fixture lengths
Warranty	5-year limited warranty
Performance	
Illuminance at Distance	Minimum 1 fc at 133 ft (HO 4000K, 48 in fixture, 10° x 60°, DMX/RDM)
Color Consistency	2 SDCM, 3 SDCM (2200K)

Colors and Color Temperatures



Controls

ON/OFF 0-10V DALI



Ratings

IP66 IK07*
*asymmetric wallwash lens is IK06 rated

Certifications



Color Rendering	Minimum CRI 80
Lumen Maintenance	L70 280,000 hrs, L95 35,000 hrs

Physical

Housing Material	Low copper content extruded aluminum
Lens Material	Clear tempered glass
Hardware Material	Stainless steel
End Cap Material	Machined aluminum
Gasket Material	Silicone
Surface Finish	Electrostatically applied polyester powder coat
Weight	12 in: 4.5 lbs, 24 in: 7 lbs, 36 in: 10.5 lbs, 48 in: 14 lbs

Electrical and control

Voltage	100 to 277 volts, 347 volts available (consult factory for details)
Fixture Cable	Power and data in one cable, End-to-end option (ETE): 16 in black input cable (no jumper cable needed for minimum spacing between two fixtures)
Leader Cable Conductor	5C #16-5
Maximum Cable and Fixture Run Length	252 ft (On/Off, 277V, RO version), 164 ft (On/Off, 277V, HO version)
Control	On/Off control, Lumentalk, 0-10V dimming, DALI dimming, Lutron® EcoSystem® Enabled dimming, DMX/RDM enabled
Resolution (DMX/RDM)	Per foot or per fixture (configured with LumenID V3 software), 8-bit or 16-bit

Environmental

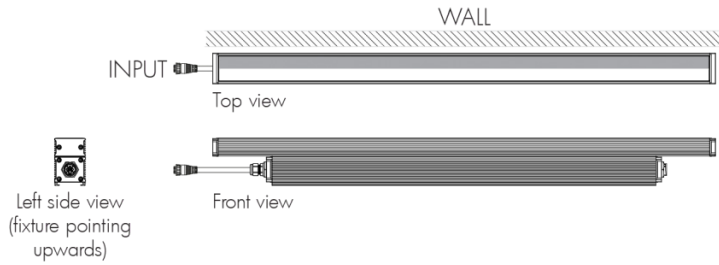
Storage Temperature	-40 °F to 185 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-40 °F to 122 °F
Ingress Protection Rating	IP66, Wet location rated
Impact Resistance Rating	IK07 (asymmetric wallwash lens is IK06 rated)

Accessories (order separately)

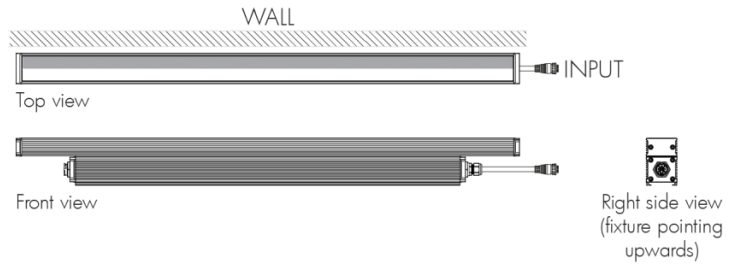
Optical Accessories	Lumenfacade Radial Louver
Cables	Leader cable (standard), Jumper cable (standard), Leader cable (ETE), Jumper cable (ETE)
Control Boxes	DMX/RDM enabled (daisy chain or star configuration), Ethernet enabled (daisy chain or star configuration), Lumentalk Data Bridge
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID, LumentalkID

Asymmetric wallwash optic details

WWLF - Asymmetric wallwash optic, left feed



WWRF - Asymmetric wallwash optic, right feed

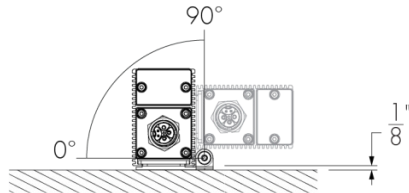


- Always position frosted side toward the wall.
- Fixture's feeding side is based on uplight installations. Feeding sides are reversed when fixture is used in a downlight application.
- Recommended setback from wall is 1/10 of the wall height. Example: 2 ft setback for a 20 ft wall.

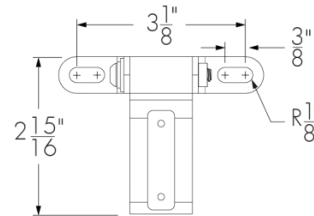
Mounting options

Surface Mount

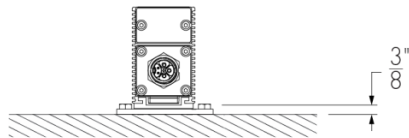
SAM - Slim Adjustable Mounting



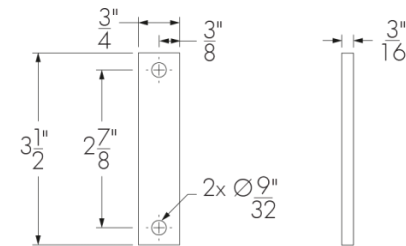
SAM - Mounting hole pattern



UMP - Fixed Mounting



UMP - Mounting hole pattern



How to order

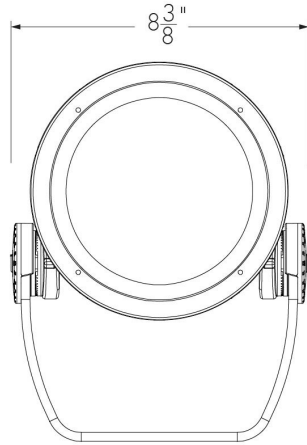
Housing (2)	Voltage (3)	Length	Color and Color Temperature (5)	Optics	Mounting Options	Finish	Control	Options
LOG ASHRAE Lumenfacade™, 5 W/ft ASHRAE compliant (1)	100 100 volts	12 13 3/8 in (4.5 lbs) (2)	22K 2200K	WWLF Asymmetric Wallwash, left feed	SAM Slim Adjustable Mounting	BK Black Sandtex®	NO On/Off control	ETE End-to-end configuration (factory installed 16 in black input cable included)
LOG RO Lumenfacade™ Regular Output, 8.5 W/ft	120 120 volts	24 25 3/8 in (7 lbs)	27K 2700K	WWRF Asymmetric Wallwash, right feed	UMP Fixed Mounting (8)	BRZ Bronze Sandtex®	LT Lumentalk (4) (12) (13)	CRC Corrosion-resistant coating for hostile environments (16) (17)
LOG HO Lumenfacade™ High Output, 15.25 W/ft	208 208 volts	36 37 3/8 in (10.5 lbs)	30K 3000K	8x8 8° x 8° (7)	UMAS Universal Adjustable Mounting (8)	SLV Silver Sandtex®	DIM 0-10V dimming	3GV 3G ANSI C136.31-2010 Vibration Rating for bridge applications (18)
	220 220 volts	48 49 3/8 in (14 lbs)	35K 3500K	10x10 10° x 10° (7)	WAM2 Adjustable Wall Mounting 2 in	WH Smooth white	DALI DALI dimming	CE CE (certification covers European Economic Area) (19)
	240 240 volts		40K 4000K	10x30 10° x 30°	WAM6 Adjustable Extended Arm Mounting 6 in	CC Custom color and finish (please specify RAL color) (9) (10) (11)	ES Lutron® EcoSystem® Enabled dimming (14)	
	277 277 volts		RD Red (4)	10x60 10° x 60°	WAM12 Adjustable Extended Arm Mounting 12 in		DMX/RDM DMX/RDM enabled (15)	
			GR Green (4)	10x90 10° x 90°	WAM18 Adjustable Extended Arm Mounting 18 in			
			BL Blue (4)	15x25 15° x 25°				
				30x30 30° x 30°				
				30x60 30° x 60°				
				35x35 35° x 35°				
				50x80 50° x 80°				
				60x60 60° x 60°				
				80x80 80° x 80°				
				90x90 90° x 90°				

Notes:

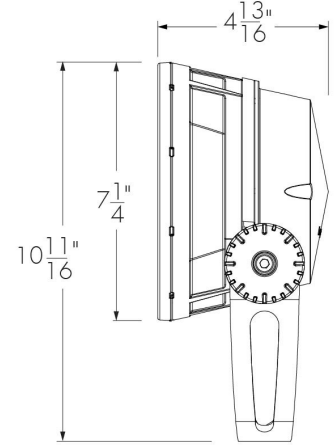
- ASHRAE version not available for 12 in fixture lengths.
- Power consumption is typically 20% higher for 12 in fixture lengths.
- 347 volts available, consult factory for details.
- To connect 12 in fixture lengths to the Lumentalk system, DIM or DMX/RDM must be specified as the control option, and a Lumentalk Data Bridge (LDB) is required. See the typical wiring diagrams in the specification sheet for details.
- Consult factory for availability of static Royal Blue, 6500K and 90+ CRI.
- Static colors made to order 8-10 weeks.
- For best results use with HO fixtures at a 6 in setback from surface. Contact factory for application support.
- Suitable to use when 3GV option is specified.
- Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
- Setup charges apply for RAL colors. Consult factory for details.
- Longer lead times can be expected for custom RAL color finishes.
- Available for 24 in, 36 in and 48 in fixture lengths only.
- A Lumentranslator 2 (LTL2) and LumentalkID (LIDL) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
- Available for 24 in (ASHRAE and RO only), 36 in and 48 in fixture lengths only.
- A control box (CBX) and LumenID (LID) must be specified.
- Use only when exposed to salt spray and harsh chemicals. This option is not required for normal outdoor exposure.
- Setup charges apply. Consult factory for details.
- Available with UMP and UMAS mounting options only.
- Consult European specification sheet and installation instructions for CE wiring information.

Project Name _____ Qty _____

Type _____ Catalog / Part Number _____



Front view



Side view

Photometric summary

Symmetric

	Delivered output (lm)	Intensity (peak cd)
XN (4°)	1830*	156,410*
VN (6°)	1716*	90,813*
NS (10°)	2467*	35,359*
NF (20°)	2334*	22,375*
M (30°)	2264*	12,595*
FL (40°)	2047*	5306*
WFL (60°)	1836*	1382*

Asymmetric

	Delivered output (lm)	Intensity (peak cd)
NAS	1569*	26,002*
WW	2148*	6582*

Based on 4000K configuration.

Photometric performance is measured in compliance with IESNA LM-79-08.

*Estimated. Consult website for the latest photometric files.

Optics



XN - 4° VN - 6° NS - 10° NF - 20° M - 30°



FL - 40° WFL - 60° NAS WW

Description

The Lumenbeam Medium is an IP66-rated luminaire for lighting landscapes, trees, columns, monuments, and architectural details. It has numerous options, including optics for flood or accent lighting, a choice of color temperatures and colors, as well as various accessories, spread lenses, and controls. The luminaire also has an anti-corrosion option for use in harsh, chemical, or coastal environments.

Features

Color and Color Temperature 2200K, 2700K, 3000K, 3500K, 4000K, 5700K, Red, Green, Blue

Optics (nominal distribution) XN (4°), VN (6°), NS (10°), NF (20°), M (30°), FL (40°), WFL (60°), NAS (Narrow Asymmetric), WW (Asymmetric Wallwash)

Optical Option Linear spread lens horizontal distribution, Linear spread lens vertical distribution

Options Short Yoke, 3G ANSI C136.31-2010 Vibration Rating for bridge applications, Corrosion-resistant coating for hostile environments

Cable Color Black, White

Power Consumption 28 W

Warranty 5-year limited warranty

Performance

Maximum Delivered Output 2467lm (4000K, NS 10°)

Maximum Delivered Intensity 156,410 cd at nadir (4000K, XN 4°)

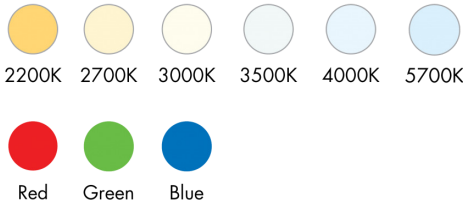
Illuminance at Distance Minimum 1 fc at 395 ft (4000K, XN 4°)

Color Consistency 3 SDCM

Color Rendering Minimum CRI 80

Lumen Maintenance L70 > 250,000 hrs (Ta 25 °C) (> 80,000 hrs for XN 4°, VN 6°, NAS optics only)

Colors and Color Temperatures



Controls

ON/OFF 0-10V DALI DMXrdm

Ratings

IP66 IK09

Certifications



Physical

Housing Material	Low copper content high pressure die-cast aluminum
Yoke Material	Heavy aluminum (standard yoke included)
Lens Material	Clear tempered glass
Hardware Material	Stainless steel
Gasket Material	Silicone
Surface Finish	Electrostatically applied polyester powder coat
Weight	6.7 lbs
EPA	Front = 0.44 sq ft, Side = 0.18 sq ft

Electrical and control

Voltage	100 to 277 volts
Fixture Cable	Power and data in one cable
Conductors	3C #16-3 (NO control), 5C #16-5 (DIM, DALI control), 6C #14-3/#24-3 (DMX/RDM control)
Control	On/Off control, 0-10V dimming, DALI dimming, DMX/RDM enabled, Lumentalk system is enabled with LDB accessory - see typical wiring diagrams for details
Resolution (DMX/RDM)	Per fixture, 8-bit or 16-bit

Environmental

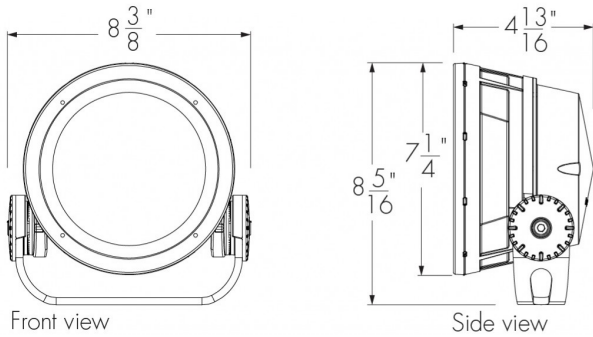
Storage Temperature	-40 °F to 158 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-40 °F to 122 °F
Ingress Protection Rating	IP66, Wet location rated
Impact Resistance Rating	IK09

Accessories (order separately)

Optical Accessories	Lumenbeam Medium Snoot, Lumenbeam Medium Snoot wide, Lumenbeam Medium Visor, Lumenbeam Medium Linear spread lens adjustable, Lumenbeam Medium Wire guard
Control Boxes	DMX/RDM enabled (daisy chain or star configuration), Ethernet enabled (daisy chain or star configuration), Lumentalk Data Bridge
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID, LumentalkID

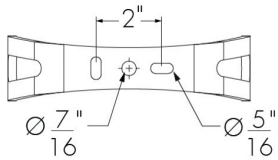
Mounting options

SY - Short yoke

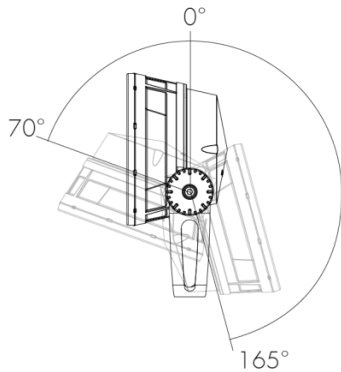


Mounting details

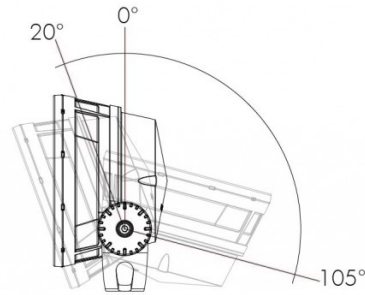
Mounting hole pattern - standard and short yoke



Adjustable pivot limits (adjustable in 6 degree increments)



Standard yoke



Short yoke

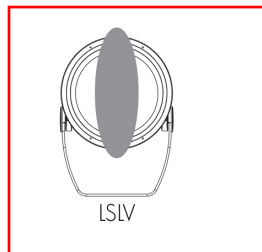
Optical options

LSLH - Linear spread lens horizontal distribution



LSLH - Linear spread lens horizontal distribution

LSLV - Linear spread lens vertical distribution



Beam angles

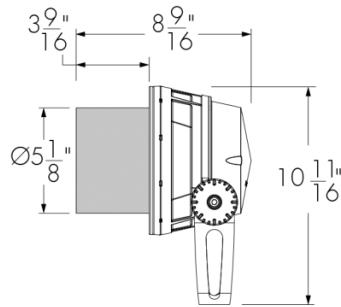
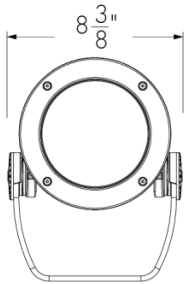
Optic installed in fixture	Beam angle with LSLH/LSLV
XN	5° x 60°
VN	7° x 60°
NS	13° x 66°
NF	16° x 62°
M	23° x 65°
FL	33° x 70°

Factory installed, not adjustable on site. Not available for WFL, NAS and WW optics. See 'Optical Accessories' section for field adjustable spread lens (LSLA).

Optical accessories (order separately)

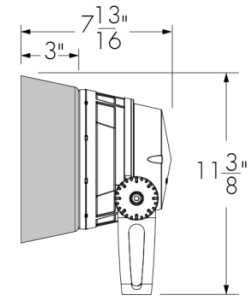
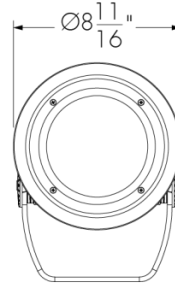
Installed optical accessories will affect the maximum pivot limits for each mounting option, consult factory for details.

SN - Snoot



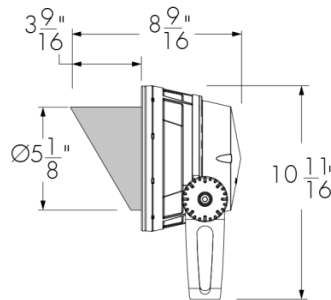
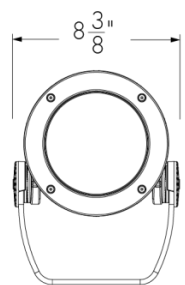
LBMSN-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

SNW - Snoot wide



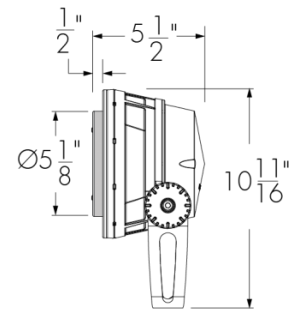
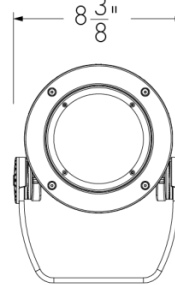
LBMSNW-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

VS - Visor



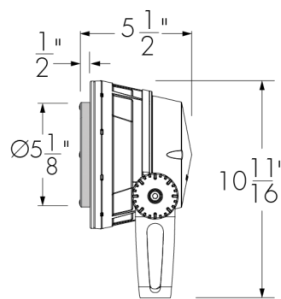
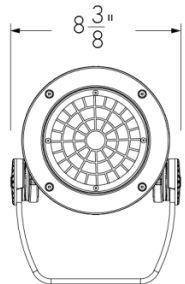
LBMVS-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

LSLA - Linear spread lens adjustable



LBMLSLA-FINISH-OPTIONS (CRC)
Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

WG - Wire guard



LBMWG-FINISH-OPTIONS (CRC)
Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

Accessory combinations

	+	Snoot	Snoot wide	Visor
Linear spread lens adjustable		LBMSNLSLA	N/A*	LBMVLSLA
Wire guard		LBMSNWG	N/A	LBMVSWG

Accessory combinations must be ordered together on a single line.
Ex: A snoot + wire guard combination order code is **LBMSNWG-FINISH-BK-OPTIONS**. A maximum of two accessories can be combined per fixture.
*Consult factory for a linear spread lens adjustable + snoot wide combination.

How to order

Housing	Voltage	Color and Color Temperature (1)	Optics	Optical Option (4) (7)	Finish	Control (11) (12)	Options	Certification	Cable Length (14) (18)	Cable Color
LBM Lumenbeam™ Medium	100 100 volts	22K 2200K	XN Extra Narrow 4°	LSLH Linear spread lens horizontal distribution (5)	BK Black Sandtex®	NO On/Off control	SY Short Yoke	UL UL compliant	3FT 3 ft (14) (18)	BK Black
	120 120 volts	27K 2700K	VN Very Narrow 6°	LSLH Linear spread lens horizontal distribution (5) (6)	BRZ Bronze Sandtex®	DIM 0-10V dimming	3GV 3G ANSI C136.31-2010 Vibration Rating for bridge applications	CE CE compliant (17)	10FT 10 ft	WH White (19)
	208 208 volts	30K 3000K	NS Narrow Spot 10°	LSLV Linear spread lens vertical distribution (5) (6)	SI Silver Sandtex®	DALI DALI dimming	CEII CE compliant Class II double insulated (17)	20FT 20 ft		
	220 220 volts	35K 3500K	NF Narrow Flood 20°		WH Smooth white	DMX/RDM DMX/RDM enabled (13) (14)	CRC Corrosion- resistant coating for hostile environments (15) (16)	30FT 30 ft		
	240 240 volts	40K 4000K	M Medium 30°		BKTX Textured black			50FT 50 ft		
	277 277 volts	57K 5700K	FL Flood 40°		BRZTX Textured bronze non- metallic			70FT 70 ft		
		RD Red (2) (3)	WFL Wide Flood 60°		GRATX Textured medium gray			100FT 100 ft		
		GR Green (2) (3)	NAS Narrow Asymmetric		GRNTX Textured green					
		BL Blue (2) (3)	WW Asymmetric Wallwash		WHTX Textured white					
					CC Custom color and finish (please specify RAL color) (8) (9) (10)					

Notes:

1. Consult factory for availability of static Royal Blue, Amber, 6500K and 90+ CRI.
2. Static colors made to order 8-10 weeks.
3. Not available for XN optic.
4. Optical options are factory installed and cannot be changed in the field.
5. Not available with VN and NF optics when combined with 2200K, 2700K, 3000K, 3500K, 4000K and 5700K static colors.
6. Field adjustable spread lens optical accessory available, order separately.
7. Not available with WFL, NAS and WW optics.
8. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
9. Setup charges apply for RAL colors. Consult factory for details.
10. Longer lead times can be expected for custom RAL color finishes.
11. Lumentalk system is enabled with LDB accessory. DIM or DMX/RDM must be specified in the order code. See the typical wiring diagrams in the specification sheet for details.
12. A Lumentranslator 2 (LTL2) and LumentalkID (LIDL) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
13. A control box (CBX) and LumenID (LID) must be specified.
14. Maximum of 3 ft cable length for daisy chain DMX applications with CBX-DS.
15. Use only when exposed to salt spray and harsh chemicals. This option is not required for normal outdoor exposure.
16. Setup charges apply. Consult factory for details.
17. Consult European specification sheets and installation instructions for CE and CE Class II wiring information.
18. 3 ft cable length is standard unless otherwise specified.
19. Not available with CE or CBI certification options.



Catalog # : _____

Project : **TYPE SL4-
east elevation egress**

Prepared By : _____

Date : _____

Slim Wall Pack (WPSLS)

Small LED Slim Wall Pack



OVERVIEW

Lumen Range	1,000 - 4,000
Wattage Range	12 - 40
Efficacy Range (LPW)	98 - 122
Weight lbs(kg)	3.8 (1.7)

QUICK LINKS

[Ordering Guide](#)[Performance](#)[Dimensions](#)[Photometrics](#)

FEATURES & SPECIFICATIONS

Construction

- Rigid Precision Die cast-aluminum housing for durability and consistency.
- Vertical fins serve as a heat sink and resist accumulation of dust and debris.
- The Patent Pending thermal stacking heat removal technology extracts heat from within the housing moving it away from LEDs and integral components.
- Luminaire hinges open from the bottom to prevent leakage.
- Luminaire is proudly manufactured and tested in the U.S.
- Fixtures are finished with LSI's DuraGrip® polyester powder coat finishing process. The DuraGrip finish withstands extreme weather changes without cracking or peeling. Other standard LSI finishes available. Consult factory
- Shipping weight: 3.8 lbs in carton.

Optical System

- High-performance Chip On Board (COB) LEDs behind clear tempered glass for maximum light output.
- 3000K | 4000K | 5000K color temperatures.
- Minimum CRI of 71.
- Zero uplight.

Electrical

- High-performance driver features over-voltage, under voltage, short-circuit and over temperature protection.
- 0-10 volt dimming (10% - 100%) standard.
- Standard Universal Voltage (120-277 Vac) Input 50/60 Hz
- L70 Calculated Life: >100k Hours
- Total harmonic distortion: <20%
- Power factor: >.85
- Input power stays constant over life.
- Driver Off-State Power is 0 watts.
- Chip On Board (COB) LEDs with integrated circuit board mounted directly to the housing to maximize heat dissipation and promote long life.
- Components are fully encased in potting material for moisture resistance. Driver complies with FCC standards. Driver and key electronic components can easily be accessed.
- Minimum 2.5kV surge rating
- Operating temperature: -40°C to +50°C (-40°F to +122°F)

Controls

- Optional 120V electronic button Photocontrol.
- Apertures for field or factory installed photo-control.

Installation

- Surface mounts direct to J-box or wall.
- Features a bubble level and removable hinged face frame for ease of installation.

Warranty

- LSI LED Fixtures carry a 5-year warranty.
- 1 Year warranty on optional Button Photocell.

Listings

- Listed to UL 1598 and UL 8750.
- CSA Listed
- RoHS Compliant.
- DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.
- American Recovery and Reinvestment Act Funding Compliant.
- Suitable For Wet Locations.

Specifications and dimensions subject to change without notice.





Small LED Slim Wall Pack (WPSLS)

TYPE SL4-
east elevation agress

ORDERING GUIDE

[Back to Quick Links](#)

TYPICAL ORDER EXAMPLE: **WPSLS LED 1L UNV DIM 30 PC120 BZA**

Family Prefix	Lumen Package	Color Temp	Controls	Finishes
WPSLS - Small Slim Wall Pack	1L - 1000 Lumens 2L - 2000 Lumens 4L - 4000 Lumens	30 - 3000K 40 - 4000K 50 - 5000K	PC120 - 120V Photocontrol PM208-277 - 208-277V Photocontrol	BZA - Bronze WHT - White BLK - Black

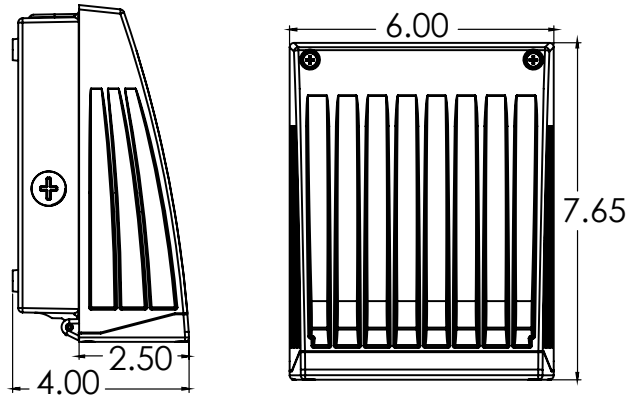
PERFORMANCE

Lumens	3000K		4000K		5000K		Wattage
	Delivered Lumens	Efficacy	Delivered Lumens	Efficacy	Delivered Lumens	Efficacy	
1L	1206	97.79	1206	97.79	1366	111.11	12
2L	2125	107.2	2125	107.2	2418	121.97	20
4L	3712	100.18	3712	100.18	4394	116.21	40

LED		HID			Annual Savings
Wattage	Annual Cost	Source Wattage	Total Wattage Used	Annual Cost	
12	\$5	50	72	\$52	\$47
		70	90	\$59	\$54
20	\$9	50	72	\$52	\$43
		70	90	\$59	\$50
		100	129	\$77	\$68
40	\$18	100	129	\$77	\$59
		150	185	\$100	\$82
		175	210	\$112	\$94

PRODUCT DIMENSIONS

[Back to Quick Links](#)



PHOTOMETRICS

[Back to Quick Links](#)

Luminaire photometry has been conducted by a NVLAP accredited testing laboratory in accordance with IESNA LM-79-08. As specified by IESNA LM-79-08 the entire luminaire is tested as the source resulting in a luminaire efficiency of 100%. See <http://www.lsi-industries.com/products/led-lighting-solutions.aspx> for detailed photometric data.

WPSLS-4L-40

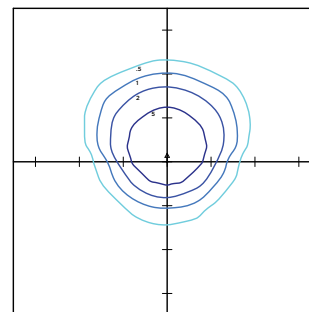
Luminaire Data

Wide Distribution	
Description	4000 Kelvin, 70 CRI
Delivered Lumens	4,053
Watts	37.0
Efficacy	109
IES Type	Type III - Very Short
BUG Rating	B1-U0-G1

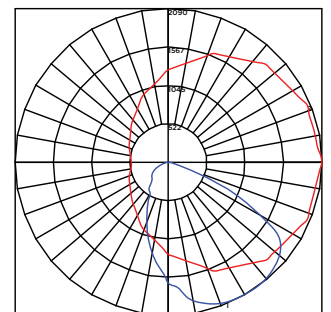
Zonal Lumen Summary

Zone	Lumens	%Luminaire
Low (0-30°)	1239.6	30.6%
Medium (30-60°)	2246.2	55.4%
High (60-80°)	559.6	13.8%
Very High (80-90°)	7.3	0.2%
Uplight (90-180°)	0.0	0.0%
Total Flux	4052.7	100%

ISO FOOTCANDLE PLOT



POLAR CURVE



10' Mounting Height/10' Grid Spacing

■ 10 FC ■ 5 FC ■ 2 FC ■ 1 FC



Constitution - XCN4 LED Decorative Pedestrian & Area Light



This latest iteration of the LED Constitution decorative and pedestrian area light features LSI's innovative and high-performance silicone optics, as also featured in LSI's ground-breaking, patent-pending Mirada Series fixtures. The Constitution is designed to illuminate pathways, walkway areas and campus sites. Its contemporary, sleek design complements architectural design elements well.

Features & Specifications

Optical System

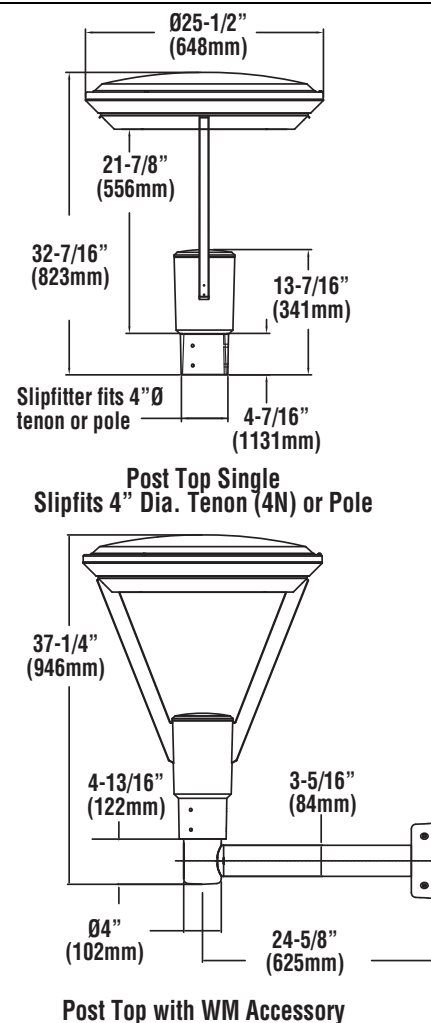
- State-of-the-Art one piece silicone optic sheet delivers industry leading optical control with an integrated gasket to provide IP66 rated sealed optical chamber in 1 component.
- Proprietary silicone refractor optics provide exceptional coverage and uniformity in IES Types 2, 3, 5W and FT.
- Silicone optical material does not yellow or crack with age and provides a minimum light transmittance of 93%.
- Optical distributions are field rotatable (in 90° increments).
- Available in 5000K, 4000K, and 3000K (+/- 275K) color temperatures.
- Minimum CRI of 70. Consult Factory for Higher CRI requirements.
- Integral Louver (IL) option available for improved back-light control without sacrificing street side performance. See page 4 for more details.

Electrical

- High-performance driver features over-voltage, under-voltage, short-circuit and over temperature protection.
- 0-10V dimming (10% - 100%) standard.
- Standard Universal Voltage (120-277 Vac) Input 50/60 Hz or optional High Voltage (347-480 Vac).
- L70 Calculated Life: >100k Hours (See Lumen Maintenance on Page 2)
- Total harmonic distortion: <20%
- Operating temperature: - -40°C to +50°C (-40°F to +122°F)
- Power factor: >.90
- Input power stays constant over life.
- Field replaceable surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).
- High-efficacy LEDs mounted to metal-core circuit board to maximize heat dissipation
- Terminal block provided accepts up to 10ga wire, however the luminaire is supplied with a 32' 3 conductor wire harness.
- Components are fully encased in potting material for moisture resistance. Driver complies with FCC standards. Driver and key electronic components can easily be accessed.



Product Dimensions





Features & Specifications (Cont.)

Construction

- Rugged die-cast aluminum housing.
- Cast aluminum wiring access door located in lower hub/fitter.
- Rigid die-cast aluminum arms for consistency and strength.
- Precision die cast aluminum heatsink and optical frame.
- Removable spun aluminum cap/driver enclosure is retained by captive stainless steel fasteners and safety cables. Housing and top cap interface is sealed with a one-piece extruded silicone gasket. Tool-less entry option is available.
- All exposed fasteners are black oxide coated stainless steel. Internal fasteners are stainless steel or zinc electroplated steel.
- Luminaire is proudly made in the U.S.
- IP65 rated luminaire protects integral components from harsh environments.
- 1.5G rated for ANSI C136.31 high vibration applications
- Fixtures are finished with LSI's DuraGrip® polyester powder coat finishing process. The DuraGrip finish withstands extreme weather changes without cracking or peeling. Other standard LSI finishes available. Consult factory.
- Shipping weight: 45 lbs in carton.

Controls

- Optional integral passive infrared motion and daylight sensor activates switching of luminaire light levels (see page 5 for more details).
- 7-pin ANSI C136.41-2013 photocontrol receptacle option available for twist lock photocontrols or wireless control modules.
- LSI's Gold and Platinum wireless control system options reduce energy and maintenance costs while optimizing light quality 24/7. (see page 5 for more details)

Installation

- Mounts to 4" O.D. pole or tenon.
- Secures to pole with 6 stainless steel set screws.
- 32' wire leads are provided bundled in the slip fitter hub for ease of wiring.

Warranty

- LSI LED Fixtures carry a 5-year warranty.

Listings

- Listed to UL 1598 and UL 8750.
- RoHS Compliant.
- State of California Title 24.
- DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.
- American Recovery and Reinvestment Act Funding Compliant.
- Lighting Facts Approved.
- Suitable For wet Locations.
- IP65 rated Luminaire. IP66 rated optical chamber.
- 1.5G rated for ANSI C136.31 high vibration applications

Performance

ELECTRICAL DATA*							
Lumens	120V	208V	240V	277V	347V	480V	Watts
10L	0.63	0.36A	0.31A	0.27A	0.22A	0.16A	75
18L	1.29A	0.75A	0.65A	0.56A	0.45A	0.32A	155
25L	1.98A	1.14A	.99A	.86A	0.68A	0.49A	237

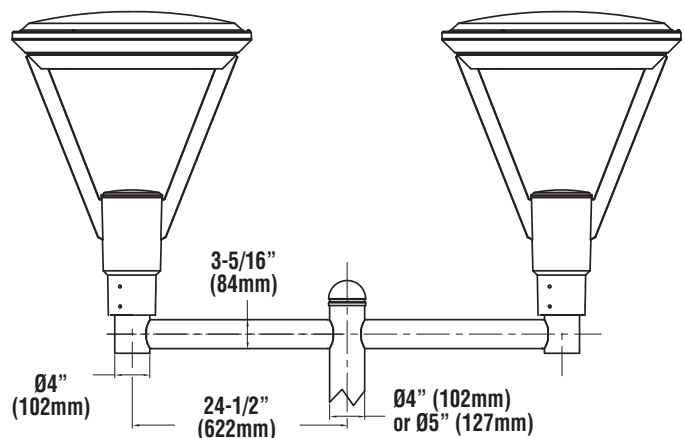
*Electrical data at 25C (77F). Actual wattage may differ by +/-10%.

RECOMMENDED LUMEN MAINTENANCE ¹					
Ambient	Initial ²	25 hr ²	50 hr ²	75 hr ³	100 hr ³
0 C	1.06	1.05	1.05	1.05	1.04
10 C	1.04	1.02	1.02	1.02	1.01
20 C	1.01	1.00	0.99	0.99	0.99
25 C	1.00	0.98	0.97	0.97	0.96
30 C	0.99	0.97	0.96	0.96	0.95
40 C	0.97	0.92	0.89	0.86	0.83

1 - Lumen maintenance values at 25C are calculated per TM-21 based on LM-80 data and in-situ testing.

2 - In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times the IESNA LM-80-08 total test duration for the device under testing.

3 - In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times the IESNA LM-80-08 total test duration for the device under testing.



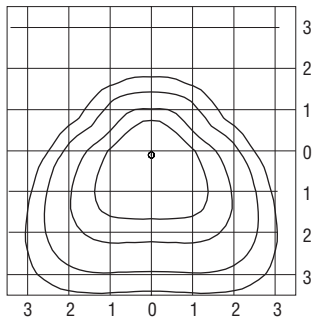
Post Top with BK MPT BO (x2)
Mounts to 4" or 5" Dia. D180 Bolt-on Pole
(select 3" reduced drilling pattern)

LUMINAIRE EPA CHART - Constitution		
	MOUNTING STYLE	EPA
■ PT Single	PT	1.0
■ PT D180° with BK MPT BO (2)	PT	2.0

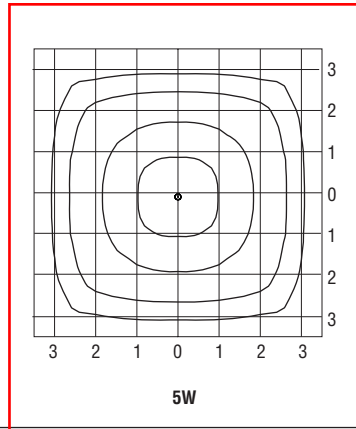


Performance (Cont.)

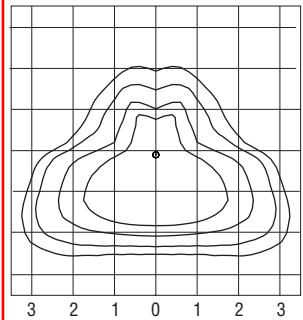
All published luminaire photometric testing performed to IESNA LM-79 standards by NVLAP, certified laboratory. ISO footcandle plots below demonstrate the Constitution (XCN4) light patterns only. Not for total fixture output. For complete specifications and IES files, see website.



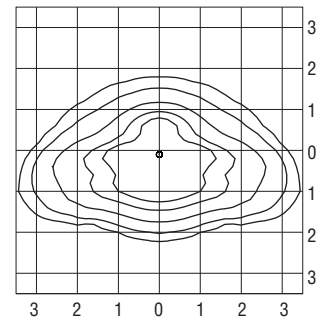
FT



5W



Type 3



Type 2

PERFORMANCE											
Lumens	Distribution Type	3000K			4000K			5000K			Wattage
		Delivered Lumens	Efficacy	BUG Rating	Delivered Lumens	Efficacy	BUG Rating	Delivered Lumens	Efficacy	BUG Rating	
10L	2	8,879	118	B3-U2-G3	9,578	128	B3-U2-G3	9,634	128	B3-U2-G3	75
	3	9,312	124	B2-U2-G3	10,045	134	B2-U2-G3	10,187	136	B2-U2-G3	75
	FT	9,066	121	B3-U2-G3	9,780	130	B3-U2-G3	9,847	131	B3-U2-G3	75
	5W	8,921	119	B4-U2-G2	9,624	128	B4-U2-G2	9,771	130	B4-U2-G2	75
18L	2	16,620	107	B3-U2-G3	17,929	114	B4-U2-G4	18,108	117	B4-U2-G4	155
	3	17,475	113	B3-U2-G3	18,851	122	B3-U2-G4	18,982	122	B3-U2-G3	155
	FT	17,042	110	B4-U2-G2	18,384	119	B3-U2-G4	18,738	121	B3-U2-G4	155
	5W	17,241	111	B3-U2-G3	18,599	120	B4-U2-G2	18,606	120	B3-U2-G3	155
25L	2	22,583	95	B4-U2-G3	24,361	103	B4-U2-G3	24,546	104	B4-U2-G3	237
	3	23,660	100	B3-U2-G4	25,523	108	B3-U2-G4	25,834	109	B3-U2-G4	237
	FT	23,217	98	B3-U2-G4	25,045	106	B3-U2-G4	25,449	107	B3-U2-G4	237
	5W	22,687	96	B5-U2-G3	24,474	103	B5-U2-G3	24,905	105	B5-U2-G4	237



Ordering Guide

TYPICAL ORDER EXAMPLE: **XCN4 PT LED 18L 50 UE BRZ GCM**

Luminaire Prefix	Distribution	Light Source	Lumens	Color Temp	Line Voltage	Finish	Optional Controls	Options
XCN4 - Constitution	2 - Type II 3 - Type III 5W - Type 5 Wide F1 - Forward Throw (Type IV)	LED	10L - 10,000 Lumens 18L - 18,000 Lumens 25L - 25,000 Lumen	50 - 5000K 40 - 4000K 30 - 3000K	UE - Universal Voltage (120-277v) HV - High Voltage (347-480v)	BRZ - Bronze BLK - Black GPT - Graphite MSV - Metallic Silver WHT - White PLP - Platinum Plus SVG - Satin Verde Green	Wireless Controls System 1 PCM - Platinum Control System PCMH - Host/Satellite Platinum Control System GCM - Gold Control System (Blank) - None Stand-Alone Control (Blank) - None IMS - Integral Motion Sensor ⁸	PCR 7P - Photoelectric Control Receptacle ² IL - Integral Louver Shield TE - Toolless Access

color to match SEZ fixtures

ACCESSORY ORDERING INFORMATION (Accessories are field installed)		
Description	Order Number	Description
BK MPT B04 - Bolt on Bracket (for PT 180) For 4" O.D. Round Poles	490025CLR ⁸	WM - Wall Mount Bracket (PT Only)
BK MPT B05 - Bolt on Bracket (for PT 180) For 5" O.D. Round Poles	490035CLR ⁸	DFK208,240 Double Fusing (208V, 240V)
IL - Integral Louver Shield (Black only)	654939	DFK480 Double Fusing (480V)
PC120 Photocell for use with PCR option (120V)	122514 ^{3,7}	FK347 Single Fusing (347V)
PC208-277 Photocell for use with PCR option (208V, 240V, 277V)	122515 ^{3,7}	PMOS120 - 120V Pole-Mount Occupancy Sensor
PC347 Photocell for use with PCR option (347V)	122516 ^{3,7}	PMOS208/240 - 208, 240V Pole-Mount Occupancy Sensor
PC480 Photocell for use with PCR option (480V)	1225180 ^{3,7}	PMOS277 - 277V Pole-Mount Occupancy Sensor
FK120 Single Fusing (120V)	FK120 ⁴	ALSC UNV TL5 - AirLink 5 Pin Twist Lock Controller
FK277 Single Fusing (277V)	FK277 ⁴	ALSC UNV TL7 - AirLink 7 Pin Twist Lock Controller
		C/F
		DFK208, 240 ⁴
		DFK480 ⁴
		FK347 ⁴
		518030CLR ⁵
		534239CLR ⁵
		518029CLR ⁵
		661409
		661410

FOOTNOTES:

- 1 - Requires a SiteManager and override switch.
- 2 - Photocell must be ordered separately. See Accessories.
- 3 - Factory installed PCR option required. See Options.
- 4 - Fusing must be located in hand hole of pole.
- 5 - To be used in conjunction with PCM/GCM control modules in fixture. Consult factory.

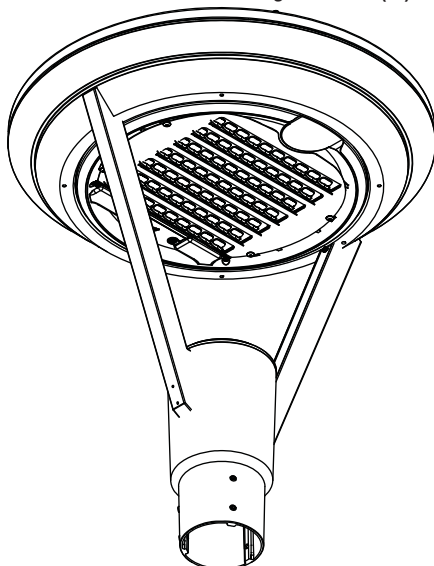
- 6 - Consists of a daylight & motion dual sensor . Light levels are field adjustable, via a handheld remote configurator tool.
- 7 - These photocells provide Dusk/Dawn, on-off control only. Consult factory for alternate photocells providing additional functionality.
- 8 - Order poles with 3" reduced drilling pattern. For PT mounting configurations other than D180, consult factory. Order one bracket per fixture

Accessories/Options

Integral Louver (IL)

Optional Integral Louver available for improved back-light control without sacrificing street side performance.

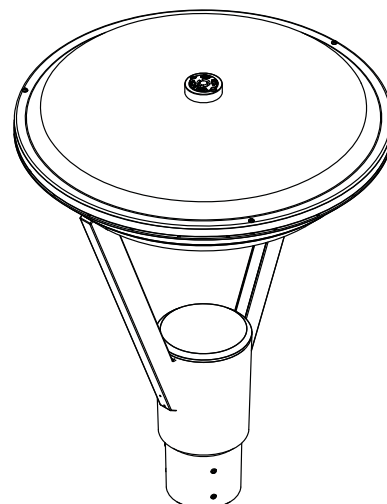
Fixture Shown with Integral Louver (IL)



7 Pin Photoelectric Control

7-pin ANSI C136.41-2013 photocontrol receptacle option available for twist lock photocontrols or wireless control modules. Control accessories sold separately. Dimming leads from the receptacle will be connected to the driver dimming leads (Consult factory for alternate wiring).

Fixture Shown with PCR 7P





TYPE SP1-
parking lot-type V

Constitution - XCN4

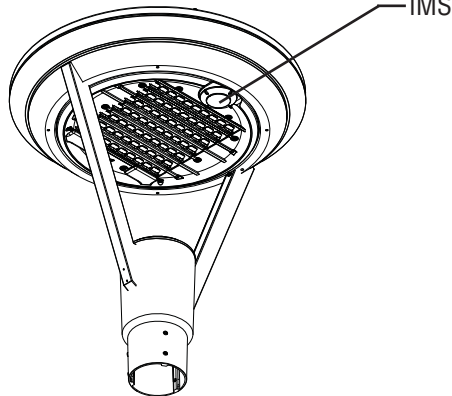
LED Decorative Pedestrian & Area Light

Controls

Occupancy Sensor / Daylight Sensor (IMS)

Optional integral passive infrared motion and daylight sensor activates switching of luminaire light levels. Standard Factory settings: High level light is activated and increased to full bright upon detection of motion. Low light level (30% maximum drive current) is activated when target zone is absent of motion activity for ~5 minutes. Sensor has a detection cone of approximately 45°, see coverage diagram. Optional configurator tool allows for easy and safe programming of each luminaire from the ground level.

Fixture Shown with IMS

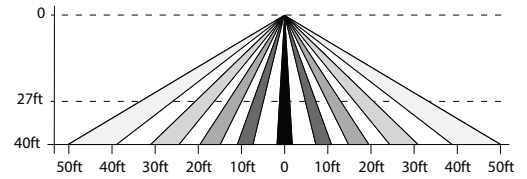


IMS/PC Remote Configurator Tool

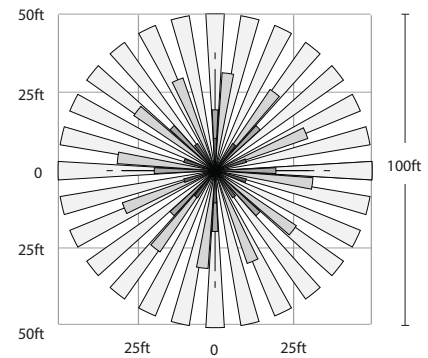


Optional IMS Coverage Diagram

SIDE VIEW

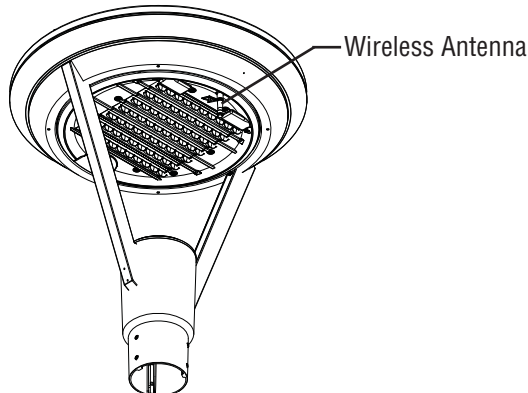


TOP VIEW



Wireless Control Systems

Fixture Shown with Wireless Controls





AirLink™
enabled by Synapse®



Wireless Lighting Controller 5 Pin & 7 Pin Twist Lock

The 5 Pin Twist Lock Controller (TL5) & The 7 Pin Twist Lock Controller (TL7) are intelligent wireless lighting controllers with exceptional fault tolerance & a multitude of features. Each TL5 & TL7 provides intelligent On/Off switching, dimming, control, highly accurate power metering, status monitoring of your lighting fixtures & digital sensor input (TL7 only).

Features

- Integrated Photocell
- ANSI C136.41 Dimming Receptacle Support
- Utility grade power monitoring
- Remote control and scheduling
- Flexible Dimming Controls
- Secure, over-the-air upgrades to support future enhancements
- Seamless integration into the AirLink Site Manager system
- Digital sensor input for motion sensing (TL7 only)

Power and Performance

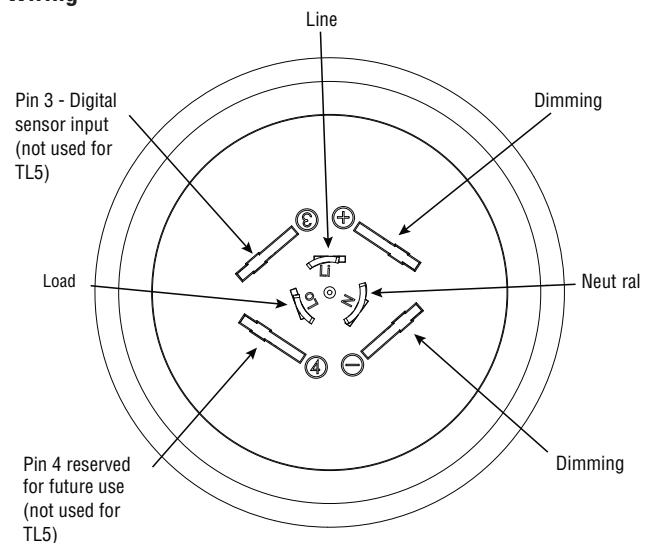
- Operating environmental: -40°F to 158°F (-40°C to 70°C); 20% to 90% RH non-condensing; IP66

- Input power: 100–277 VAC +/- 10% (Max 305V)50/60 Hz
- Switched output: Default ON
- Load rating: 5A @ 100V to 277V (+/- 10%)
- Dimming control: 0–10V with short circuit protection
- Dimming output: maximum current 10mA
- Sensor input: One digital input that can be used for motion-based lighting controls (TL7 only)
- Power monitoring: Utility grade - 2% accuracy
- Power readings: Voltage, Watts

Other

- Dimensions: 4.53" W x 2.68" H (115mm W x 68mm H)
- Radio: SNAP 2.4 GHz; 802.15.4; +20 dBm Transmit Power; -104 dBm Receive Sensitivity
- Warranty: 5 years

Wiring



Contact LSI Controls



Sales
controls.sales@lsi-industries.com



Support
controls.support@lsi-industries.com
1 (800) 436-7800 (support, option 8)



More information
For more information on AirLink, visit our website at www.lsi-airlink.com/airlink

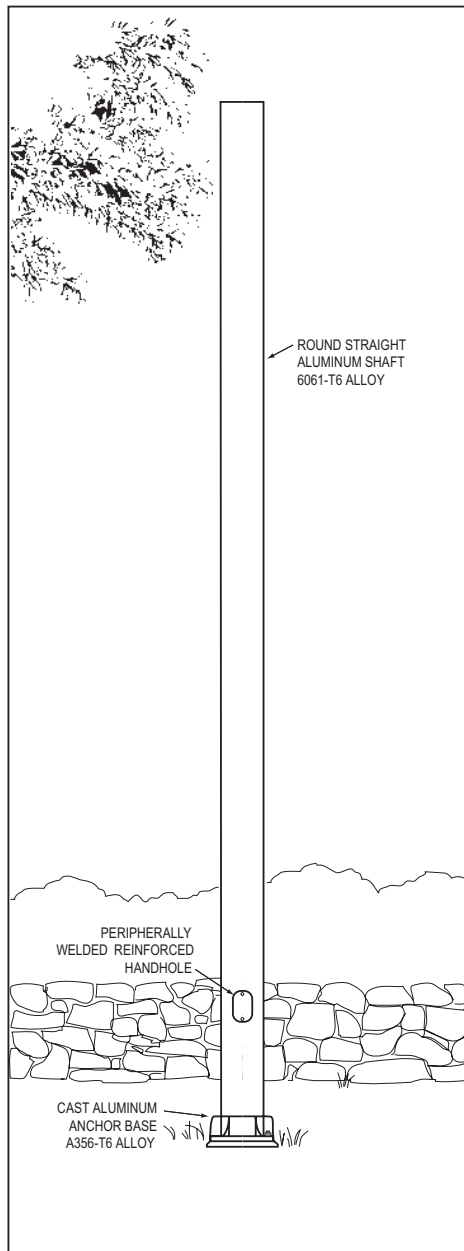
Aluminum

8' TO 30' ROUND STRAIGHT ALUMINUM POLE 4-BOLT ANCHOR BASE



**TYPE SP1/ SP2/SP3-
site pole**

- 8' to 30' mounting heights
- 4-bolt base
- Luminaires may be mounted on tenons, brackets, or shaft may be drilled to manufacturer's mounting specifications



SPECIFICATIONS

All aluminum alloys comply with metallurgical and mechanical properties set forth in the Aluminum Association Standards.

SHAFT

The shaft is extruded new seamless 6061 alloy aluminum tubing and heat treated to produce a T6 temper. The shaft is drilled to manufacturer's specifications for mounting luminaires. All shafts are polished with fine grit aluminum oxide cloths, resulting in a high quality, circumferential satin brushed finish. After finishing each standard is wrapped for protection in shipment.

ANCHOR BASE

The anchor base is cast from A356 alloy aluminum and is heat treated to a T6 condition. The shaft is inserted into the anchor base casting. The anchor base casting is joined by a continuous circumferential weld at the outside tip and inside bottom of the anchor base. A356 nut covers are included with each anchor base unless otherwise specified.

HANDHOLES

All standards in this model range include a peripherally reinforced flush covered handhole centered 18" above the bottom of the standard. The opening in the 4 1/2", 5" and 6" diameter standard measures 3" x 5". The opening in the 4" diameter standard measures 2 3/8" x 4 1/2"

ANCHOR BOLTS

Each anchor base standard includes four steel hot dip galvanized anchor bolts each with two nuts, two flat washers and one lock washer sized to match the anchor bolts. A schedule of bolt sizes appears on the next page. A grounding lug is installed opposite the handhole.

SPECIAL FINISHES

Natural anodized, duranodic anodized, painted, or powder coated finishes may be specified as an addition to the satin brushed finish, if required. All aluminum parts and accessories receive a finish similar to that specified.

ANCHOR BASE AND BOLT DETAIL

POLE DIAMETER	BOLT CIRCLE	BOLT PROJECTION	BOLT SIZE	CONDUIT OPENING	BASE SIZE
4"	7 1/2"	3 1/4"	3/4" x 15"	3 3/4"	8 3/4"
5"	7 1/2"	3 1/4"	3/4" x 15"	4 1/2"	9 1/4"
6"	8 3/4" - 10 3/4"	3 1/2"	3/4" x 25"	5 1/2"	10 1/4"

ORDERING EXAMPLE

48-A/125	4" x .125 x 8'	7' 8"	Straight	SB
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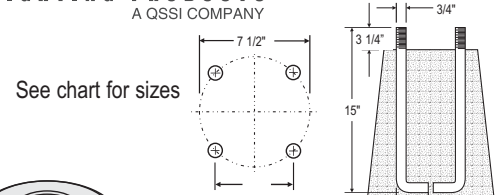
Model Number Size Mount Height Pole Type Finish

Finish Options
 SB=Satin Brushed Finish (Standard)
 NA=Natural Anodized
 DA=Duranodic Anodized
 PA=Painted
 PC=Powder Coated

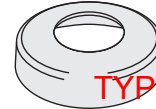
This example illustrates the standard ordering sequence. Select each part of the ordering number from the Ordering Chart on the following page.

POLES

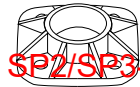
Aluminum



See chart for sizes



Spun cover optional at additional cost



Nut covers standard site pole

8' TO 30' ROUND STRAIGHT ALUMINUM POLE 4-BOLT ANCHOR BASE

POLES		TYPICAL WEIGHT AND ALLOWABLE SIZE OF LUMINAIRES*						DIMENSIONS OF STANDARDS		
MODEL NUMBER	MOUNT HEIGHT	LUMINAIRE WEIGHT-LBS	EFFECTIVE PROJECTED AREA-SQ FT-AT:					STANDARD HEIGHT	OUTSIDE DIAMETER	WALL
			70 MPH	80 MPH	90 MPH	100 MPH	110 MPH			
48-A/125	8'	75	15.1	11.2	8.6	6.8	5.5	8'	4"	.125
4.58-A/125	8'	75	19.6	14.6	11.3	9.1	7.5	8'	4 1/2"	.125
48-A/188	8'	75	28.9	21.8	17.0	13.7	11.3	8'	4"	.188
410-A/125	10'	75	11.2	8.2	6.1	4.7	3.8	10'	4"	.125
4.510-A/125	10'	150	14.4	10.6	8.1	6.5	5.3	10'	4 1/2"	.125
410-A/188	10'	150	21.8	16.3	12.6	10.1	8.2	10'	4"	.188
510-A/125	10'	150	18.3	13.6	10.6	8.5	6.9	10'	5"	.125
412-A/125	12'	75	8.4	6.0	4.3	3.2	2.6	12'	4"	.125
4.512-A/125	12'	75	11.2	8.1	6.0	4.8	3.8	12'	4 1/2"	.125
412-A/188	12'	75	17.2	12.7	9.7	7.7	6.3	12'	4"	.188
512-A/125	12'	150	14.1	10.3	8.0	6.3	5.1	12'	5"	.125
512-A/156	12'	150	17.9	13.2	10.3	8.2	6.7	12'	5"	.156
512-A/188	12'	150	21.7	16.2	12.6	10.1	8.2	12'	5"	.188
414-A/125	14'	150	6.1	4.1	2.8	1.9	1.5	14'	4"	.125
4.514-A/125	14'	150	8.3	5.8	4.2	3.3	2.6	14'	4 1/2"	.125
414-A/188	14'	150	13.4	9.7	7.3	5.8	4.6	14'	4"	.188
514-A/125	14'	150	10.9	7.8	6.0	4.7	3.8	14'	5"	.125
514-A/156	14'	150	14.2	10.3	8.0	6.3	5.1	14'	5"	.156
514-A/188	14'	150	17.4	12.8	9.9	7.9	6.4	14'	5"	.188
416-A/125	16'	150	4.4	2.8	1.6	1.0	0.7	16'	4"	.125
4.516-A/125	16'	150	6.3	4.2	2.8	2.1	1.6	16'	4 1/2"	.125
416-A/188	16'	150	10.7	7.5	5.5	4.3	3.4	16'	4"	.188
516-A/125	16'	150	8.5	5.9	4.4	3.4	2.7	16'	5"	.125
516-A/156	16'	150	11.3	8.0	6.1	4.8	3.8	16'	5"	.156
516-A/188	16'	150	14.0	10.1	7.8	6.1	4.9	16'	5"	.188
616-A/156	16'	150	18.1	13.6	10.6	8.4	6.8	16'	6"	.156
616-A/188	16'	150	22.3	16.8	13.0	10.4	8.5	16'	6"	.188
418-A/188	18'	150	8.5	5.7	4.0	3.1	2.4	18'	4"	.188
518-A/125	18'	150	6.5	4.3	3.1	2.4	1.8	18'	5"	.125
518-A/156	18'	150	8.9	6.1	4.6	3.5	2.8	18'	5"	.156
518-A/188	18'	150	11.3	8.0	6.8	4.7	3.8	18'	5"	.188
618-A/188	18'	150	18.5	13.9	10.7	8.5	6.9	18'	6"	.188
4.520-A/188	20'	150	6.8	4.3	2.9	2.1	1.6	20'	4 1/2"	.188
520-A/125	20'	150	4.9	3.0	2.1	1.5	1.1	20'	5"	.125
520-A/156	20'	150	7.2	4.7	3.4	2.6	2.0	20'	5"	.156
520-A/188	20'	150	9.4	6.4	4.8	3.6	2.8	20'	5"	.188
620-A/156	20'	150	12.6	9.3	7.1	5.5	4.4	20'	6"	.156
620-A/188	20'	150	15.9	11.8	9.1	7.1	5.7	20'	6"	.188
4.525-A/188	25'	150	3.1	1.3	-	-	-	25'	4 1/2"	.188
625-A/156	25'	150	7.3	5.2	3.8	2.8	2.1	25'	6"	.156
625-A/188	25'	150	9.8	7.1	5.3	4.0	3.1	25'	6"	.188
630-A/188	30'	200	5.2	3.5	2.4	1.6	1.1	30'	6"	.188

10'-6" pole

SP3

SP1-
SP2

*EPA calculations allow for 1.3 Gust Factor. **Standard includes factory installed vibration dampener. Variations from standard sizes listed above, available upon inquiry at the factory. Satisfactory performance of lighting standards is dependent upon the standard being properly attached to a supporting foundation of adequate design. PEMCO does not design or offer recommendations for foundations.



Constitution - XCN4 LED Decorative Pedestrian & Area Light



This latest iteration of the LED Constitution decorative and pedestrian area light features LSI's innovative and high-performance silicone optics, as also featured in LSI's ground-breaking, patent-pending Mirada Series fixtures. The Constitution is designed to illuminate pathways, walkway areas and campus sites. Its contemporary, sleek design complements architectural design elements well.

Features & Specifications

Optical System

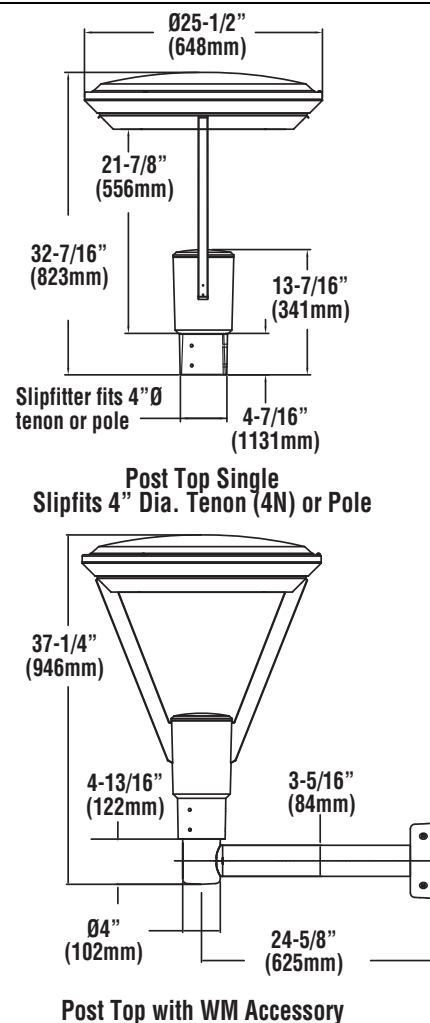
- State-of-the-Art one piece silicone optic sheet delivers industry leading optical control with an integrated gasket to provide IP66 rated sealed optical chamber in 1 component.
- Proprietary silicone refractor optics provide exceptional coverage and uniformity in IES Types 2, 3, 5W and FT.
- Silicone optical material does not yellow or crack with age and provides a minimum light transmittance of 93%.
- Optical distributions are field rotatable (in 90° increments).
- Available in 5000K, 4000K, and 3000K (+/- 275K) color temperatures.
- Minimum CRI of 70. Consult Factory for Higher CRI requirements.
- Integral Louver (IL) option available for improved back-light control without sacrificing street side performance. See page 4 for more details.

Electrical

- High-performance driver features over-voltage, under-voltage, short-circuit and over temperature protection.
- 0-10V dimming (10% - 100%) standard.
- Standard Universal Voltage (120-277 Vac) Input 50/60 Hz or optional High Voltage (347-480 Vac).
- L70 Calculated Life: >100k Hours (See Lumen Maintenance on Page 2)
- Total harmonic distortion: <20%
- Operating temperature: - -40°C to +50°C (-40°F to +122°F)
- Power factor: >.90
- Input power stays constant over life.
- Field replaceable surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).
- High-efficacy LEDs mounted to metal-core circuit board to maximize heat dissipation
- Terminal block provided accepts up to 10ga wire, however the luminaire is supplied with a 32' 3 conductor wire harness.
- Components are fully encased in potting material for moisture resistance. Driver complies with FCC standards. Driver and key electronic components can easily be accessed.



Product Dimensions





Features & Specifications (Cont.)

Construction

- Rugged die-cast aluminum housing.
- Cast aluminum wiring access door located in lower hub/fitter.
- Rigid die-cast aluminum arms for consistency and strength.
- Precision die cast aluminum heatsink and optical frame.
- Removable spun aluminum cap/driver enclosure is retained by captive stainless steel fasteners and safety cables. Housing and top cap interface is sealed with a one-piece extruded silicone gasket. Tool-less entry option is available.
- All exposed fasteners are black oxide coated stainless steel. Internal fasteners are stainless steel or zinc electroplated steel.
- Luminaire is proudly made in the U.S.
- IP65 rated luminaire protects integral components from harsh environments.
- 1.5G rated for ANSI C136.31 high vibration applications
- Fixtures are finished with LSI's DuraGrip® polyester powder coat finishing process. The DuraGrip finish withstands extreme weather changes without cracking or peeling. Other standard LSI finishes available. Consult factory.
- Shipping weight: 45 lbs in carton.

Controls

- Optional integral passive infrared motion and daylight sensor activates switching of luminaire light levels (see page 5 for more details).
- 7-pin ANSI C136.41-2013 photocontrol receptacle option available for twist lock photocontrols or wireless control modules.
- LSI's Gold and Platinum wireless control system options reduce energy and maintenance costs while optimizing light quality 24/7. (see page 5 for more details)

Installation

- Mounts to 4" O.D. pole or tenon.
- Secures to pole with 6 stainless steel set screws.
- 32' wire leads are provided bundled in the slip fitter hub for ease of wiring.

Warranty

- LSI LED Fixtures carry a 5-year warranty.

Listings

- Listed to UL 1598 and UL 8750.
- RoHS Compliant.
- State of California Title 24.
- DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.
- American Recovery and Reinvestment Act Funding Compliant.
- Lighting Facts Approved.
- Suitable For wet Locations.
- IP65 rated Luminaire. IP66 rated optical chamber.
- 1.5G rated for ANSI C136.31 high vibration applications

Performance

ELECTRICAL DATA*							
Lumens	120V	208V	240V	277V	347V	480V	Watts
10L	0.63	0.36A	0.31A	0.27A	0.22A	0.16A	75
18L	1.29A	0.75A	0.65A	0.56A	0.45A	0.32A	155
25L	1.98A	1.14A	.99A	.86A	0.68A	0.49A	237

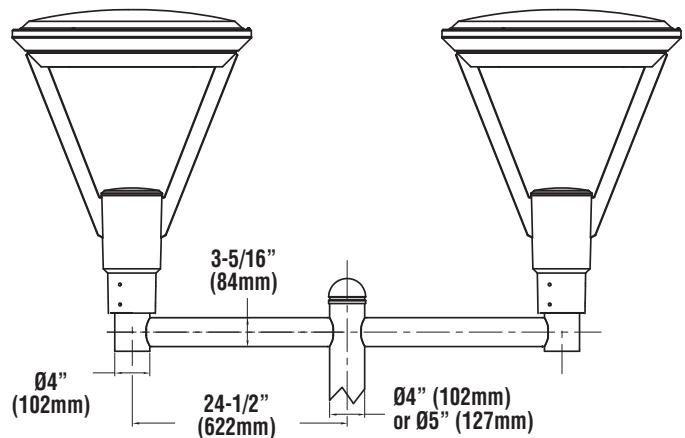
*Electrical data at 25C (77F). Actual wattage may differ by +/-10%.

RECOMMENDED LUMEN MAINTENANCE ¹					
Ambient	Initial ²	25 hr ²	50 hr ²	75 hr ³	100 hr ³
0 C	1.06	1.05	1.05	1.05	1.04
10 C	1.04	1.02	1.02	1.02	1.01
20 C	1.01	1.00	0.99	0.99	0.99
25 C	1.00	0.98	0.97	0.97	0.96
30 C	0.99	0.97	0.96	0.96	0.95
40 C	0.97	0.92	0.89	0.86	0.83

1 - Lumen maintenance values at 25C are calculated per TM-21 based on LM-80 data and in-situ testing.

2 - In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times the IESNA LM-80-08 total test duration for the device under testing.

3 - In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times the IESNA LM-80-08 total test duration for the device under testing.



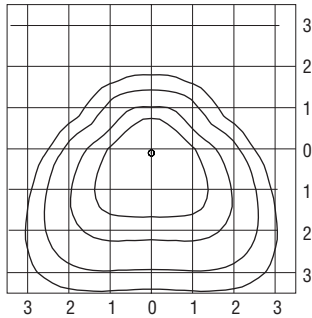
Post Top with BK MPT BO (x2)
Mounts to 4" or 5" Dia. D180 Bolt-on Pole
(select 3" reduced drilling pattern)

LUMINAIRE EPA CHART - Constitution		
	MOUNTING STYLE	EPA
■ PT Single	PT	1.0
■ PT D180° with BK MPT BO (2)	PT	2.0

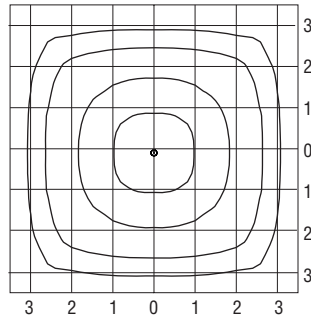


Performance (Cont.)

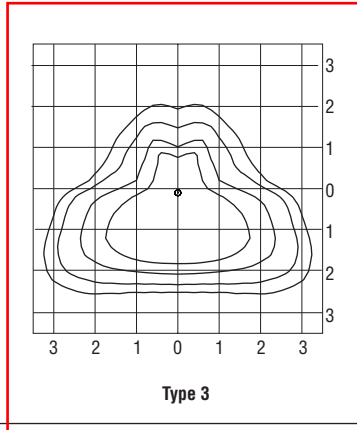
All published luminaire photometric testing performed to IESNA LM-79 standards by NVLAP, certified laboratory. ISO footcandle plots below demonstrate the Constitution (XCN4) light patterns only. Not for total fixture output. For complete specifications and IES files, see website.



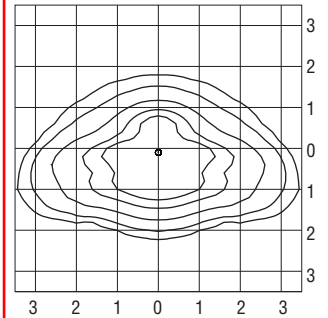
FT



5W



Type 3



Type 2

PERFORMANCE											
Lumens	Distribution Type	3000K			4000K			5000K			Wattage
		Delivered Lumens	Efficacy	BUG Rating	Delivered Lumens	Efficacy	BUG Rating	Delivered Lumens	Efficacy	BUG Rating	
10L	2	8,879	118	B3-U2-G3	9,578	128	B3-U2-G3	9,634	128	B3-U2-G3	75
	3	9,312	124	B2-U2-G3	10,045	134	B2-U2-G3	10,187	136	B2-U2-G3	75
	FT	9,066	121	B3-U2-G3	9,780	130	B3-U2-G3	9,847	131	B3-U2-G3	75
	5W	8,921	119	B4-U2-G2	9,624	128	B4-U2-G2	9,771	130	B4-U2-G2	75
18L	2	16,620	107	B3-U2-G3	17,929	114	B4-U2-G4	18,108	117	B4-U2-G4	155
	3	17,475	113	B3-U2-G3	18,851	122	B3-U2-G4	18,982	122	B3-U2-G3	155
	FT	17,042	110	B4-U2-G2	18,384	119	B3-U2-G4	18,738	121	B3-U2-G4	155
	5W	17,241	111	B3-U2-G3	18,599	120	B4-U2-G2	18,606	120	B3-U2-G3	155
25L	2	22,583	95	B4-U2-G3	24,361	103	B4-U2-G3	24,546	104	B4-U2-G3	237
	3	23,660	100	B3-U2-G4	25,523	108	B3-U2-G4	25,834	109	B3-U2-G4	237
	FT	23,217	98	B3-U2-G4	25,045	106	B3-U2-G4	25,449	107	B3-U2-G4	237
	5W	22,687	96	B5-U2-G3	24,474	103	B5-U2-G3	24,905	105	B5-U2-G4	237



Ordering Guide

TYPICAL ORDER EXAMPLE: **XCN4 PT LED 18L 50 UE BRZ GCM**

Luminaire Prefix	Distribution	Light Source	Lumens	Color Temp	Line Voltage	Finish	Optional Controls	Options
XCN4 - Constitution	2 - Type II 3 - Type III 5W - Type 5 Wide FT - Forward Throw (Type IV)	LED	10L - 10,000 Lumens 18L - 18,000 Lumens 25L - 25,000 Lumen	50 - 5000K 40 - 4000K 30 - 3000K	UE - Universal Voltage (120-277v) HV - High Voltage (347-480v)	BRZ - Bronze BLK - Black GPT - Graphite MSV - Metallic Silver WHT - White PLP - Platinum Plus SVG - Satin Verde Green	Wireless Controls System 1 PCM - Platinum Control System PCMH - Host/Satellite Platinum Control System GCM - Gold Control System (Blank) - None Stand-Alone Control (Blank) - None IMS - Integral Motion Sensor ⁸	PCR 7P - Photoelectric Control Receptacle ² IL - Integral Louver Shield TE - Toolless Access

color to match SEZ fixtures

ACCESSORY ORDERING INFORMATION (Accessories are field installed)			
Description	Order Number	Description	Order Number
BK MPT B04 - Bolt on Bracket (for PT 180) For 4" O.D. Round Poles	490025CLR ⁸	WM - Wall Mount Bracket (PT Only)	C/F
BK MPT B05 - Bolt on Bracket (for PT 180) For 5" O.D. Round Poles	490035CLR ⁸	DFK208,240 Double Fusing (208V, 240V)	DFK208, 240 ⁴
IL - Integral Louver Shield (Black only)	654939	DFK480 Double Fusing (480V)	DFK480 ⁴
PC120 Photocell for use with PCR option (120V)	122514 ^{3,7}	FK347 Single Fusing (347V)	FK347 ⁴
PC208-277 Photocell for use with PCR option (208V, 240V, 277V)	122515 ^{3,7}	PMOS120 - 120V Pole-Mount Occupancy Sensor	518030CLR ⁵
PC347 Photocell for use with PCR option (347V)	122516 ^{3,7}	PMOS208/240 - 208, 240V Pole-Mount Occupancy Sensor	534239CLR ⁵
PC480 Photocell for use with PCR option (480V)	1225180 ^{3,7}	PMOS277 - 277V Pole-Mount Occupancy Sensor	518029CLR ⁵
FK120 Single Fusing (120V)	FK120 ⁴	ALSC UNV TL5 - AirLink 5 Pin Twist Lock Controller	661409
FK277 Single Fusing (277V)	FK277 ⁴	ALSC UNV TL7 - AirLink 7 Pin Twist Lock Controller	661410

FOOTNOTES:

- 1 - Requires a SiteManager and override switch.
- 2 - Photocell must be ordered separately. See Accessories.
- 3 - Factory installed PCR option required. See Options.
- 4 - Fusing must be located in hand hole of pole.
- 5 - To be used in conjunction with PCM/GCM control modules in fixture. Consult factory.

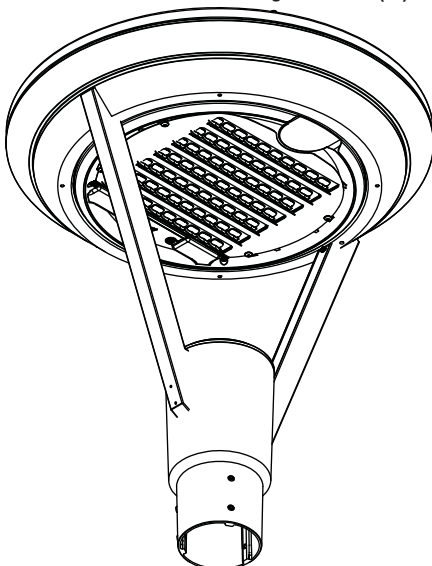
- 6 - Consists of a daylight & motion dual sensor . Light levels are field adjustable, via a handheld remote configurator tool.
- 7 - These photocells provide Dusk/Dawn, on-off control only. Consult factory for alternate photocells providing additional functionality.
- 8 - Order poles with 3" reduced drilling pattern. For PT mounting configurations other than D180, consult factory. Order one bracket per fixture

Accessories/Options

Integral Louver (IL)

Optional Integral Louver available for improved back-light control without sacrificing street side performance.

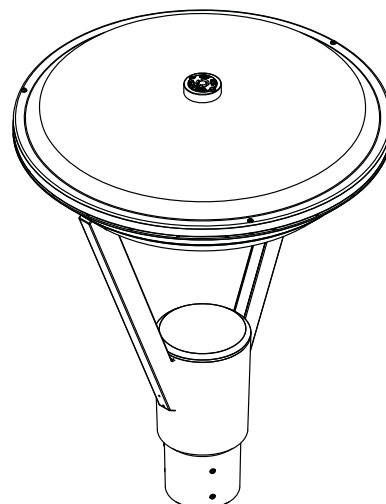
Fixture Shown with Integral Louver (IL)



7 Pin Photoelectric Control

7-pin ANSI C136.41-2013 photocontrol receptacle option available for twist lock photocontrols or wireless control modules. Control accessories sold separately. Dimming leads from the receptacle will be connected to the driver dimming leads (Consult factory for alternate wiring).

Fixture Shown with PCR 7P





TYPE SP2-
parking lot-type III

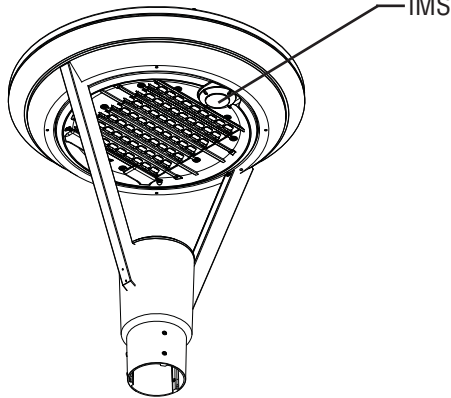
Constitution - XCN4 LED Decorative Pedestrian & Area Light

Controls

Occupancy Sensor / Daylight Sensor (IMS)

Optional integral passive infrared motion and daylight sensor activates switching of luminaire light levels. Standard Factory settings: High level light is activated and increased to full bright upon detection of motion. Low light level (30% maximum drive current) is activated when target zone is absent of motion activity for ~5 minutes. Sensor has a detection cone of approximately 45°, see coverage diagram. Optional configurator tool allows for easy and safe programming of each luminaire from the ground level.

Fixture Shown with IMS

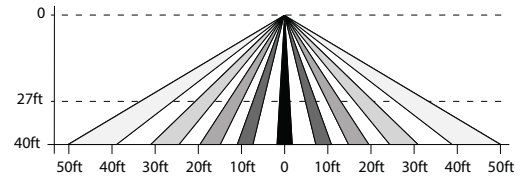


IMS/PC Remote Configurator Tool

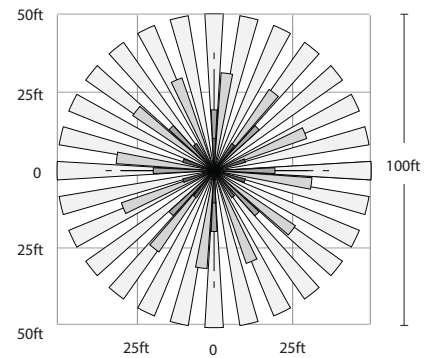


Optional IMS Coverage Diagram

SIDE VIEW

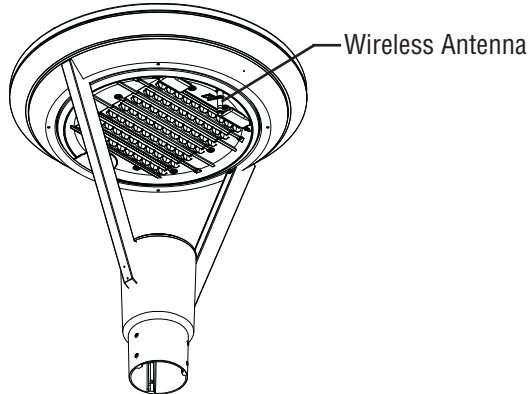


TOP VIEW



Wireless Control Systems

Fixture Shown with Wireless Controls





AirLink™
enabled by Synapse®



Wireless Lighting Controller 5 Pin & 7 Pin Twist Lock

The 5 Pin Twist Lock Controller (TL5) & The 7 Pin Twist Lock Controller (TL7) are intelligent wireless lighting controllers with exceptional fault tolerance & a multitude of features. Each TL5 & TL7 provides intelligent On/Off switching, dimming, control, highly accurate power metering, status monitoring of your lighting fixtures & digital sensor input (TL7 only).

Features

- Integrated Photocell
- ANSI C136.41 Dimming Receptacle Support
- Utility grade power monitoring
- Remote control and scheduling
- Flexible Dimming Controls
- Secure, over-the-air upgrades to support future enhancements
- Seamless integration into the AirLink Site Manager system
- Digital sensor input for motion sensing (TL7 only)

Power and Performance

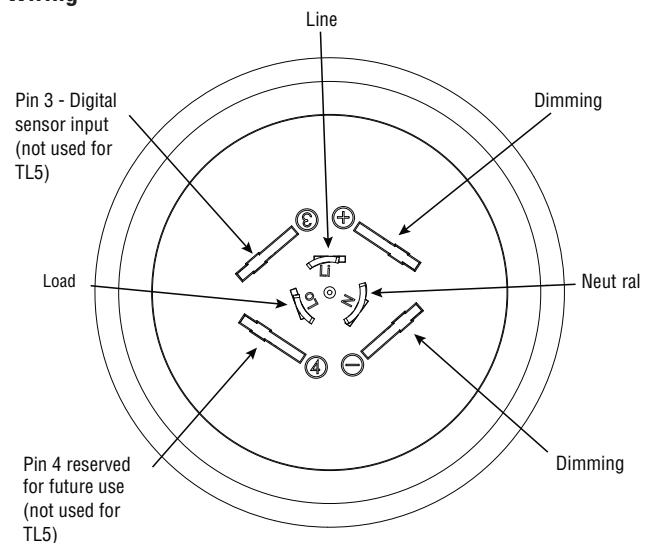
- Operating environmental: -40°F to 158°F (-40°C to 70°C); 20% to 90% RH non-condensing; IP66

- Input power: 100–277 VAC +/- 10% (Max 305V)50/60 Hz
- Switched output: Default ON
- Load rating: 5A @ 100V to 277V (+/- 10%)
- Dimming control: 0–10V with short circuit protection
- Dimming output: maximum current 10mA
- Sensor input: One digital input that can be used for motion-based lighting controls (TL7 only)
- Power monitoring: Utility grade - 2% accuracy
- Power readings: Voltage, Watts

Other

- Dimensions: 4.53" W x 2.68" H (115mm W x 68mm H)
- Radio: SNAP 2.4 GHz; 802.15.4; +20 dBm Transmit Power; -104 dBm Receive Sensitivity
- Warranty: 5 years

Wiring



Contact LSI Controls



Sales
controls.sales@lsi-industries.com



Support
controls.support@lsi-industries.com
1 (800) 436-7800 (support, option 8)



More information
For more information on AirLink, visit our website at www.lsi-airlink.com/airlink



Constitution - XCN4 LED Decorative Pedestrian & Area Light



This latest iteration of the LED Constitution decorative and pedestrian area light features LSI's innovative and high-performance silicone optics, as also featured in LSI's ground-breaking, patent-pending Mirada Series fixtures. The Constitution is designed to illuminate pathways, walkway areas and campus sites. Its contemporary, sleek design complements architectural design elements well.

Features & Specifications

Optical System

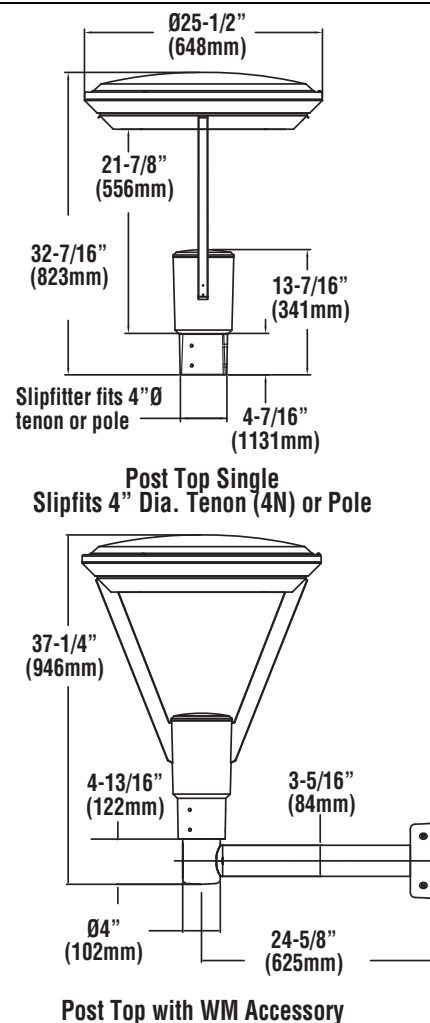
- State-of-the-Art one piece silicone optic sheet delivers industry leading optical control with an integrated gasket to provide IP66 rated sealed optical chamber in 1 component.
- Proprietary silicone refractor optics provide exceptional coverage and uniformity in IES Types 2, 3, 5W and FT.
- Silicone optical material does not yellow or crack with age and provides a minimum light transmittance of 93%.
- Optical distributions are field rotatable (in 90° increments).
- Available in 5000K, 4000K, and 3000K (+/- 275K) color temperatures.
- Minimum CRI of 70. Consult Factory for Higher CRI requirements.
- Integral Louver (IL) option available for improved back-light control without sacrificing street side performance. See page 4 for more details.

Electrical

- High-performance driver features over-voltage, under-voltage, short-circuit and over temperature protection.
- 0-10V dimming (10% - 100%) standard.
- Standard Universal Voltage (120-277 Vac) Input 50/60 Hz or optional High Voltage (347-480 Vac).
- L70 Calculated Life: >100k Hours (See Lumen Maintenance on Page 2)
- Total harmonic distortion: <20%
- Operating temperature: - -40°C to +50°C (-40°F to +122°F)
- Power factor: >.90
- Input power stays constant over life.
- Field replaceable surge protection device meets a minimum Category C Low operation (per ANSI/IEEE C62.41.2).
- High-efficacy LEDs mounted to metal-core circuit board to maximize heat dissipation
- Terminal block provided accepts up to 10ga wire, however the luminaire is supplied with a 32' 3 conductor wire harness.
- Components are fully encased in potting material for moisture resistance. Driver complies with FCC standards. Driver and key electronic components can easily be accessed.



Product Dimensions





Constitution - XCN4 LED Decorative Pedestrian & Area Light

Features & Specifications (Cont.)

Construction

- Rugged die-cast aluminum housing.
- Cast aluminum wiring access door located in lower hub/fitter.
- Rigid die-cast aluminum arms for consistency and strength.
- Precision die cast aluminum heatsink and optical frame.
- Removable spun aluminum cap/driver enclosure is retained by captive stainless steel fasteners and safety cables. Housing and top cap interface is sealed with a one-piece extruded silicone gasket. Tool-less entry option is available.
- All exposed fasteners are black oxide coated stainless steel. Internal fasteners are stainless steel or zinc electroplated steel.
- Luminaire is proudly made in the U.S.
- IP65 rated luminaire protects integral components from harsh environments.
- 1.5G rated for ANSI C136.31 high vibration applications
- Fixtures are finished with LSI's DuraGrip® polyester powder coat finishing process. The DuraGrip finish withstands extreme weather changes without cracking or peeling. Other standard LSI finishes available. Consult factory.
- Shipping weight: 45 lbs in carton.

Controls

- Optional integral passive infrared motion and daylight sensor activates switching of luminaire light levels (see page 5 for more details).
- 7-pin ANSI C136.41-2013 photocontrol receptacle option available for twist lock photocontrols or wireless control modules.
- LSI's Gold and Platinum wireless control system options reduce energy and maintenance costs while optimizing light quality 24/7. (see page 5 for more details)

Installation

- Mounts to 4" O.D. pole or tenon.
- Secures to pole with 6 stainless steel set screws.
- 32' wire leads are provided bundled in the slip fitter hub for ease of wiring.

Warranty

- LSI LED Fixtures carry a 5-year warranty.

Listings

- Listed to UL 1598 and UL 8750.
- RoHS Compliant.
- State of California Title 24.
- DesignLights Consortium® (DLC) qualified product. Not all versions of this product may be DLC qualified. Please check the DLC Qualified Products List at www.designlights.org/QPL to confirm which versions are qualified.
- American Recovery and Reinvestment Act Funding Compliant.
- Lighting Facts Approved.
- Suitable For wet Locations.
- IP65 rated Luminaire. IP66 rated optical chamber.
- 1.5G rated for ANSI C136.31 high vibration applications

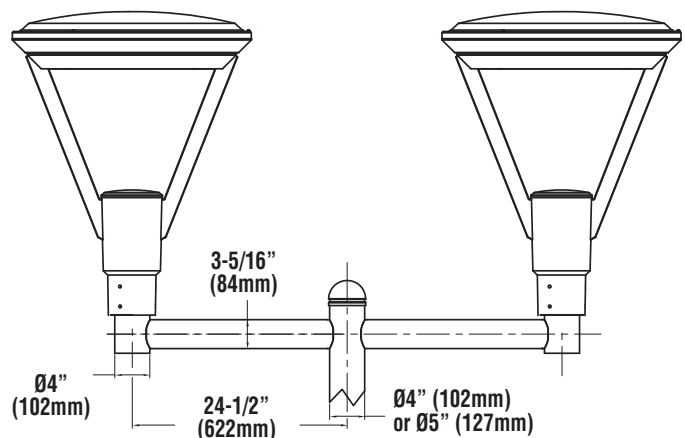
Performance

ELECTRICAL DATA*							
Lumens	120V	208V	240V	277V	347V	480V	Watts
10L	0.63	0.36A	0.31A	0.27A	0.22A	0.16A	75
18L	1.29A	0.75A	0.65A	0.56A	0.45A	0.32A	155
25L	1.98A	1.14A	.99A	.86A	0.68A	0.49A	237

*Electrical data at 25C (77F). Actual wattage may differ by +/-10%.

RECOMMENDED LUMEN MAINTENANCE ¹					
Ambient	Initial ²	25 hr ²	50 hr ²	75 hr ³	100 hr ³
0 C	1.06	1.05	1.05	1.05	1.04
10 C	1.04	1.02	1.02	1.02	1.01
20 C	1.01	1.00	0.99	0.99	0.99
25 C	1.00	0.98	0.97	0.97	0.96
30 C	0.99	0.97	0.96	0.96	0.95
40 C	0.97	0.92	0.89	0.86	0.83

- 1 - Lumen maintenance values at 25C are calculated per TM-21 based on LM-80 data and in-situ testing.
- 2 - In accordance with IESNA TM-21-11, Projected Values represent interpolated value based on time durations that are within six times the IESNA LM-80-08 total test duration for the device under testing.
- 3 - In accordance with IESNA TM-21-11, Calculated Values represent time durations that exceed six times the IESNA LM-80-08 total test duration for the device under testing.



Post Top with BK MPT BO (x2)
Mounts to 4" or 5" Dia. D180 Bolt-on Pole
(select 3" reduced drilling pattern)

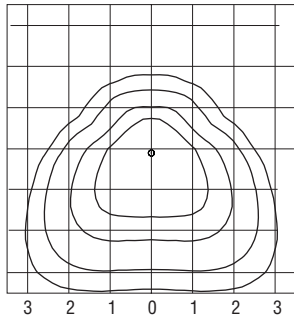
LUMINAIRE EPA CHART - Constitution		
	MOUNTING STYLE	EPA
■ PT Single	PT	1.0
■ PT D180° with BK MPT BO (2)	PT	2.0



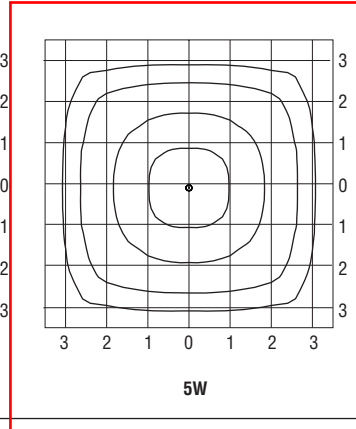
Constitution - XCN4 LED Decorative Pedestrian & Area Light

Performance (Cont.)

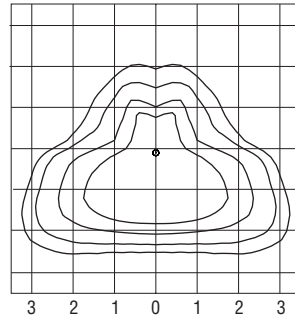
All published luminaire photometric testing performed to IESNA LM-79 standards by NVLAP, certified laboratory. ISO footcandle plots below demonstrate the Constitution (XCN4) light patterns only. Not for total fixture output. For complete specifications and IES files, see website.



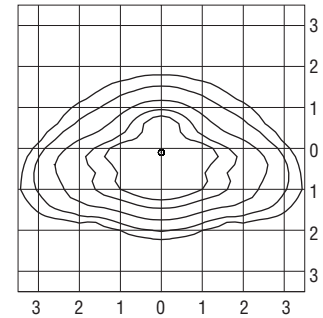
FT



5W



Type 3



Type 2

PERFORMANCE											
Lumens	Distribution Type	3000K			4000K			5000K			Wattage
		Delivered Lumens	Efficacy	BUG Rating	Delivered Lumens	Efficacy	BUG Rating	Delivered Lumens	Efficacy	BUG Rating	
10L	2	8,879	118	B3-U2-G3	9,578	128	B3-U2-G3	9,634	128	B3-U2-G3	75
	3	9,312	124	B2-U2-G3	10,045	134	B2-U2-G3	10,187	136	B2-U2-G3	75
	FT	9,066	121	B3-U2-G3	9,780	130	B3-U2-G3	9,847	131	B3-U2-G3	75
	5W	8,921	119	B4-U2-G2	9,624	128	B4-U2-G2	9,771	130	B4-U2-G2	75
18L	2	16,620	107	B3-U2-G3	17,929	114	B4-U2-G4	18,108	117	B4-U2-G4	155
	3	17,475	113	B3-U2-G3	18,851	122	B3-U2-G4	18,982	122	B3-U2-G3	155
	FT	17,042	110	B4-U2-G2	18,384	119	B3-U2-G4	18,738	121	B3-U2-G4	155
	5W	17,241	111	B3-U2-G3	18,599	120	B4-U2-G2	18,606	120	B3-U2-G3	155
25L	2	22,583	95	B4-U2-G3	24,361	103	B4-U2-G3	24,546	104	B4-U2-G3	237
	3	23,660	100	B3-U2-G4	25,523	108	B3-U2-G4	25,834	109	B3-U2-G4	237
	FT	23,217	98	B3-U2-G4	25,045	106	B3-U2-G4	25,449	107	B3-U2-G4	237
	5W	22,687	96	B5-U2-G3	24,474	103	B5-U2-G3	24,905	105	B5-U2-G4	237



Constitution - XCN4 LED Decorative Pedestrian & Area Light

Ordering Guide

TYPICAL ORDER EXAMPLE: **XCN4 PT LED 18L 50 UE BRZ GCM**

Luminaire Prefix	Distribution	Light Source	Lumens	Color Temp	Line Voltage	Finish	Optional Controls	Options
XCN4 - Constitution	2 - Type II 3 - Type III 5W - Type 5 Wide PT - Forward Throw (Type IV)	LED	10L - 10,000 Lumens 18L - 18,000 Lumens 25L - 25,000 Lumens	50 - 5000K 40 - 4000K 30 - 3000K	UE - Universal Voltage (120-277v) HV - High Voltage (347-480v)	BRZ - Bronze BLK - Black GPT - Graphite MSV - Metallic Silver WHT - White PLP - Platinum Plus SVG - Satin Verde Green	Wireless Controls System 1 PCM - Platinum Control System PCMH - Host/Satellite Platinum Control System GCM - Gold Control System (Blank) - None Stand-Alone Control (Blank) - None IMS - Integral Motion Sensor ⁸	PCR 7P - Photoelectric Control Receptacle ² IL - Integral Louver Shield TE - Toolless Access

color to match
SEZ fixtures

ACCESSORY ORDERING INFORMATION		(Accessories are field installed)	
Description	Order Number	Description	Order Number
BK MPT B04 - Bolt on Bracket (for PT 180) For 4" O.D. Round Poles	490025CLR ⁸	WM - Wall Mount Bracket (PT Only)	C/F
BK MPT B05 - Bolt on Bracket (for PT 180) For 5" O.D. Round Poles	490035CLR ⁸	DFK208,240 Double Fusing (208V, 240V)	DFK208, 240 ⁴
IL - Integral Louver Shield (Black only)	654939	DFK480 Double Fusing (480V)	DFK480 ⁴
PC120 Photocell for use with PCR option (120V)	122514 ^{3,7}	FK347 Single Fusing (347V)	FK347 ⁴
PC208-277 Photocell for use with PCR option (208V, 240V, 277V)	122515 ^{3,7}	PMOS120 - 120V Pole-Mount Occupancy Sensor	518030CLR ⁵
PC347 Photocell for use with PCR option (347V)	122516 ^{3,7}	PMOS208/240 - 208, 240V Pole-Mount Occupancy Sensor	534239CLR ⁵
PC480 Photocell for use with PCR option (480V)	1225180 ^{3,7}	PMOS277 - 277V Pole-Mount Occupancy Sensor	518029CLR ⁵
FK120 Single Fusing (120V)	FK120 ⁴	ALSC UNV TL5 - AirLink 5 Pin Twist Lock Controller	661409
FK277 Single Fusing (277V)	FK277 ⁴	ALSC UNV TL7 - AirLink 7 Pin Twist Lock Controller	661410

FOOTNOTES:

- 1 - Requires a SiteManager and override switch.
- 2 - Photocell must be ordered separately. See Accessories.
- 3 - Factory installed PCR option required. See Options.
- 4 - Fusing must be located in hand hole of pole.
- 5 - To be used in conjunction with PCM/GCM control modules in fixture. Consult factory.

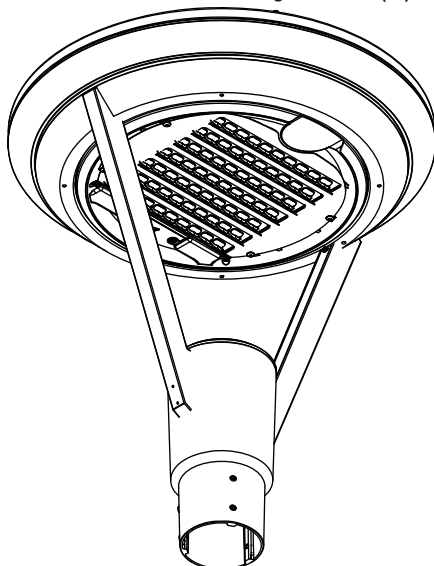
- 6 - Consists of a daylight & motion dual sensor . Light levels are field adjustable, via a handheld remote configurator tool.
- 7 - These photocells provide Dusk/Dawn, on-off control only. Consult factory for alternate photocells providing additional functionality.
- 8 - Order poles with 3" reduced drilling pattern. For PT mounting configurations other than D180, consult factory. Order one bracket per fixture

Accessories/Options

Integral Louver (IL)

Optional Integral Louver available for improved back-light control without sacrificing street side performance.

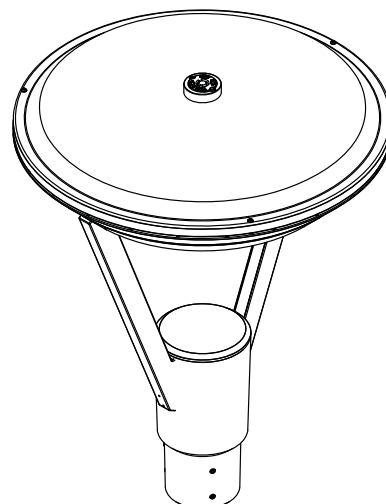
Fixture Shown with Integral Louver (IL)



7 Pin Photoelectric Control

7-pin ANSI C136.41-2013 photocontrol receptacle option available for twist lock photocontrols or wireless control modules. Control accessories sold separately. Dimming leads from the receptacle will be connected to the driver dimming leads (Consult factory for alternate wiring).

Fixture Shown with PCR 7P





TYPE SP3-
1st floor site

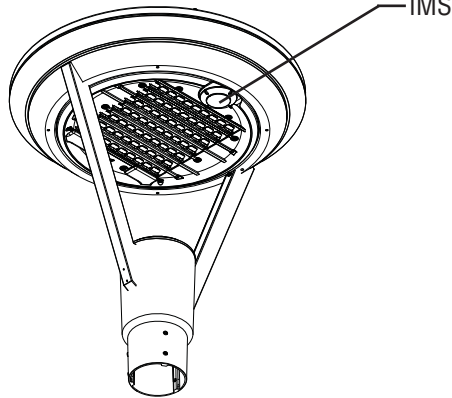
Constitution - XCN4 LED Decorative Pedestrian & Area Light

Controls

Occupancy Sensor / Daylight Sensor (IMS)

Optional integral passive infrared motion and daylight sensor activates switching of luminaire light levels. Standard Factory settings: High level light is activated and increased to full bright upon detection of motion. Low light level (30% maximum drive current) is activated when target zone is absent of motion activity for ~5 minutes. Sensor has a detection cone of approximately 45°, see coverage diagram. Optional configurator tool allows for easy and safe programming of each luminaire from the ground level.

Fixture Shown with IMS

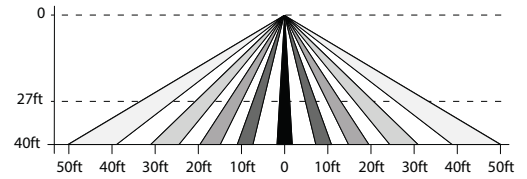


IMS/PC Remote Configurator Tool

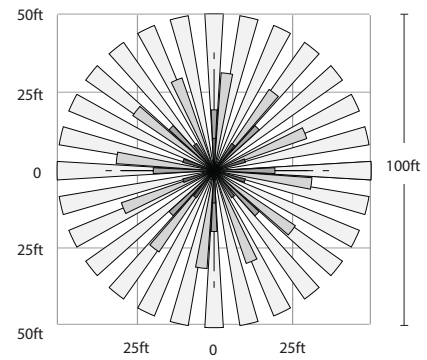


Optional IMS Coverage Diagram

SIDE VIEW

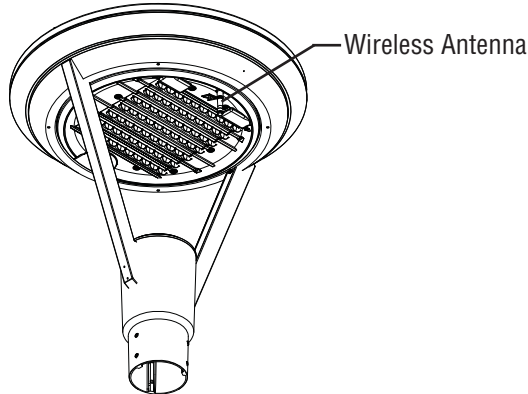


TOP VIEW



Wireless Control Systems

Fixture Shown with Wireless Controls





AirLink™

enabled by Synapse®



- Input power: 100–277 VAC +/- 10% (Max 305V)50/60 Hz
- Switched output: Default ON
- Load rating: 5A @ 100V to 277V (+/- 10%)
- Dimming control: 0–10V with short circuit protection
- Dimming output: maximum current 10mA
- Sensor input: One digital input that can be used for motion-based lighting controls (TL7 only)
- Power monitoring: Utility grade - 2% accuracy
- Power readings: Voltage, Watts

Wireless Lighting Controller 5 Pin & 7 Pin Twist Lock

The 5 Pin Twist Lock Controller (TL5) & The 7 Pin Twist Lock Controller (TL7) are intelligent wireless lighting controllers with exceptional fault tolerance & a multitude of features. Each TL5 & TL7 provides intelligent On/Off switching, dimming, control, highly accurate power metering, status monitoring of your lighting fixtures & digital sensor input (TL7 only).

Features

- Integrated Photocell
- ANSI C136.41 Dimming Receptacle Support
- Utility grade power monitoring
- Remote control and scheduling
- Flexible Dimming Controls
- Secure, over-the-air upgrades to support future enhancements
- Seamless integration into the AirLink Site Manager system
- Digital sensor input for motion sensing (TL7 only)

Power and Performance

- Operating environmental: -40°F to 158°F (-40°C to 70°C); 20% to 90% RH non-condensing; IP66

Contact LSI Controls



Sales
controls.sales@lsi-industries.com



Support
controls.support@lsi-industries.com
1 (800) 436-7800 (support, option 8)

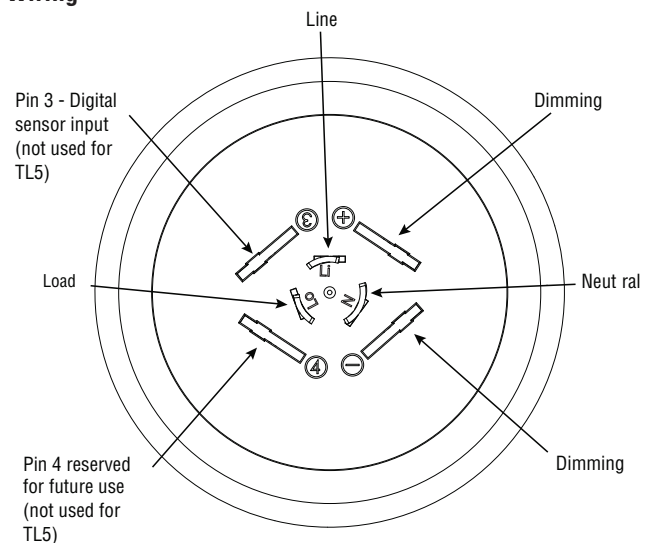


More information
For more information on AirLink, visit our website at www.lsi-airlink.com/airlink

Other

- Dimensions: 4.53" W x 2.68" H (115mm W x 68mm H)
- Radio: SNAP 2.4 GHz; 802.15.4; +20 dBm Transmit Power; -104 dBm Receive Sensitivity
- Warranty: 5 years

Wiring

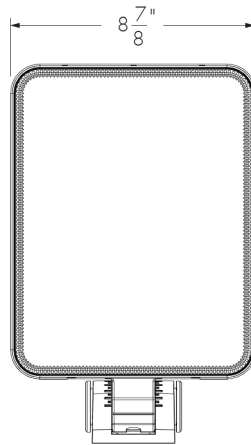


Project Name _____ Qty _____

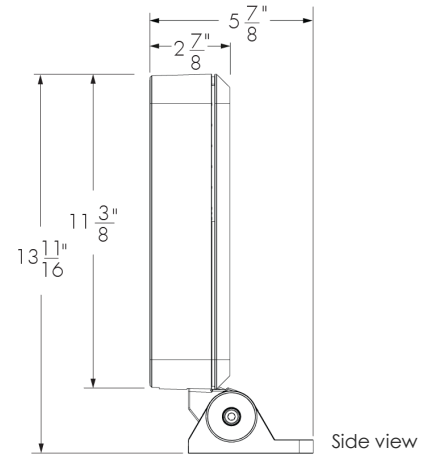
Type _____ Catalog / Part Number _____



6° increments pivot



Front view



Side view

Photometric Summary

Symmetric

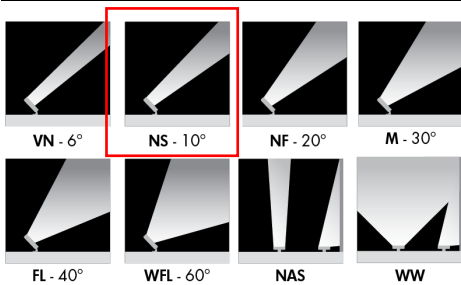
	Delivered output (lm)	Intensity (peak cd)
VN (6°)	2178	118,970
NS (10°)	2356	84,869
NF (20°)	2115	20,025
M (30°)	1937	10,528
FL (40°)	1820	4490
WFL (60°)	1665	1505

Asymmetric

	Delivered output (lm)	Intensity (peak cd)
NAS	2480	38,203 (@2.5°)
WW	2059	9153 (@5°)

Based on RGBW configuration (full output), DMX/RDM. Estimated. Consult website for the latest photometric files.

Optics



Colors and Color Temperatures



Description

The Lumenquad Large Color Changing, 50W LED luminaire, has a sleek 2 7/8 in profile with no visible wiring or hardware and seamlessly integrates with any architecture while also applying dynamic color. Lumenpulse's latest generation of LED boards possess an optimized candela and lumens recipe for both Narrow and Wide optics. The Lumenquad Large Color Changing is the epitome of versatile and can be configured with numerous options including optics for wallwash and floodlighting, RGB, RGBW or RGBA color mixing, as well as various mounting options, accessories, controls, and multiple standard finishes.

Features

3,000K

Color and Color Temperature

Additive RGB, Additive RGB + white ~~4000K~~, Additive RGB + amber

Optics (nominal distribution)

VN (6°), NS (10°), NF (20°), M (30°), FL (40°), WFL (60°), NAS (Narrow Asymmetric), WW (Asymmetric Wallwash)

Mounting Options

Surface mount, Wall mount, Wall mount over recessed JBOX, Pole mount, Tenon mount, Stake mount, (All mounting options have a pivot adjustable in 6° increments, consult factory for universal pivot option)

Optical Options (factory installed)

Linear spread lens horizontal distribution, Linear spread lens vertical distribution, Honeycomb louver

Options

Corrosion-resistant coating for hostile environments

Power Consumption

50 W

Warranty

5-year limited warranty

Performance

Maximum Delivered Output

2480 lm (RGBW full output, NAS Narrow Asymmetric @ 2.5°, DMX/RDM)

Maximum Delivered Intensity

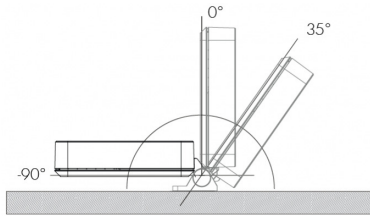
118,970 cd at nadir (RGBW full output, VN 6°, DMX/RDM)

Illuminance at Distance

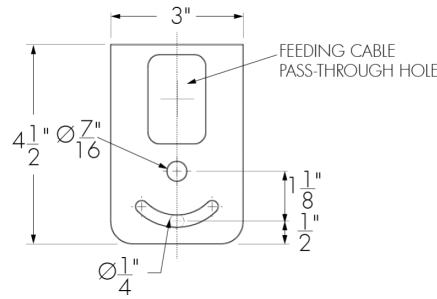
Minimum 1 fc at 345 ft (RGBW full output, VN 6°, DMX/RDM)

Mounting options

SM - Surface mount

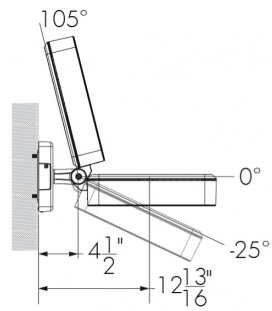


SM - Mounting hole pattern

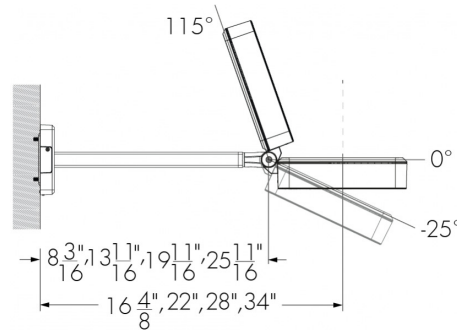


The SM mounting option cannot be interchanged with any other mounting option. All others mountings are interchangeable. Consult factory for details.

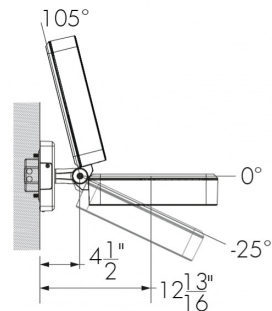
WM - Wall mount



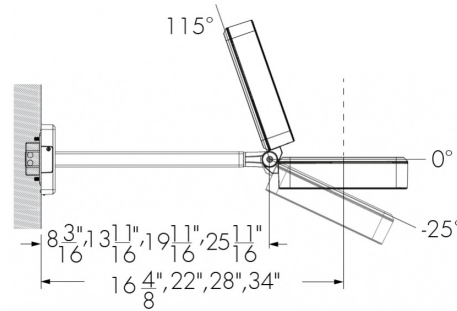
WAM - Wall arm mount 6 in, 12 in, 18 in or 24 in



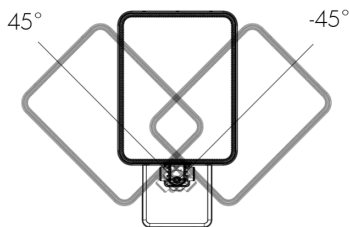
WMRJB - Recessed JBOX wall mount



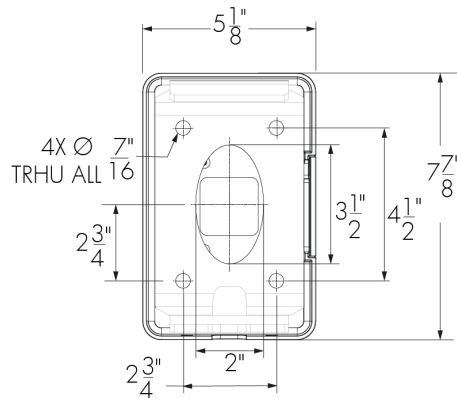
WAMRJB - Recessed JBOX wall arm mount 6 in, 12 in, 18 in or 24 in



Wall mount horizontal pivot limits



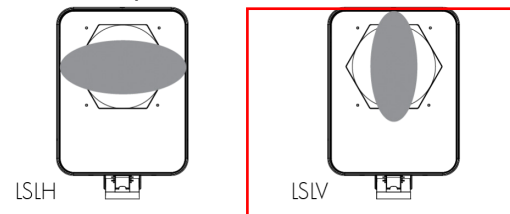
WM, WAM, WMRJB and WAMRJB - Mounting hole pattern



Optical options

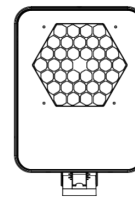
LSLH - Linear spread lens horizontal distribution

LSLV - Linear spread lens vertical distribution



	Beam angle with LSLH/LSLV
VN	7° x 60°
NS	13° x 60°
NF	18° x 65°
M	25° x 66°
FL	35° x 70°

HL - Honeycomb louver



Factory installed, not adjustable on site. Not available for WFL, NAS, WW optics.

See 'Optical Accessories' section for field adjustable spread lens (LSLA).

Factory installed, not adjustable on site. HL not available for NAS, WW optics.

The addition of a honeycomb louver will affect beam distribution. Consult factory for application support.

Optical accessories (factory installed, order separately)

Installed optical accessories will affect the maximum pivot limits for each mounting option, consult factory for details.

SN - Snoot

LQLSN-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior FINISH from the list of finishes in the fixture order code.

VS - Visor

LQLVS-FINISH-BK-OPTIONS (CRC)
Interior surface painted black. Please specify the exterior FINISH from the list of finishes in the fixture order code.

LSLA - Linear spread lens adjustable

LQLLSLA-FINISH-OPTIONS (CRC)
Please specify the exterior FINISH from the list of finishes in the fixture order code.

WG - Wire guard

LQLWG-FINISH-OPTIONS (CRC)
Please specify the exterior FINISH from the list of finishes in the fixture order code.

Accessory combinations

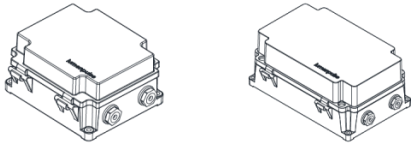
	+	Snoot	Visor	Wire guard
Linear spread lens adjustable		YES	YES	NO
Wire guard		YES	YES	N/A

Accessory combinations must be ordered together on a single line. Ex: A snoot + wire guard combination order code is LQLSNWG-BK-BK. A maximum of two accessories can be combined per fixture.

Accessories (order separately)

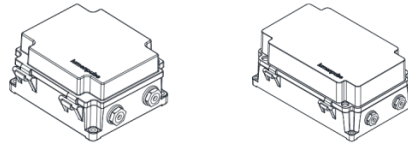
Control Boxes

CBX-DMX/RDM-DMX/RDM enabled (daisy chain or star configuration)



DMX/RDM control box. Up to six power and data outputs to fixtures or fixture runs. Refer to CBX specification sheet and installation instructions for details. Lumenterminators provided with CBX (2x for daisy chain configuration, 6x for star configuration), consult factory to order spares.

CBX-ENET-Ethernet enabled (daisy chain or star configuration)



Ethernet control box. Up to four power and data outputs to fixture or fixture runs. Refer to Ethernet CBX specification sheet and installation instructions for details.

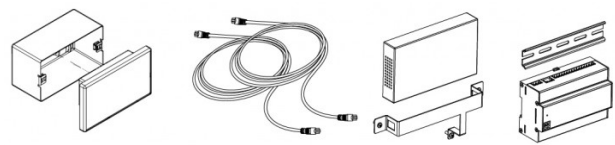
Control Systems

LTN2-Lumentone™ 2



Lumentone 2 is a simple pre-programmed DMX 512 controller with a push button rotary dial and live feedback.

PHAROS-Pharos® kit



The Pharos kit, available for 1 or 2 DMX universes, allows for complete control of large lighting installations. 2 DMX universes kit shown.

Diagnostic and Addressing Tools

LID-LumenID



LumenID is a diagnostic and addressing DMX/RDM tool. It must be specified on all DMX applications. Refer to LID specification sheet for details.

LID-LT-LumentalkID



LumentalkID is a diagnostic and addressing tool. It must be specified for all Lumentalk (LT) applications. Refer to LID-LT specification sheet for details.

connect with type FL2- 3rd floor clerestory window

How to order

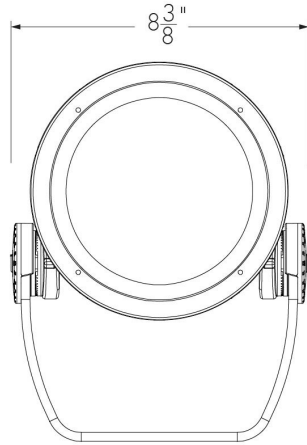
Housing	Voltage	Color and Color Temperature	Optics	Optical Options (2)	Mounting Options (5) (6)	Finish	Control	Options	Certification	Cable Length (14) (17) (18)
LQL Lumenquad Large	100 100 volts	RGB Additive RGB	VN Very Narrow 6°	LSLH Linear spread lens horizontal distribution (3)	SM Surface mount	BK Black Sandtex®	LT Lumentalk (11) (12)	CRC Corrosion- resistant coating for hostile environments (13)	UL UL compliant	3FT 3 ft (14)
	120 120 volts	RGBW Additive RGB + white 4000K standard.	NS Narrow spot 10°	LSLV Linear spread lens vertical distribution (3)	WM Wall mount	BRZ Bronze Sandtex®	DMX/RDM DMX/RDM enabled (13) (14)		CE CE compliant (14)	10FT 10 ft
	208 208 volts	4000K standard.	NF Narrow flood 20°	HL Honeycomb louver (4)	WAM6 Wall arm mount 6 in	SI Silver Sandtex®	DAL18 DALI-2 dimming Type 8		CEI CE compliant Class II double insulated (16)	20FT 20 ft
	220 220 volts	2700K, 3000K and 3500K available, consult factory. (1)	M Medium 30°		WAM12 Wall arm mount 12 in	WH Smooth white				30FT 30 ft
	240 240 volts		FL Flood 40°		WAM18 Wall arm mount 18 in	BKTX Textured black				50FT 50 ft
	277 277 volts	RGBA Additive RGB + amber	WFL Wide Flood 60°		WAM24 Wall arm mount 24 in	BRZTX Textured bronze non- metallic				70FT 70 ft
	347 347 volts		NAS Narrow Asymmetric		WMRJB Recessed JBOX wall mount	CRATX Textured medium gray				100FT 100 ft
			WW Asymmetric Wallwash		WAMRJB6 Recessed JBOX wall arm mount 6 in	GRNTX Textured green				
					WAMRJB12 Recessed JBOX wall arm mount 12 in	WHTX Textured white				
					WAMRJB18 Recessed JBOX wall arm mount 18 in	CC Custom color and finish (please specify RAL color) (8) (9) (10)				
					WAMRJB24 Recessed JBOX wall arm mount 24 in					
				RPM4/1 Round pole mount 4 in						
				RPM4.5/1 Round pole mount 4.5 in						
				RPM5/1 Round pole mount 5 in						
				RPM4/2 Round pole mount 4 in for two fixtures						
				RPM4.5/2 Round pole mount 4.5 in for two fixtures						
				RPM5/2 Round pole mount 5 in for two fixtures						
				PLTM Lumentech pole mount (7)						
				TN2 Tenon adapter for 2 3/8 in O.D. pole						
				TN4 Tenon adapter for 4 in O.D. pole						
				SK Stake mount						

Notes:

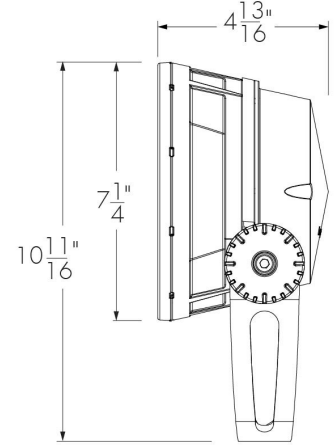
1. Longer lead times apply for Royal Blue, 2700K, 3000K and 3500K white color temperature mixes.
2. Optical options are factory installed and cannot be changed in the field.
3. Not available with WFL, NAS and WW optics.
4. Not available with NAS and WW optics.
5. All mounting options (except for SM mounting) are interchangeable. Consult factory for details.
6. All mounting options have a pivot adjustable in 6° increments, consult factory for universal pivot option.
7. Available with Lumentech poles with a square or round profile. PLTU - Universal Yoke accessory must be ordered to fit with the PLTM mounting option. Refer to Lumentech specification sheet and installation instructions for more details.
8. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
9. Charges apply for RAL colors. Consult factory for details.
10. Longer lead times can be expected for custom RAL color finishes.
11. Not available with 347V.
12. A Lumentranslator 2 and LumentalkID (LIDLIT) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
13. A control box (CBX) and LumenID (LID) must be specified.
14. Maximum of 3 ft cable length for daisy chain DMX applications with CBX-DS.
15. Use only when exposed to salt spray and harsh chemicals. This option is not required for normal outdoor exposure.
16. Consult European specification sheets and installation instructions for CE and CE Class II wiring information.
17. Not applicable to WMRJB and WAMRJB 6 in to 24 in mounting options. Cable lengths for these mounting options are determined by the length of the mounting bracket.
18. UL fixtures specified with a Smooth white finish and a SM, WM or WAM 6 in to 24 in mounting option are provided with a white cable. A black cable is provided for all other fixture configurations.

Project Name _____ Qty _____

Type _____ Catalog / Part Number _____



Front view



Side view

Photometric summary

Symmetric

	Delivered output (lm)	Intensity (peak cd)
XN (4°)	1830*	156,410*
VN (6°)	1716*	90,813*
NS (10°)	2467*	35,359*
NF (20°)	2334*	22,375*
M (30°)	2264*	12,595*
FL (40°)	2047*	5306*
WFL (60°)	1836*	1382*

Asymmetric

	Delivered output (lm)	Intensity (peak cd)
NAS	1569*	26,002*
WW	2148*	6582*

Based on 4000K configuration.

Photometric performance is measured in compliance with IESNA LM-79-08.

*Estimated. Consult website for the latest photometric files.

Optics



XN - 4° VN - 6° NS - 10° NF - 20° M - 30°



FL - 40° WFL - 60° NAS WW

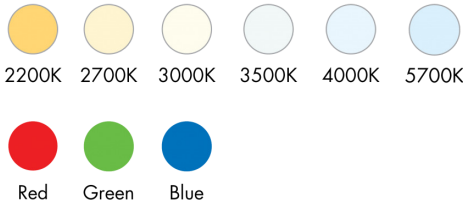
Description

The Lumenbeam Medium is an IP66-rated luminaire for lighting landscapes, trees, columns, monuments, and architectural details. It has numerous options, including optics for flood or accent lighting, a choice of color temperatures and colors, as well as various accessories, spread lenses, and controls. The luminaire also has an anti-corrosion option for use in harsh, chemical, or coastal environments.

Features

Color and Color Temperature	2200K, 2700K, 3000K, 3500K, 4000K, 5700K, Red, Green, Blue
Optics (nominal distribution)	XN (4°), VN (6°), NS (10°), NF (20°), M (30°), FL (40°), WFL (60°), NAS (Narrow Asymmetric), WW (Asymmetric Wallwash)
Optical Option	Linear spread lens horizontal distribution, Linear spread lens vertical distribution
Options	Short Yoke, 3G ANSI C136.31-2010 Vibration Rating for bridge applications, Corrosion-resistant coating for hostile environments
Cable Color	Black, White
Power Consumption	28 W
Warranty	5-year limited warranty
Performance	
Maximum Delivered Output	2467lm (4000K, NS 10°)
Maximum Delivered Intensity	156,410 cd at nadir (4000K, XN 4°)
Illuminance at Distance	Minimum 1 fc at 395 ft (4000K, XN 4°)
Color Consistency	3 SDCM
Color Rendering	Minimum CRI 80
Lumen Maintenance	L70 > 250,000 hrs (Ta 25 °C) (> 80,000 hrs for XN 4°, VN 6°, NAS optics only)

Colors and Color Temperatures



Controls

ON/OFF 0-10V DALI DMXrdm

Ratings

IP66 IK09

Certifications



Physical

Housing Material	Low copper content high pressure die-cast aluminum
Yoke Material	Heavy aluminum (standard yoke included)
Lens Material	Clear tempered glass
Hardware Material	Stainless steel
Gasket Material	Silicone
Surface Finish	Electrostatically applied polyester powder coat
Weight	6.7 lbs
EPA	Front = 0.44 sq ft, Side = 0.18 sq ft

Electrical and control

Voltage	100 to 277 volts
Fixture Cable	Power and data in one cable
Conductors	3C #16-3 (NO control), 5C #16-5 (DIM, DALI control), 6C #14-3/#24-3 (DMX/RDM control)
Control	On/Off control, 0-10V dimming, DALI dimming, DMX/RDM enabled, Lumentalk system is enabled with LDB accessory - see typical wiring diagrams for details
Resolution (DMX/RDM)	Per fixture, 8-bit or 16-bit

Environmental

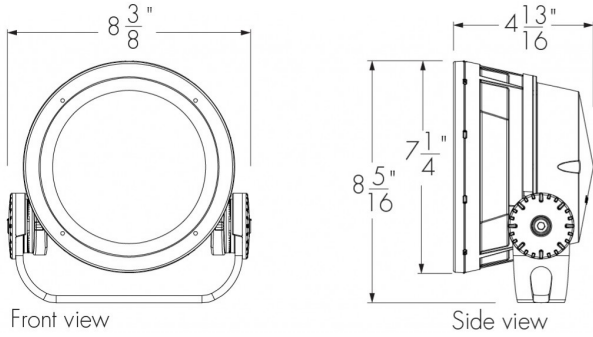
Storage Temperature	-40 °F to 158 °F (device must reach start-up temperature value before operating)
Start-up Temperature	-13 °F to 122 °F
Operating Temperature	-40 °F to 122 °F
Ingress Protection Rating	IP66, Wet location rated
Impact Resistance Rating	IK09

Accessories (order separately)

Optical Accessories	Lumenbeam Medium Snoot, Lumenbeam Medium Snoot wide, Lumenbeam Medium Visor, Lumenbeam Medium Linear spread lens adjustable, Lumenbeam Medium Wire guard
Control Boxes	DMX/RDM enabled (daisy chain or star configuration), Ethernet enabled (daisy chain or star configuration), Lumentalk Data Bridge
Control Systems	Lumentone™ 2, Pharos® kit
Diagnostic and Addressing Tools	LumenID, LumentalkID

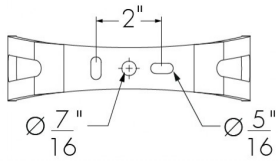
Mounting options

SY - Short yoke

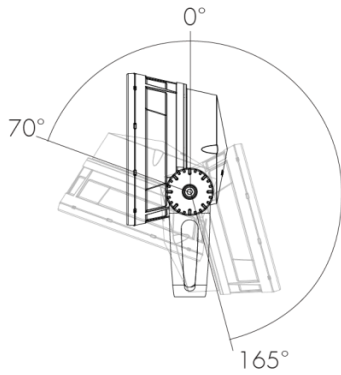


Mounting details

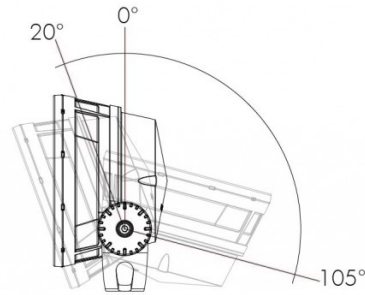
Mounting hole pattern - standard and short yoke



Adjustable pivot limits (adjustable in 6 degree increments)



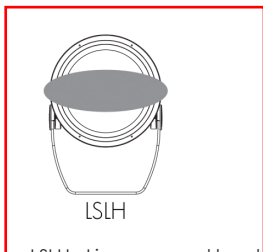
Standard yoke



Short yoke

Optical options

LSLH - Linear spread lens horizontal distribution



LSLH - Linear spread lens horizontal distribution

LSLV - Linear spread lens vertical distribution



LSLV

Beam angles

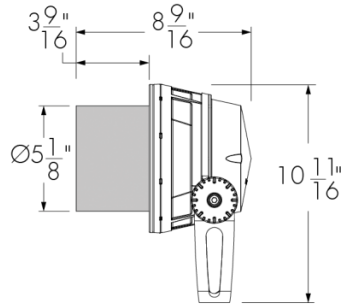
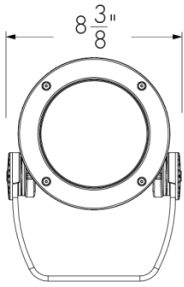
Optic installed in fixture	Beam angle with LSLH/LSLV
XN	5° x 60°
VN	7° x 60°
NS	13° x 66°
NF	16° x 62°
M	23° x 65°
FL	33° x 70°

Factory installed, not adjustable on site. Not available for WFL, NAS and WW optics. See 'Optical Accessories' section for field adjustable spread lens (LSLA).

Optical accessories (order separately)

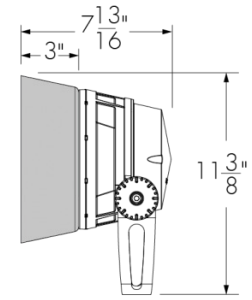
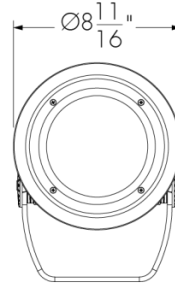
Installed optical accessories will affect the maximum pivot limits for each mounting option, consult factory for details.

SN - Snoot



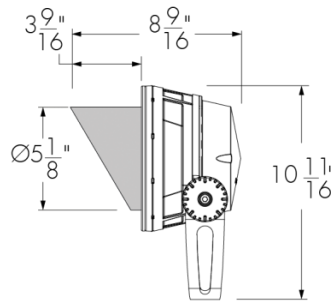
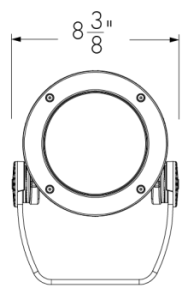
LBMSN-FINISH-BK-OPTIONS (CRC)
 Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

SNW - Snoot wide



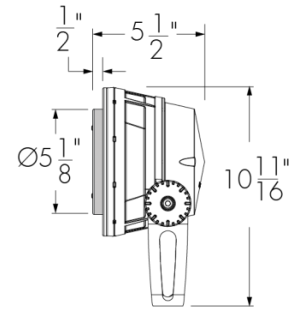
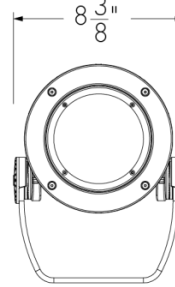
LBMSNW-FINISH-BK-OPTIONS (CRC)
 Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

VS - Visor



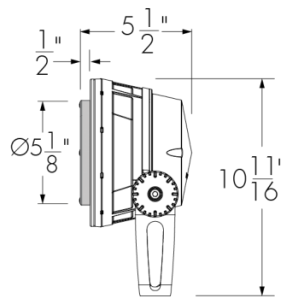
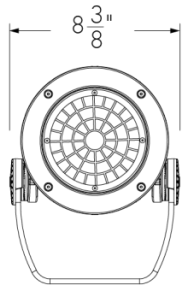
LBMVS-FINISH-BK-OPTIONS (CRC)
 Interior surface painted black. Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

LSLA - Linear spread lens adjustable



LBMLSLA-FINISH-OPTIONS (CRC)
 Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

WG - Wire guard



LBMWG-FINISH-OPTIONS (CRC)
 Please specify the exterior **FINISH** from the list of finishes in the fixture order code.

Accessory combinations

	+	Snoot	Snoot wide	Visor
	Linear spread lens adjustable	LBMSNLSLA	N/A*	LBMVLSLA
	Wire guard	LBMSNWG	N/A	LBMVSWG

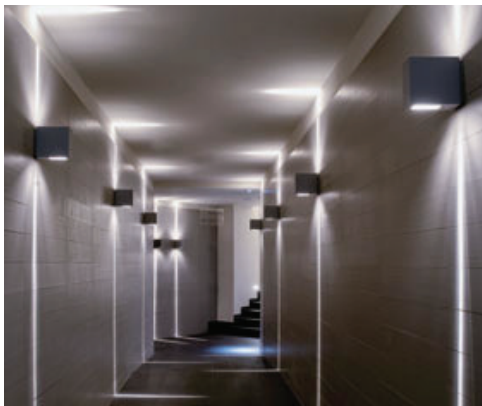
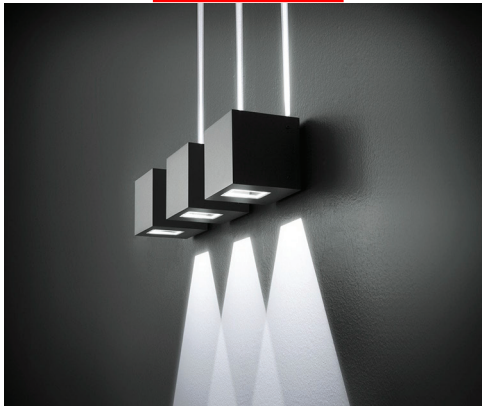
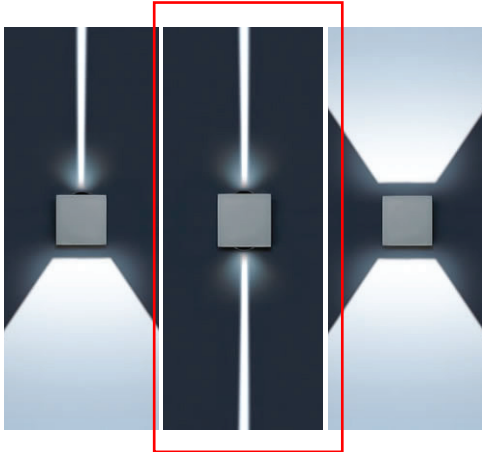
Accessory combinations must be ordered together on a single line.
 Ex: A snoot + wire guard combination order code is **LBMSNWG-FINISH-BK-OPTIONS**. A maximum of two accessories can be combined per fixture.
 *Consult factory for a linear spread lens adjustable + snoot wide combination.

How to order

Housing	Voltage	Color and Color Temperature (1)	Optics	Optical Option (4) (7)	Finish	Control (11) (12)	Options	Certification	Cable Length (14) (18)	Cable Color
LBM Lumenbeam™ Medium	100 100 volts	22K 2200K	XN Extra Narrow 4°	LSLH Linear spread lens horizontal distribution (5) (6)	BK Black Sandtex®	NO On/Off control	SY Short Yoke	UL UL compliant	3FT 3 ft (14) (18)	BK Black
	120 120 volts	27K 2700K	VN Very Narrow 6°		BRZ Bronze Sandtex®	DIM 0-10V dimming	3GV 3G ANSI C136.31-2010 Vibration Rating for bridge applications	CE CE compliant (17)	10FT 10 ft	WH White (19)
	208 208 volts	30K 3000K		LSLV Linear spread lens vertical distribution (5) (6)	SI Silver Sandtex®	DALI DALI dimming		CEII CE compliant Class II double insulated (17)	20FT 20 ft	
	220 220 volts	35K 3500K	NS Narrow Spot 10°		WH Smooth white	DMX/RDM DMX/RDM enabled (13) (14)	CRC Corrosion- resistant coating for hostile environments (15) (16)		30FT 30 ft	
	240 240 volts	40K 4000K	NF Narrow Flood 20°						50FT 50 ft	
	277 277 volts	57K 5700K	M Medium 30°						70FT 70 ft	
			RD Red (2) (3)	FL Flood 40°		BKTX Textured black			100FT 100 ft	
			GR Green (2) (3)	WFL Wide Flood 60°		BRZTX Textured bronze non- metallic				
			BL Blue (2) (3)	NAS Narrow Asymmetric		GRATX Textured medium gray				
				WW Asymmetric Wallwash		GRNTX Textured green				
					WHTX Textured white					
					CC Custom color and finish (please specify RAL color) (8) (9) (10)					

Notes:

1. Consult factory for availability of static Royal Blue, Amber, 6500K and 90+ CRI.
2. Static colors made to order 8-10 weeks.
3. Not available for XN optic.
4. Optical options are factory installed and cannot be changed in the field.
5. Not available with VN and NF optics when combined with 2200K, 2700K, 3000K, 3500K, 4000K and 5700K static colors.
6. Field adjustable spread lens optical accessory available, order separately.
7. Not available with WFL, NAS and WW optics.
8. Lumenpulse offers a wide selection of RAL CLASSIC (K7) colors with a smooth texture and high-gloss finish. Please consult factory for a list of available K7 colors, other RAL textures and glosses, or to match alternate color charts. Final color matching results may vary.
9. Setup charges apply for RAL colors. Consult factory for details.
10. Longer lead times can be expected for custom RAL color finishes.
11. Lumentalk system is enabled with LDB accessory, DIM or DMX/RDM must be specified in the order code. See the typical wiring diagrams in the specification sheet for details.
12. A Lumentranslator 2 (LTL2) and LumentalkID (LIDL) must be specified for Lumentalk applications. Consult Lumentranslator 2 and Lumentalk pages and specification sheets for details.
13. A control box (CBX) and LumenID (LID) must be specified.
14. Maximum of 3 ft cable length for daisy chain DMX applications with CBX-DS.
15. Use only when exposed to salt spray and harsh chemicals. This option is not required for normal outdoor exposure.
16. Setup charges apply. Consult factory for details.
17. Consult European specification sheets and installation instructions for CE and CE Class II wiring information.
18. 3 ft cable length is standard unless otherwise specified.
19. Not available with CE or CBI certification options.



Collection of wall mounted luminaires for exterior applications. Lift has an innovative optical system that produces pleasing graphic effects. By using a combination of Wide Flood or Narrow Spot beams, this luminaire offers limitless possibility of lighting effects.

Luminaire characteristics:

Power input: 18.5W
Lumens: 215 to 400lm (for 3000K, 90CRI)
Luminaire efficacy: 11 to 21lm/W

Source: White LED (LM-80 tested),
3000K : 90CRI,
4000K : 90CRI.

Lumen maintenance: 70% of initial lumens at 50 000 hours (L70) (LM79 tested).

Optics: Narrow spot or wide flood.

Material: Body: Die-cast aluminum
Diffuser: Clear tempered glass
Reflector: 99.98% pure aluminum
Hardware: Stainless steel screws and silicone gaskets.

Electrical: Universal high efficiency electronic LED driver rated at 50 000 hours, 120V-277V.

Mounting: Install on a standard 4" junction box.

Finish: Aluminum gray.

Weight: 13.4lbs (6.1kg).

Warranty: 5 year limited warranty.

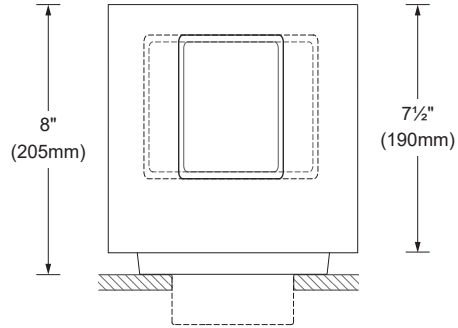
Ratings: IP65, IK06

Certification:  cULus listed for wet location.

DIMENSIONS



FRONT VIEW



BOTTOM VIEW

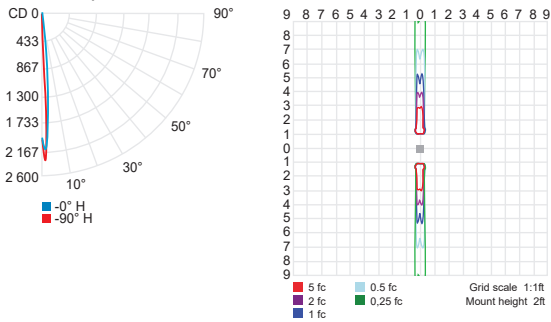
PHOTOMETRIC DATA

Photometric performance is measured in accordance with IESNA LM-79.
Visit sistimalux.com for complete photometric data.

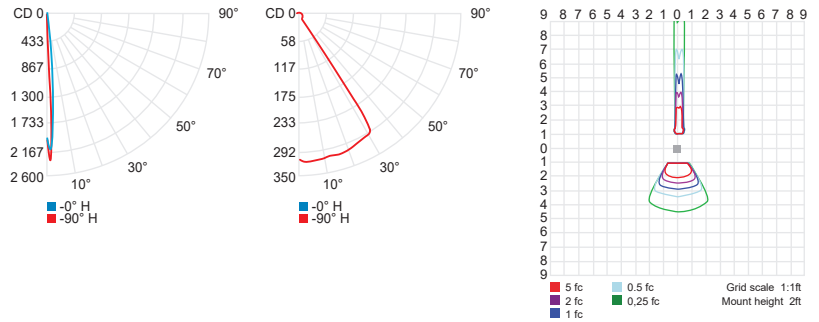
LOAD (W)	CCT (K)	CRI	OPTIC	LUMENS (lm)	EFFICACY (lm / w)	MAX CANDELA (cd)	MODELS
18.5W	3000K*	90	Narrow spot 5°	105	5	2565	S5040W
			Combined beam	105 (5°) - 200 (67°)	5 (5°) - 10 (67°)	2565 (5°) - 340 (67°)	S5033W
			Wide flood 67°	200	10	340	S5026W

*Photometric data is the same for 3000K and 4000K.

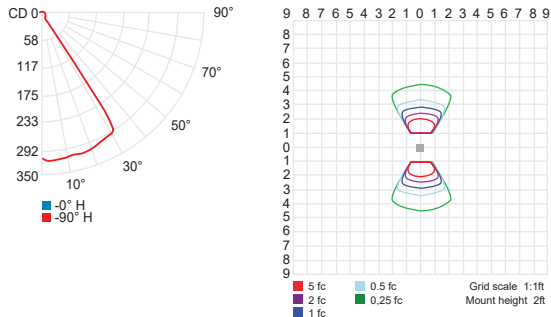
Narrow spot 5° (3000K, 90CRI)



Combined beam 5°-67° (3000K, 90CRI)



Wide flood 67° (3000K, 90CRI)



ORDERING INFO

- UNV - 14
FIXTURE

MODEL

S5040W - 3000K 90CRI, Narrow spot

S5040N - 4000K 90CRI, Narrow spot

S5033W - 3000K 90CRI, Combined beam

S5033N - 4000K 90CRI, Combined beam

S5026W - 3000K 90CRI, Wide flood

S5026N - 4000K 90CRI, Wide flood

VOLTAGE

UNV - 120-277V

FINISH

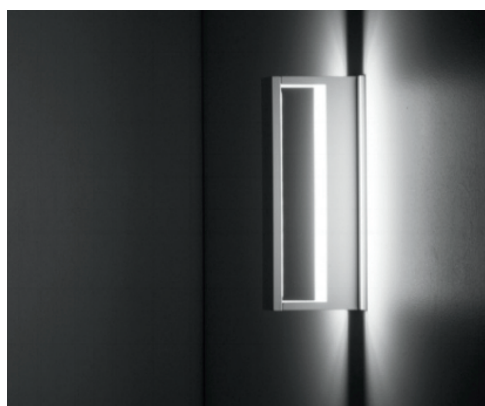
14 - Aluminum gray

Wall mounted luminaire for commercial interior applications. Modern minimal design suitable for lobbies, corridors, or other applications where low glare indirect lighting is desired. ADA compliant.

Luminaire characteristic:

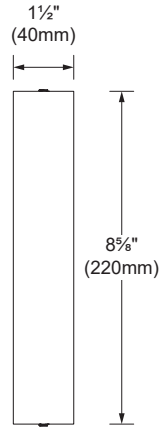
Power input: 10.5W
Lumens: 605lm (for 3000K, 90CRI)
Luminaire efficacy: 58lm/W

Source:	White LED (LM-80), 2700K: 80CRI, 3000K: 80CRI, 3000K: 90CRI.
Lumen maintenance:	70% of initial lumens at 50 000 hours (L70) (LM-79).
Optic:	Diffused indirect light
Material:	Body: Die-cast aluminum Diffuser: Tempered glass
Mounting:	See mounting option on page 2.
Electrical:	Integral high efficiency LED driver, rated at 50 000 hours. 120V/277V.
Dimming:	Down to 10%, leading (triac) and trailing edge (ELV) (120V) or 0-10V for J2 and JB mounting. (page 4)
Finish:	White painted (RAL9003) or black matte painted
Weight:	2lbs (0.91kg)
Warranty:	5 year limited warranty.
Ratings:	IP20
Certification:	cULus listed for damp location.

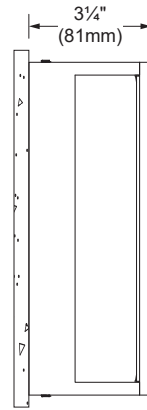


DIMENSIONS

DIRECT FEED (DF)

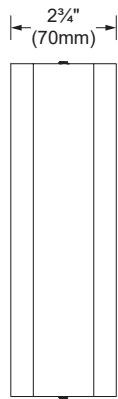


FRONT VIEW

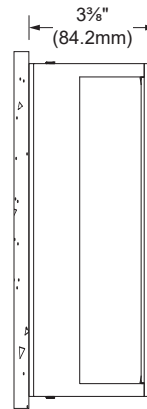


SIDE VIEW

JUNCTION BOX 2" (J2)

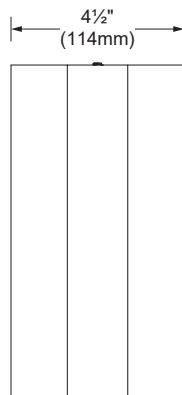


FRONT VIEW

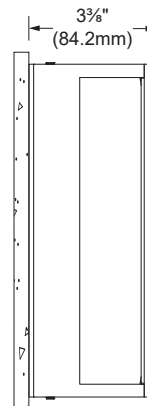


SIDE VIEW

JUNCTION BOX 4" (JB)



FRONT VIEW



SIDE VIEW

LED COLOR FIDELITY DATA

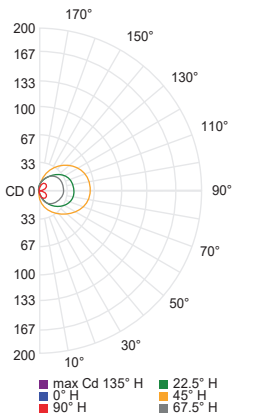
CRI	CCT	R1	R2	R3	R4	R5	R6	R7	R8	R9	R10	R11	R12	R13	R14	R15	Rf	Rg	Melanopic ratio
80	2700K	81	92	94	80	82	92	81	56	6	83	81	80	84	98	73	85	96	0.469
	3000K	80	88	95	82	80	84	85	62	10	72	82	67	82	97	73	83	99	0.478
90	3000K	91	94	96	91	91	93	92	80	54	86	91	83	92	97	87	91	100	0.535

PHOTOMETRIC DATA

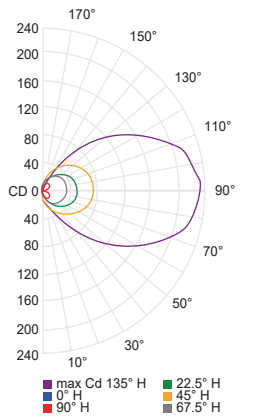
Photometric performance is measured at an accredited independent laboratory in accordance with IESNA LM-79. Visit sistemalux.com for complete photometric data.

CCT (K)	CRI	LOAD (W)	OPTIC	LUMENS (lm)	EFFICACY (lm/w)	MAX CANDELA (cd)	MODELS
2700K	80	10.5W	Indirect light	575	54	190	1230-827
3000K				705	67	235	1230-830
	90	605		58	200	1230-930	

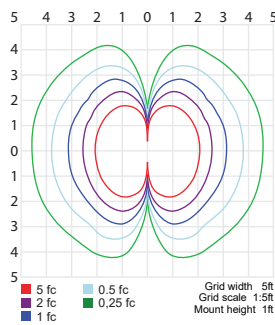
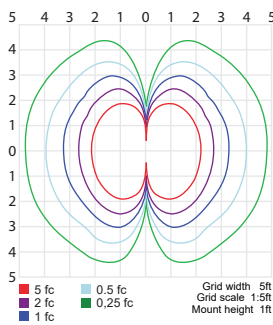
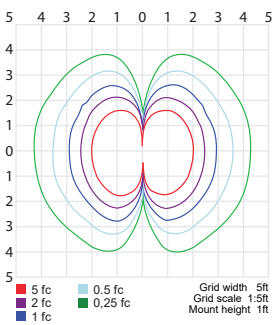
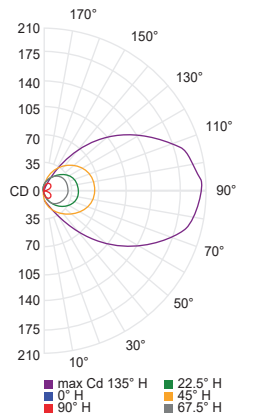
Indirect light (2700K, 80CRI)



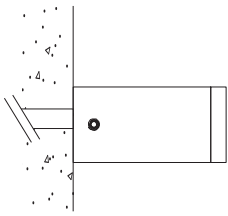
Indirect light (3000K, 80CRI)



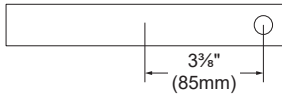
Indirect light (3000K, 90CRI)



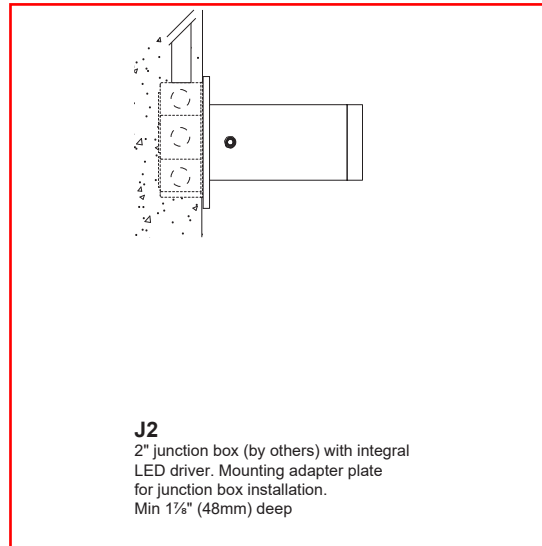
MOUNTING OPTIONS



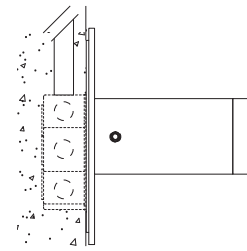
Direct feed position



DF
Direct feed with integral LED driver. Connections made inside fixture (14-18AWG). Rigid or flexible conduit up to Ø1" cable, romex or bx. Installed directly to surface.



J2
2" junction box (by others) with integral LED driver. Mounting adapter plate for junction box installation. Min 1 1/2" (48mm) deep



JB
4" standart octogonal junction box (by others) with integral LED driver. Mounting adapter plate for junction box installation. Min 1 1/2" (38mm) deep

ORDERING INFO

1230 - - - -
FIXTURE



MOUNTING

DF - Direct feed

J2 - Surface mounted with 2" junction box

JB - Surface mounted with 4" standart octogonal junction box

LED

827 - 2700K, 80CRI

830 - 3000K, 80CRI

930 - 3000K, 90CRI

VOLTAGE

120 - 120V

UNV - 120-277V⁽¹⁾

FINISH

01 - White

52 - Black matte

DIMMING*

D10 - 0-10V⁽²⁾

LTE - Leading and trailing edge dimming (120V only)

⁽¹⁾ For direct feed (DF) mounting with 120-277V (UNV) voltage, no dimming available.

⁽²⁾ Available for 120-277V (UNV) voltage with surface 2" junction box (J2) or surface 4" junction box (JB) mounting.

* 10% dimming options: For leading and trailing edge and 0-10V (D10 and LTE), the dimming levels will vary depending on the dimmer used and the number of luminaires on the line.