December 20, 2019

ADDENDUM #1

TO CONTRACT DOCUMENTS FOR: Project #CP191921 – Gas Turbine Building - Chilled Water Plant Addition

ADVERTISEMENT DATE: December 3, 2019

PREPARED FOR: The Curators of the University of Missouri

425 South Woods Mill Rd, Suite 300
Chesterfield, MO 63017
(314) 682-1500

The contract documents for the above noted project and the work covered thereby and herein modified.

GENERAL INFORMATION:

1) Existing Gas Turbine Building Foundation Drawings (CP901392) and Cooling Tower Foundation Drawings (CP062102) are being provided for Reference Only to facilitate contractor awareness of adjacent foundations when excavating alley for Domestic Water and Sanitary Sewer pipe routing.
2) Referenced Subsurface Investigation, Soil Analysis and Construction Recommendations as well as supplemental letter are being provided for Reference Only.
3) Reference attached CP191921_Bid_QA_Log.pdf for responses to all recent bid questions

PROJECT MANUAL:

1) Special Conditions page SC-13
   a. Delete part 17.a.(1).(a),(iv) – Mechanical Contractor must have carried a PP (Power Piping) Stamp for the last three years.
2) Section 33 61 12 – Hydronic Energy Distribution
   a. Revise part 2.01.A.2.a as follows: 4 inches to 12 inches: AWWA C900; Class 235 (DR 18); cast iron O.D. equivalent; with grooved ends suitable for restrained joint coupling.
   b. Delete part 2.01.A.2.b
3) Section 07 72 73 – Membrane Leak Detection System
   a. Added to Project Manual and attached to Addendum
4) Section 26 22 00 – Low-Voltage Transformers
   a. Add “ABB” to part 2.1.A as an acceptable manufacturer
5) Section 26 24 13 – Switchboards
   a. Add “ABB” to part 2.2.A as an acceptable manufacturer

6) Section 26 24 16 – Panelboards
   a. Add “ABB” to part 2.3.A as an acceptable manufacturer
   b. Add “ABB” to part 2.4.A as an acceptable manufacturer

7) Section 26 25 00 – Enclosed Bus Assemblies
   a. Add “ABB” to part 2.1.A as an acceptable manufacturer

8) Section 26 28 16 – Enclosed Switches
   a. Add “ABB” to part 2.1.A as an acceptable manufacturer

DRAWINGS:

1) G-002
   a. Add following statement as Phase 2 Constraint #7: Existing parking area fixtures
      at parking lot RC-9 shall not be out of service during nighttime hours. Do not
      disconnect existing power supply circuit until new power supply circuit work is
      complete and cut-over work can be completed during daylight hours. See sheet
      ED-100 and E-100 for additional information.
   b. Revise aerial view “Project Laydown Plan” per SK-1.

2) M-601
   a. Sand Filtration Schedule: Increase Flow of FLTR-1 from 140 GPM to 200 GPM

Attachments: (7)
1) L4180 Gas Turbine Building North Addition - Final-signed
2) L4180 CP191921 Gas Turbine Building Supplemental Letter
3) CP062102_V_I_Record_Drawings_Structural
   a) SB101
   b) SB102
   c) SB301
   d) SB311
   e) SB312
   f) SB313
   g) SB314
   h) SB315
4) CP901392.Foundation_drawings
   a) S5
   b) S8
   c) S9
5) 07 72 73 Membrane Leak Detection System
6) SK-1: Revised Project Laydown Plan
7) CP191921_Bid_QA_Log

END OF ADDENDUM #1
GENERAL SHEET NOTES

1. Not to change all sizes, heights, hardware, casings and materials in the area after completion.

2. CONSTRUCTION DATE IS NOT SET. DATE WILL BE DETERMINED AT TIME OF CONSTRUCTION. "CONTRACTOR TO SUBMIT CONSTRUCTION DATE PLAN FOR ENGINEER'S APPROVAL.

COOLING TOWER BASIN PLAN
UNIVERSITY OF MISSOURI
POWER PLANT-COOLING TOWER
AND 480V SUS REPLACEMENT

SECTION

DETAIL

ANCHOR BLOCK SECTION

NOT USED

ANCHOR BLOCK SECTION

TYPICAL ANCHOR BLOCK

SECTION
TYPE A GRADE BEAM
(INCLUDED AS CS-1)

TYPE B GRADE BEAM
(INCLUDED AS CS-1)

TYPE C GRADE BEAM
(INCLUDED AS CS-1)

TYPE D GRADE BEAM
(INCLUDED AS CS-1)

NOTES:
1. SEE DRAWING CS-1 FOR LIVE DETAIL.
SUBSURFACE INVESTIGATION, SOIL ANALYSIS AND CONSTRUCTION RECOMMENDATIONS

For: MU Gas Turbine Building Addition
CP191921
Columbia, Missouri

PREPARED FOR:
MR. KENNETH KEANE, PE
UNIVERSITY OF MISSOURI
GENERAL SERVICES BUILDING
COLUMBIA, MISSOURI 65211

JUNE 27, 2019

PREPARED BY:
Engineering Surveys & Services
1113 FAY STREET
COLUMBIA, MO 65201
(573) 449-2646

MISSOURI ENGINEERING CORPORATION NUMBER 2004005018
COLUMBIA ◆ JEFFERSON CITY ◆ SEDALIA ◆ WILDWOOD
Mr. Kenneth Keane, PE  
University of Missouri  
General Services Building  
Columbia, MO 65211  

RE  Geotechnical Engineering  
MU Power Plant  
Gas Turbine Building –North Addition  
CP191921  
Columbia, Missouri

Dear Mr. Keane:

At your request, this firm conducted a subsurface investigation including the drilling of four soil and rock borings for the above referenced project. The purpose of the investigation was to obtain soil samples for engineering analysis such that geotechnical design parameters and pertinent construction considerations could be provided for the proposed project.

The site of the proposed project is located in the City of Columbia in Boone County, Missouri on the campus of the University of Missouri, Columbia. Specifically, the project is at the University’s power plant located in the northeast quadrant of the intersection of Stewart and Providence Roads. The addition will be located directly north of the northwest corner of the gas turbine building.

It is our understanding that the project consists of the construction of a 40 by 100 foot addition to the northwest corner of the gas turbine building. Construction is anticipated to consist of a steel framed structure, similar to the construction of the existing building. Maximum column reactions could be as high as 450 kips, including wind and seismic forces. Finished floor is anticipated to match that of the existing structure at ±714.0 feet.

Topography, Field Investigation, and Subsurface Conditions

The topography of the investigation area can be described as highly modified by man. The site is paved and slopes to the northwest. There is approximately 5.5 feet of fall from the south end of the proposed addition to the northwest corner. Site drainage is currently handled by runoff to storm drains located west of the site.

All borings were advanced using a 4-inch continuous flight, solid stem auger with a drag type drill bit and powered with a truck-mounted CME drill rig. The borings were advanced to depths ranging from 12.2 to 18.5 feet. Undisturbed soil samples were attempted; however, due to the nature of the subsurface materials, only one useable sample was successfully obtained. Undisturbed samples were obtained using 3-inch O.D. thin-walled tube sampling procedures in accordance with ASTM D1587. Disturbed samples were obtained as either auger or split spoon samples. Standard Penetration Tests were performed in accordance with ASTM procedures as outlined in ASTM D1586. Copies of the boring location plan and boring logs are enclosed with
this letter. The stratification lines indicated on the boring logs represent approximate boundaries and the transition may be gradual.

All samples were obtained using appropriate ASTM procedures. Drilling was monitored by an engineer from this firm. The engineer provided technical direction, performed field tests, and prepared and transported the samples to the laboratory for testing.

The ground surface elevations and locations for the borings were determined at the time of drilling. The surface elevations are referenced to a topographic survey developed by this firm. The surface elevations of the borings are assumed correct to within 0.2 feet.

The subsurface profile was variable over the site of investigation. In general, underlying 10 to 12 inches of asphalt in borings B1 and B2 or 6 to 8 inches of concrete in borings B3 and B4 baserock was encountered. Baserock consisted of a mixture of “rollstone” and wastelime and ranged from 2 to 3.3 feet thick. Underlying the baserock, a man-made fill was encountered. Beneath the fill, naturally occurring clay-rich soils with varying amounts of sand and silt were encountered. The lower portion of this stratum transitioned to a shaley clay with chert gravel and cobbles. The shaley clay was in turn underlain by limestone bedrock. Boring B1 encountered naturally occurring silty clay beneath the fill that continued to auger refusal on limestone.

The fill was described as a combination of silty and sandy silty and shaley clays with colors ranging from brown to dark brown and gray, moist, and soft to firm in consistency. Thickness of this stratum ranged from 2.5 to 7 feet. Some of the fill was placed during the construction of the gas turbine plant but no records were available indicating that the fill was monitored.

Underlying the man-made fill, clay-rich soils were encountered. The clay-rich soils were described as brown to tan with some brown in color, moist, firm to stiff in consistency and contained varying amounts of silt, sand and chert gravel and cobbles. The lower portion of the stratum in borings B2, B3 and B4 transitioned to shaley clay. The chert laden lower portion of this stratum was visually identified as residual soils.

Limestone bedrock was encountered underlying the residual soil layer. Drilling for all four borings was terminated at auger refusal on limestone bedrock. The depth to auger refusal ranged from 12.2 feet in boring B1 to 18.5 feet in boring B4. Elevations of the limestone stratum ranged between 695 to 697 feet. Several of the borings encountered a 6 to 12 inch mantle of weathered limestone capping the limestone stratum.

Groundwater was encountered in three of the four borings at depths ranging from 13.5 to 14.5 feet. The groundwater is believed to be associated with the soil/rock interface as well as the wastelime stratum. Groundwater is anticipated to affect construction of the foundation system and should be prepared for accordingly. The exact location of the groundwater surface should be expected to fluctuate depending on normal seasonal variations in precipitation and other climatic conditions, surface runoff, permeability of on-site soils, continuity of pervious material, and
Laboratory tests performed on soil samples obtained during the field investigation provided a range of results. The natural moisture contents of the soils were found to range from 14 to 41 percent. The dry density of the one undisturbed sample that was obtained was 96 pounds per cubic foot (pcf). The cohesion as measured in the unconfined compression test was 0.7 tons per square foot (tsf). A copy of the “Laboratory Summary” is attached to the end of this letter.

**Engineering Analysis and Recommendations**

In the design of the proposed structure the following seismic Site Classifications may be used. These parameters are based on the 2018 International Building Codes and are site specific.

1. Site Class C
2. Mapped Spectral Response, Short Periods (Ss) 0.167
3. Mapped Spectral Response, Short Periods (S1) 0.093
4. Site Coefficient as a Function of Ss (Fa) 1.3
5. Site Coefficient as a Function of S1 (Fv) 1.5

We highly recommend that the structure be designed as an independent structure with flexible connections to the existing building to limit any effects of differential settlement between the new and existing structures.

Site grading for this project is expected to be minimal with most of it consisting of preparing the subgrade for pavement patching after foundation construction.

Shallow spread and mat foundations as well as deep cast-in-place piers were considered for this project and recommendations for each are presented in this letter. Based on the proposed loads and the variable nature of the subsurface conditions encountered at the site, including undocumented fill, it is recommended that the structure be supported on a deep foundation system consisting of cast in place drilled piers.

**Shallow Foundation Systems**

The use of a shallow foundation system will require that all existing undocumented fill be removed from beneath the base of the footings and zone of influence to native stiff residual soils or bedrock. The removed material should be replaced with select soil, approved by the geotechnical engineer, or granular fill. This will require the removal of up to seven (7) feet in the vicinity of boring B3 with an average depth of five (5) feet removed across the site. The zone of influence beneath the footings is 0.6 feet horizontally for each foot vertically in depth. Thus, three (3) feet of overexcavation below the design bearing elevation would require the footing excavation to be widened by 1.8 feet on each side before placing the engineered fill. We recommend that if a granular fill is used, it be either a “rollstone,” MoDOT 1007, Type 1 or Type 5 or an approved equal up to the bearing elevation. Any approved soil or granular fill may be used above the bearing elevation. It is also recommended that the upper 2 feet of material...
beneath pavements or slabs-on-grade consist of low plasticity soil or granular fill. Low volume change material is defined in the “Construction Considerations” section of this letter. The fill should be compacted to the specifications provided later in this letter.

Both spread and mat shallow foundation systems were considered. Due to the rocky nature of the native residual soils, settlement calculations are at best difficult. However, settlement calculations for a mat foundation system indicated as much as 1.6 inches of settlement are possible with a bearing capacity of 2,000 pounds per square foot (psf). A mat foundation was not considered a viable option.

A shallow spread foundation system containing both integral perimeter and isolated column pads, and bearing on stiff native residual soils or granular fill on top of stiff native residual soils, as recommended above, may be sized for a net allowable bearing capacity of 4,000 pounds per square foot (psf). Foundations bearing on select engineered soil fill may be sized for a net allowable bearing capacity of 2,500 psf. The charts below provide an estimated total settlement for various bearing capacities and footing sizes. Two charts were provided, one based on using select soil fill to replace the existing man-made fill and one using the above mentioned granular fill. Frost protection will be provided if these foundations are maintained at a minimum depth of 36 inches below finished exterior grade.
Additionally, a shallow foundation system will place an additional lateral load on the existing piers for the Gas Turbine Building in the vicinity of boring B3 and B4. The effects of the additional lateral loads on the piers should be analyzed by a structural engineer prior to the selection of this type of foundation system.

Incidental foundations for steps and small exterior retaining walls, may be proportioned for a net allowable bearing pressure of 2,000 psf bearing on existing baserock and fill. Total settlement would be less than one inch. Frost protection will be provided if these foundations are maintained at a minimum depth of 36 inches below finished exterior grade.

**Deep Foundation System**

The preferred foundation system would match the systems of the existing Gas Turbine building and the Water Cooling Tower is a deep foundation system consisting of cast-in-place piers. Cast-in-place piers bearing on Pennsylvanian age limestone or shale beds at elevations ranging between the elevations of 695 and 697 should be designed with the following parameters:

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>ALLOWABLE DESIGN VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Skin friction in soil</td>
<td>neglect</td>
</tr>
<tr>
<td>2. Skin friction in Pennsylvanian age material (uplift only)</td>
<td>2,000 psf</td>
</tr>
<tr>
<td>3. End bearing on Pennsylvanian age shale and Limestone</td>
<td>20 ksf</td>
</tr>
</tbody>
</table>

End bearing elevation is considered as achieved once the shaft has penetrated the chert laden glacial and residual soils, and has reached the Pennsylvanian age shales or limestones. Settlement of the drilled shaft foundation system on Pennsylvanian age shale and limestone is
expected to be in the order of ½ inch or less and is expected to occur during construction. It is recommended that a qualified geotechnical engineer verify the suitability of the bearing material and the condition of the base of the pier prior to concrete placement.

Should a higher bearing capacity be required, the piers could extend to the Mississippian age Burlington Limestone. Piers extending into the massive Burlington Limestone may be proportioned using the following parameters:

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
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</thead>
<tbody>
<tr>
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<td>2. Skin friction in Pennsylvanian age material (uplift only)</td>
<td>2,000 psf</td>
</tr>
<tr>
<td>3. Skin friction in massive Burlington Limestone</td>
<td>80 psi</td>
</tr>
<tr>
<td>3. End bearing on massive Burlington Limestone</td>
<td>50 ksf</td>
</tr>
</tbody>
</table>

Due to potential weathering effects, the upper foot of the Burlington formation should not be used for skin friction calculations. Settlement should be negligible. The existing gas turbine building extends to the 50 ksf bearing material. It should be noted that extending the pier excavation to the Burlington Limestone would incur considerably more rock excavation charges.

Straight shafts are recommended for piers bearing on shale or limestone. Drilled shaft capacities should be adjusted by varying the pier diameter. A minimum shaft diameter of 30 inches is recommended for clean-out and inspection purposes. Difficult drilling conditions are expected that include construction rubble, boulder and cobble removal. Due to the considerable amount of chert cobbles and boulders that lie above the limestone and/or shale, it is recommended that at a minimum, Pengo tipped rock bits be used. Additionally, due to the rubble nature of the fill and the chert cobbles, a core barrel may be necessary to maintain a straight shaft through the overlying cobble layer. It is recommended that pier excavation to proposed bearing elevation be unclassified. If separate soil and rock excavation is classified, we recommend that the bid documents include a minimum of 5 linear feet of rock excavation allowance, per pier, to reach suitable Pennsylvanian age bearing material (20 ksf). Any required rock socket would be additional rock excavation footage. Past history in this area indicates up to an additional 15 feet with an average around 10 feet of rock removal, per pier, may be required if the excavation is extended to the Mississippian age Burlington Limestone (50 ksf). Additionally, unit prices should be established to cover any additional incidental rock removal. Finally, terminating rock excavation once suitable material is encountered is not precise, generally an additional foot of excavation is encountered to properly terminate and clean the pier excavation

Groundwater was encountered in three of the four borings. It is recommended that appropriate sizes and lengths of temporary casing be on site to provide groundwater control and prevent sidewall sloughing. Oversizing of pier excavations and the ensuing additional concrete should be expected to accommodate casing requirements.
Slabs-on-Grade

Borings indicate that a minimum of two feet of baserock and rollstone lies below the existing pavement. If a deep foundation system is used, upon removal of the asphalt and concrete, the existing aggregate may remain in place. Any material that is disturbed during demolition should be recompacted as engineered fill. In consideration of this, the slab-on-grade may be designed using a modulus of subgrade reaction of 150 pounds per cubic inch (pci).

Floor slab thickness should be designed using the above referenced modulus of subgrade reaction; however, we recommend a minimum thickness of 4 inches to allow for variations during construction. Additionally, we recommend that the slab subgrade includes a minimum 6 inch layer of free draining base course to provide a capillary break and provide a cushion should there be minor subgrade swelling. Free draining base course will meet the gradation requirements for a #67 rock as defined by ASTM C33. A minimum 6 mil thickness polyethylene vapor barrier should be installed beneath the slab to improve its performance. It is also recommended that construction joints be provided at the foundation walls and column locations to ensure that the new floor slab can move independently of the wall, floor, or support foundations. In addition, it is recommended that the slab be reinforced with a minimum of a 6 by 6-inch woven wire mesh to help prevent vertical movement should the floor slab crack. However, the structural engineer will provide the final slab reinforcement recommendations.

Construction and saw joints are recommended for all of the slabs-on-grade and should be installed such that the panels are nearly square but do not exceed a length to width ratio of 1.4 to 1.0. Maximum panel size depends on several factors including the amount of cement in the mix, the maximum course aggregate size, and slab thickness.

Pavement Recommendations

It is anticipated that minor patching of the existing pavement will be required. Due to the heavy vehicles that traverse this area, it is recommended that a heavy duty concrete pavement be used for patch work; however recommendations for both concrete and asphalt pavements are presented. Rigid pavements should be reinforced, at a minimum, with 6 x 6 inch woven wire mesh and 1/2-inch epoxy coated dowel bars for traverse joints.

The following pavement design recommendations have taken into account site specific traffic estimates, geotechnical information, and existing pavement cross sections. A California Bearing Ratio (CBR) value of 3 was used to develop the following pavement design recommendations.

HEAVY DUTY

Portland Cement Concrete

8" Portland Cement Concrete (4,000 psi mix)
6" MoDOT Type 1 crushed stone base
Asphaltic Cement Concrete

2" Type 'BP-2' Asphaltic Concrete Surface Course
5" MoDOT Plant Mix Bituminous Course
7" MoDOT Type 1 crushed stone base

Construction Considerations

All new utility trenches should be backfilled with granular or flowable fill in accordance with appropriate controlled engineered fill specifications. All trench excavations should be made with sufficient working space to permit the placing, inspection, and completion of all work including backfill construction. It is recommended that a representative of the geotechnical engineer be present during fill placement and compaction to assure that adequate compaction is achieved and that proper methods are employed.

Engineered fill and backfill should be free of frozen soil, organics, rubbish, large rocks, wood, or other deleterious material. Cohesive fills should be uniformly compacted to at least 95 percent of the “Standard” maximum dry density and be within -2 to +4 percent of optimum moisture content as described by ASTM D698. Granular fills and pavement base rock, containing enough fines such that a definite moisture density relationship exists, should be uniformly compacted to 95 percent of the “Standard” maximum dry density and should be wet enough to provide proper compaction yet dry enough so as to not cause any excessive 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 should be reworked and retested as required until the specified limits are reached. Low volume change material used in the upper 2 feet of subgrade is defined as a non-plastic granular fill with enough fines to develop a moisture/density relationship or a soil with a Liquid Limit less than 50 (LL<50) and a Plastic Index less than 30 (PI<30).

The fill material should be placed in layers, not to exceed 8 inches in loose thickness, and should be wetted or dried as required to secure specified compaction. Effective spreading equipment should be used on each lift to obtain a uniform lift thickness prior to compaction. Each layer should be uniformly compacted by means of suitable equipment of the type required by the materials composing the fill. Material that is too wet to permit proper compaction may be stockpiled or spread and permitted to dry assisted by diskng, harrowing, or pulverizing until the moisture content is reduced to a satisfactory value. The fill layers should be placed in relatively level lifts. Rocks and stones that exceed the thickness of the 8 inch loose lift layer should be removed and disposed of off the immediate construction site.

Drilled Pier Construction

Difficult drilling conditions including boulders and fractured rock are expected to exist. It is recommended that pier excavation to proposed bearing elevation be unclassified. A rock allowance should be included in the unit prices for any additional rock. Groundwater is expected to influence pier construction and a casing and dewatering allowance should also be included in the unit price.
Pier shafts should be excavated within the following tolerances:

1. The shaft centerline should be within 3 inches or four percent of the shaft diameter, whichever is less.

2. The shaft diameter should not vary by more than plus three or minus one inch.

3. The shaft should be plumb to within one percent of the total length, 12 percent of the shaft diameter, or 15 inches total, whichever is less.

If loose soil, high groundwater levels, or other conditions occur which cause the sides or bottom of the excavation to become unstable, the excavation should be advanced through a temporary casing, permanent casing, or other approved method. Any water that enters the excavation should be pumped down to a depth of less than two inches prior to concrete placement. If any pier excavation cannot be satisfactorily dewatered, concrete should be placed using tremie techniques. Groundwater was encountered during drilling, therefore it is recommended that enough casing of proper size be on location during drilling. A temporary casing is required for all downhole inspections.

All pier concrete should preferably be placed immediately after excavation due to the deteriorating nature of weathered shale material but no later than 1 to 2 hours after excavation. Concrete should be placed in dry pier excavations with the use of a tremie and free fall method and should not hit the side of the shaft or the rebar cage during placement.

All loose material and spoil should be removed from the shaft prior to placing concrete. In no case should the volume of such material exceed that which would be required to cover 5 percent of the shaft base at the bearing elevation to a depth of more than 2 inches. Shafts bearing on limestone bedrock should be excavated to a relatively level plane.

Warranties and Limitations

This report has been prepared for the exclusive use of the University of Missouri, Columbia, and its consultants for the specific project discussed, in accordance with generally accepted soils engineering practices common to the central Missouri area. No other warranties, expressed or implied, are made.

This investigation and report do not constitute a guarantee of subsurface conditions, groundwater conditions, excavation characteristics or construction conditions. We recommend that excavation conditions across the site be evaluated during construction relative to this interpretation of subsurface conditions. Variations in subsurface conditions may occur that require evaluation or revision of geotechnical design parameters or recommendations. If the scope of the project is altered or differing geotechnical conditions are encountered, it would be advisable to review and update our recommendations in consideration of those findings or variations.
Recommendations contained in this report are based on subsurface conditions and proposed designs provided as of this date. The above study and recommendations are applicable only for the conditions and locations described, and for the specific project mentioned. Use of the data contained herein by others may require interpretation or analysis that was not contemplated by our investigation and analysis. The use of this data and any interpretations or conclusions developed by others are the sole responsibility of those firms or individuals.

Factors affecting design and construction often become apparent during detailed design or actual construction that were not anticipated in the pre-design or early design phases. Engineering Surveys and Services is available during design and construction to assist in evaluating these factors and their impact on these geotechnical recommendations.

I trust this letter provides you with the requested information. Please contact us if we can be of further assistance.

enclosures
cc: Keane, Stapf (email)
LAB NO. 4180
PROJECT: Gas Turbine Building — North Addition
Columbia, Missouri

SYMBOLS AND TERMS

SAMPLE TYPES

Auger Shelby Split Giddings No NX Core Roller Bit Concrete Down Hole
Tube Spoon Tube Recovery Boring (Tri-Cone) Corer Hammer

ABBREVIATIONS

- Unconfined Compression (1)
- Water Content (2)
- Plastic (PL) & Liquid (LL) Limit (2)

USCS Unified Soil Classification System
PI Plasticity Index
ATD At Time of Drilling
RQD Rock Quality Designation
SS Split Spoon — 1 3/8" I.D., 2" O.D.
ST Shelby Tube — 3" O.D.
PA Power Auger
HA Hand Auger
AS Auger Sample
S Cuttings Sample
TV Hand-Held Torvane

DEFINITIONS

Blows per ft.— Indicates blows per 12 inches of sampler penetration when driven by a 140-pound hammer falling freely 30 inches. The Standard Penetration Resistance is the number of blows for the last 12 inches of penetration of the split—spoon sampler.

NOTES

(1) Shear Strength Data plotted on cohesion scale of Boring Logs.
(2) Classification and Index Properties plotted on Water Content Scale of Boring Logs.
<table>
<thead>
<tr>
<th>BORING NO.</th>
<th>SAMPLE NO.</th>
<th>DEPTH (FEET)</th>
<th>USCS CLASS</th>
<th>NATURAL MOISTURE CONTENT (%)</th>
<th>NATURAL DRY DENSITY (PCF)</th>
<th>ATTERBERG LIMITS</th>
<th>UNCONFINED COMPRESSION (TSF)</th>
<th>COHESION</th>
<th>STRAIN %</th>
<th>REMARKS</th>
</tr>
</thead>
<tbody>
<tr>
<td>B1</td>
<td>SS1</td>
<td>3.5-4.5</td>
<td>14</td>
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<td></td>
<td></td>
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<tr>
<td></td>
<td>SS2</td>
<td>9.5-11.0</td>
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<td>B2</td>
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<tr>
<td>B3</td>
<td>SS1</td>
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<td>ST2</td>
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<td>0.7</td>
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<td>SS3</td>
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<tr>
<td></td>
<td>SS4</td>
<td>9.5-11.0</td>
<td>20</td>
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<td></td>
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</tbody>
</table>
**LOG OF BORING NO. ** B1

**TYPE:** 4” Solid Stem Auger

<table>
<thead>
<tr>
<th>DEPTH, FT.</th>
<th>SAMPLE TYPE</th>
<th>SOIL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5</td>
<td>ASPHALT</td>
<td>See Plan of Boring Locations</td>
</tr>
<tr>
<td>2</td>
<td>BASE: Wastelime</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>FILL: SILTY CLAY: Dark brown, some brown, moist, firm, chert and limestone gravel</td>
<td>13</td>
</tr>
<tr>
<td>8</td>
<td>SILTY CLAY: Light brown, tan and gray, moist, firm to stiff, cobbles</td>
<td>8</td>
</tr>
<tr>
<td>-</td>
<td>-; brown and light brown, moist, firm to stiff</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>LIMESTONE</td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>AUGER REFUSAL</td>
<td></td>
</tr>
</tbody>
</table>

**Completion Depth:** 12.2’

**Date:** 10 June 2019

**Depth to Water ATD:** Not Encountered
<table>
<thead>
<tr>
<th>DEPTH (FT)</th>
<th>SOIL DESCRIPTION</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>ASPHALT</td>
</tr>
<tr>
<td></td>
<td>BASEROCK: Wastelime</td>
</tr>
<tr>
<td>2</td>
<td>FILL; SILTY CLAY: Orangish to dark brown, damp to moist, stiff, considerable chert</td>
</tr>
<tr>
<td>4</td>
<td>LIMESTONE: Thin beds or boulders</td>
</tr>
<tr>
<td>6</td>
<td>SILTY CLAY: Brown and light brown</td>
</tr>
<tr>
<td>8</td>
<td>SHALEY CLAY: Tan and gray, moist, stiff</td>
</tr>
<tr>
<td></td>
<td>-; tan and orangish brown, moist, firm to stiff, considerable chert gravel</td>
</tr>
<tr>
<td>10</td>
<td>-; cobbles of weathered limestone</td>
</tr>
<tr>
<td>16</td>
<td>LIMESTONE</td>
</tr>
<tr>
<td>18</td>
<td>AUGER REFUSAL</td>
</tr>
</tbody>
</table>

Completion Depth: 14.6’
Depth to Water ATD: 14.5’
**SOIL DESCRIPTION**

<table>
<thead>
<tr>
<th>DEPTH, FT.</th>
<th>SAMPLE TYPE</th>
<th>LOCATION:</th>
<th>SURF. ELEV.: 713.7'</th>
<th>UNIFIED CLASSIFICATION</th>
<th>BLOWS PER FT.</th>
<th>COHESION, TON/SQ.FT.</th>
<th>PLASTIC LIMIT</th>
<th>WATER CONTENT, %</th>
<th>LIQUID LIMIT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CONCRETE</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>BASEROCK: Wastelime and rollstone</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>FILL: SILTY CLAY: Brown, orangish brown, some gray, moist, firm to stiff, some gravel; some aggregate</td>
<td></td>
<td></td>
<td></td>
<td>96</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>SILTY CLAY: Dark gray to black, moist, firm, cobbles; brown, light brown and gray, moist, firm, considerable chert</td>
<td></td>
<td></td>
<td></td>
<td>18</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>8</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SILTY CLAY: Brown, dark brown, some gray, moist, soft</td>
<td></td>
<td></td>
<td></td>
<td>5</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>12</td>
<td>SHALEY CLAY: Light brown, considerable chert</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>TEPEE CLAY: Light brown, considerable chert</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>LIMESTONE AUGER REFUSAL</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Completion Depth:** 17.3’  
**Depth to Water ATD:** 13.5’

**Date:** 10 June 2019
<table>
<thead>
<tr>
<th>DEPTH, FT.</th>
<th>SAMPLE TYPE</th>
<th>SOIL DESCRIPTION</th>
<th>LOCATION: Boring Locations SURF. ELEV.: 713.9'</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>CONCRETE</td>
<td>BASEROCK: Rollstone and wastelime</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>FILL; SILTY CLAY: Dark brown to block, moist, dark brown, moist, firm, some chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>FILL; SILTY CLAY: Matrix, brown to light brown, damp to moist, considerable chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>SILTY CLAY: Dark brown</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>SHALEY CLAY: Gray and tan, moist, stiff to hard, chert gravel</td>
<td></td>
<td></td>
</tr>
<tr>
<td>14</td>
<td>-; cobbles</td>
<td></td>
<td></td>
</tr>
<tr>
<td>16</td>
<td>-; brown, tan and gray, moist, stiff, chert</td>
<td></td>
<td></td>
</tr>
<tr>
<td>18</td>
<td>LIMESTONE: Weathered</td>
<td></td>
<td></td>
</tr>
<tr>
<td>20</td>
<td>LIMESTONE</td>
<td></td>
<td></td>
</tr>
<tr>
<td>22</td>
<td>AUGER REFUSAL</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Completion Depth: **18.5'**  
Depth to Water ATD: **14.5'**

Date: **10 June 2019**
August 22, 2019

Mr. Kenneth Keane, PE
University of Missouri
General Services Building
Columbia, MO 65211

Dear Mr. Keane:

At the request of Mr. Matt Staph, PE with Burns and McDonnel, Inc., we have performed a supplemental subsurface analysis for the above referenced project. It is our understanding that as a result of the shear and bending moment loads on the foundations, a pile/pier analysis will be performed by Burns and McDonnel for the final foundation design. The purpose of this supplemental analysis was to provide soil and rock L-Pile parameters for pier design of the proposed addition. Following are the results of our analysis and the design parameters that Mr. Staph requested.

General

As mentioned in our geotechnical report dated June 27, 2019, a field investigation consisting of a site reconnaissance, a review of available subsurface information and the drilling of four soil and rock borings were performed on June 10, 2019. The borings were advanced using 4-inch continuous flight augers equipped with a drag-type drill bit. The borings were advanced to auger refusal and the drilling terminated. No rock coring was performed. The borings were advanced to depths ranging from 12.2 to 18.5 feet. Boring locations are shown on the plan of boring locations included in the original geotechnical report.

Recommendations

Although it is general practice to recommend limited or no lateral support in the top 5 feet for pile/pier analysis in this area, we have only observed frost depths as deep as 3 feet in extremely cold winters. As such, we recommend that at least the upper 3 feet of subgrade be modeled to provide little or no lateral support due to the actions of freeze/thaw.

The wastelime/baserock should not be included in the L-Pile analysis. Additionally, it should be recognized that the engineering properties of the existing fill is variable due to the non-homogeneous nature of the material and the unknown compaction methods. Fill was encountered in all four of the borings. Thickness of the fill ranged from 2.5 and 4.5 feet. This material should be treated as soft clay for the L-pile analysis. The Pennsylvanian age material, and its sequence of shale with limestone stringers, should be classified as a weak rock. Due to the presence of shale and clay seams, Pennsylvanian age material generally has an RQD less of than 55 percent.

L-Pile parameters for both the weak rock (Pennsylvanian material) and intact limestone (Burlington Formation) were derived from samples of similar material obtained from nearby projects.
The following soil and rock parameters may be used for the pier design:

<table>
<thead>
<tr>
<th>Material Code</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
<th>5</th>
<th>6</th>
</tr>
</thead>
<tbody>
<tr>
<td>Material Property</td>
<td>Soft Clay</td>
<td>Medium Clay</td>
<td>Stiff Clay</td>
<td>Sand (Medium Density)</td>
<td>Weak Rock (Pennsylvanian)</td>
<td>Intact Limestone (Burlington)</td>
</tr>
<tr>
<td>Eff. Unit Weight, pcf</td>
<td>120</td>
<td>125</td>
<td>130</td>
<td>110</td>
<td>140</td>
<td>164</td>
</tr>
<tr>
<td>Cohesion, psi</td>
<td>3.5</td>
<td>8</td>
<td>12</td>
<td>0</td>
<td>Qu=2,000 psi</td>
<td>Qu=8,200 psi</td>
</tr>
<tr>
<td>Friction Angle, deg</td>
<td>18</td>
<td>23</td>
<td>25</td>
<td>32</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>$\varepsilon_{50}$</td>
<td>0.020</td>
<td>0.010</td>
<td>0.005</td>
<td>-</td>
<td>$k_{r,m} = 0.0005$</td>
<td>-</td>
</tr>
<tr>
<td>k (pci)</td>
<td>30</td>
<td>100</td>
<td>500</td>
<td>60</td>
<td>1,000</td>
<td>-</td>
</tr>
<tr>
<td>RQD</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>55</td>
<td>75</td>
</tr>
<tr>
<td>Deformation Modulus, $E_m$ (ksi)</td>
<td>0.45</td>
<td>1.3</td>
<td>2.2</td>
<td>9</td>
<td>$0.4\times10^3$</td>
<td>$4.3\times10^3$</td>
</tr>
<tr>
<td>Undrained Shear Strength (psi)</td>
<td>3.5</td>
<td>6.9</td>
<td>20</td>
<td>0</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Rock Cohesion (psi)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>420</td>
<td>800</td>
</tr>
<tr>
<td>Rock/Concrete Bond Strength (psi)</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>14</td>
<td>80</td>
</tr>
</tbody>
</table>

The effective unit weight does not account for soils submerged below the groundwater surface. To obtain the effective unit weight of a soil submerged below the groundwater surface, subtract 62.4 pounds per cubic foot.

The following subsurface profiles can be used with the above chart:

<table>
<thead>
<tr>
<th>Boring B1</th>
<th>Top Depth (ft)</th>
<th>Bottom Depth (ft)</th>
<th>Material Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL=709.3'</td>
<td>0</td>
<td>3.5</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>3.5</td>
<td>7.5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>7.5</td>
<td>12</td>
<td>2</td>
</tr>
<tr>
<td></td>
<td>12</td>
<td>26</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>26</td>
<td>-</td>
<td>6</td>
</tr>
</tbody>
</table>

Water Depth Not Encountered

<table>
<thead>
<tr>
<th>Boring B2</th>
<th>Top Depth (ft)</th>
<th>Bottom Depth (ft)</th>
<th>Material Code</th>
</tr>
</thead>
<tbody>
<tr>
<td>GL=711.6'</td>
<td>0</td>
<td>3</td>
<td>NA</td>
</tr>
<tr>
<td></td>
<td>3</td>
<td>5</td>
<td>1</td>
</tr>
<tr>
<td></td>
<td>5</td>
<td>14.5</td>
<td>3</td>
</tr>
<tr>
<td></td>
<td>14.5</td>
<td>28.5</td>
<td>5</td>
</tr>
<tr>
<td></td>
<td>28.5</td>
<td>-</td>
<td>6</td>
</tr>
</tbody>
</table>

Water Depth 14.5 Feet
The thickness of the Pennsylvanian stratum (Material Code 5) is based on boring G-5 that was drilled during the original Gas Turbine Building investigation in March of 2000. At that time, the top of the 50 ksf material was at approximate elevation of 683 feet.

With regard to the following recommended allowable bearing capacities presented in our report:

<table>
<thead>
<tr>
<th>DESIGN PARAMETER</th>
<th>ALLOWABLE DESIGN VALUE</th>
</tr>
</thead>
<tbody>
<tr>
<td>1. Skin friction in soil</td>
<td>neglect</td>
</tr>
<tr>
<td>2. Skin friction in Pennsylvanian age material (uplift only)</td>
<td>2,000 psf</td>
</tr>
<tr>
<td>3. Skin friction in massive Burlington Limestone</td>
<td>80 psi</td>
</tr>
<tr>
<td>4. End bearing on Pennsylvanian age material</td>
<td>20 ksf</td>
</tr>
<tr>
<td>5. End bearing on massive Burlington Limestone</td>
<td>50 ksf</td>
</tr>
</tbody>
</table>

The provided allowable bearing capacities and skin frictions are based on laboratory tests, local knowledge and values previously used successfully on this site. Although the ultimate compressive strengths of the Burlington Limestone, ranges around 8,200 to 10,000 psi, and 2,000 psi for shale; and the cohesion of the shale around 420 psi, may allow for higher theoretical bearing capacities, it does not account for other intangibles such as: joint spacing; Rock Quality Designation (RQD); fractures; filled sinks; clay seams; or any other unforeseen circumstances. In light of this, we still recommend the design parameters presented above.

We trust this letter provides the requested information. Please contact us if we can be of further assistance.

Sincerely,

Joshua D. Lehmen, PE
V.P. Laboratory and Field Services

Cc: Keane, Staph (email)
<table>
<thead>
<tr>
<th>Requestor</th>
<th>Company</th>
<th>Contact Info</th>
<th>Date Requested</th>
<th>Question</th>
<th>Response</th>
<th>Date Responded</th>
</tr>
</thead>
<tbody>
<tr>
<td>Matt Stapf</td>
<td>Burns &amp; McDonnell</td>
<td></td>
<td>12/11/2019</td>
<td>What is the correct callout for ductile iron vs. PVC in the specifications?</td>
<td>Not sure. Please refer to the blueprints.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>Will any equipment be salvaged?</td>
<td>Yes. The equipment will be salvaged and sold at auction.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Matt Stapf</td>
<td>Burns &amp; McDonnell</td>
<td></td>
<td>12/11/2019</td>
<td>Will the laser scan be available to contractors?</td>
<td>Yes. The laser scan will be available to the awarded contractor.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>Laid-iron side-stiffener system plus meshing from project sheet H-78. TFE</td>
<td>No. The TFE will not be available to the awarded contractor.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Matt Stapf</td>
<td>Burns &amp; McDonnell</td>
<td></td>
<td>12/11/2019</td>
<td>An underground chilled water piping shall be PVC except for lines passing directly over or under steam tunnels and lines passing underground. These locations have already been identified in the drawings provided in the bid documents.</td>
<td>The locations have already been identified in the drawings provided in the bid documents.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>Will the BIM model be provided under foundations?</td>
<td>Yes. The BIM model will be provided under foundations.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Matt Stapf</td>
<td>Burns &amp; McDonnell</td>
<td></td>
<td>12/11/2019</td>
<td>Are there concerns with interferences with UT building and UT foundation with excavation?</td>
<td>Please refer to Item 8 above for existing foundation drawings.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>The laser scan of the existing conditions will not be made available to the contractor. The awarded contractor will be allowed to perform their own laser scan of the affected work areas.</td>
<td>The awarded contractor will be allowed to perform their own laser scan of the affected work areas.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Matt Stapf</td>
<td>Burns &amp; McDonnell</td>
<td></td>
<td>12/11/2019</td>
<td>Will EMT conduit be permitted for any feeder identified in the cable and conduit schedule on Sheet E-604?</td>
<td>Yes, EMT conduit shall be permitted for any feeder identified in the cable and conduit schedule on Sheet E-604.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Joel McPhee</td>
<td>Whiting Turner</td>
<td></td>
<td>12/13/2019</td>
<td>Special Conditions reference need for Power Panel (PP) stamp is this required?</td>
<td>Yes, the BIM file will be made available to the awarded contractor.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>Are current geotechnical reports up to date for the site location?</td>
<td>No, existing geotechnical reports will be provided.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Matt Stapf</td>
<td>Burns &amp; McDonnell</td>
<td></td>
<td>12/11/2019</td>
<td>How are existing footings accounted for in locating own DCX and sanitary in slab?</td>
<td>The laser scan of the existing conditions will not be made available to the contractor. The awarded contractor will be allowed to perform their own laser scan of the affected work areas.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Joel McPhee</td>
<td>Whiting Turner</td>
<td></td>
<td>12/13/2019</td>
<td>Is there clarity if the use of DWV is acceptable?</td>
<td>Yes. The project is all steel framed. DWV will not be permitted.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Ken Sanning</td>
<td>Richard A Howerton</td>
<td><a href="mailto:kals@howertonelectric.com">kals@howertonelectric.com</a></td>
<td>12/11/2019</td>
<td>Special Conditions reference need for Power Panel (PP) stamp is this required?</td>
<td>Yes, bidders will receive reference geotechnical report via addendum.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>Is the steel erector is not certified but follows AISC best practices?</td>
<td>Steel erector shall be AISC certified.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Joel McPhee</td>
<td>Whiting Turner</td>
<td></td>
<td>12/13/2019</td>
<td>For grade beams: this is the only location (interior grade beam) where 4&quot; GPS insulation is required.</td>
<td>The Life Safety Plan on A-011 &amp; A-012 calls for FE 4A-20B-C.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>Compressive strength between top of grade beam and bottom of slab on grade. &quot;Is this the GPS insulation required on all grade beams and at all columns?</td>
<td>No, existing domestic water line to be removed shall be operational at all times except for maintenance &amp; repair activities not to exceed 6 hours. The existing domestic water line shown on drawing C-J.002 is called to be removed.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Matt Stapf</td>
<td>Burns &amp; McDonnell</td>
<td></td>
<td>12/11/2019</td>
<td>Is documentation of this experience required with the bid submission?</td>
<td>No. There are no liquidated damages for this project.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>For 13.8-kV equipment and cable. Is documentation of this experience required with the bid submission?</td>
<td>Yes, the BIM file will be made available to the awarded contractor.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Joel McPhee</td>
<td>Whiting Turner</td>
<td></td>
<td>12/13/2019</td>
<td>Is there clarity if the use of DWV is acceptable?</td>
<td>Yes. The project is all steel framed. DWV will not be permitted.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Kenneth Keane</td>
<td>University of Missouri</td>
<td></td>
<td>12/11/2019</td>
<td>Is there clarity if the use of DWV is acceptable?</td>
<td>Yes. The project is all steel framed. DWV will not be permitted.</td>
<td>12/20/2019</td>
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<tr>
<td>Name</td>
<td>Company</td>
<td>Question</td>
<td>Response</td>
<td>Date Responded</td>
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<tr>
<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td>The intended measurement devices are indicated on the 6F-700 series drawings. Are we not aware of a need for airflow measurement?</td>
<td>Jim Rosick, M &amp; McDowell</td>
<td>12/20/2019</td>
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<tr>
<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td>Please clarify that:</td>
<td>Mike Jarzemkoski, Meneses Engineering</td>
<td>12/20/2019</td>
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<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td>A) confirmed that the design intent is to require one panel per grouped contiguous point tag series.</td>
<td>Jim Rosick, Burns &amp; McDonnell</td>
<td>12/20/2019</td>
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<tr>
<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td>Tag#770 should be deleted (appears to be a duplicate of Tag#737)</td>
<td>Stephen Waggoner, Luna &amp; Associates</td>
<td>12/20/2019</td>
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<tr>
<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td>A) confirmed that the design intent is to require one panel per grouped contiguous point tag series.</td>
<td>Jim Rosick, Burns &amp; McDonnell</td>
<td>12/20/2019</td>
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<tr>
<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td>The drawings will be revised in future addendums to include circuit numbers and locations, but for bidding purposes please note that each of the panels of equipment listed in the 6X question will require a 120V power connection by Dr. 26.</td>
<td>Jim Rosick, M &amp; McDowell</td>
<td>12/20/2019</td>
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<tr>
<td>Angie Janssen</td>
<td>Dimensional Metals Inc</td>
<td>Is the Carlisle Coating &amp; Waterproofing (CCW) Miraseal waterproofing system an approved substitution?</td>
<td>Stephanie Waggoner, Luna &amp; Associates</td>
<td>12/20/2019</td>
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<td></td>
</tr>
<tr>
<td>Jake McPhee</td>
<td>Rick McPhee</td>
<td>The drawings will be revised in future addendums to include circuit numbers and locations, but for bidding purposes please note that each of the panels of equipment listed in the 6X question will require a 120V power connection by Dr. 26.</td>
<td>Jim Rosick, M &amp; McDowell</td>
<td>12/20/2019</td>
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<tr>
<td>Requestor</td>
<td>Company</td>
<td>Contact Info</td>
<td>Date Requested</td>
<td>Question</td>
<td>Response</td>
<td>Date Responded</td>
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<tr>
<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td><a href="mailto:Donald.E.Mayberry@jci.com">Donald.E.Mayberry@jci.com</a></td>
<td>12/18/2019</td>
<td>M-201 (Steam Valves) - Up to ten automatic steam control valves may appear on Plan M-201 that are not found in Control Valve Schedule. Please clarify application and performance requirements for sizing and selection, including selection criteria which are specified (230900 Controls, 232213 Steam Piping, 238239 Unit Heaters, etc.)</td>
<td>Jim Rosick Burns &amp; McDonnell For the 10 steam valves in question: a) The 8&quot; valves feeding the chiller turbines are defined by 236417.2.04.F. The design intent is for these valves to be provided by the chiller manufacturers. b) The 6&quot; slide valves feeding the boilers (Unit Heaters): i. Steaming control ball valve, bronze or brass body, screwed ends; connections, spring-loaded PTFE packing, quick opening for two-position service, standard port, stainless-steel ball valve (ProporKonal, NC, with AO signal from DDC) ii. Intended for use in 230900 iii. 75 GPM @ 10 psig iv. 5 psig pressure drop v. Fail Closed Action vi. Power (other than 24 VAC by Controls Contractor) vii. Origin of signal (i.e., DDC relay from Point # 857 or Chiller Unit Control Panel, or other) viii. Fail-Safe (all S.U.H.1 spring Open; all others Spring Closed)</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Donald Mayberry</td>
<td>Johnson Controls</td>
<td><a href="mailto:Donald.E.Mayberry@jci.com">Donald.E.Mayberry@jci.com</a></td>
<td>12/18/2019</td>
<td>M-706 (Extend FC Bus in Existing Bldg) - Keyed Note-4 on Detail-A/M-706 calls for FC bus run to five existing DDC Control Panels for future conversion. Please clarify requirements by locating existing panels on plans and indicating preferred routing of extended FC bus and associated building applications (i.e., mezzanine levels). Please note that changes will be limited to one floor between locations.</td>
<td>Jim Rosick Burns &amp; McDonnell AH 1A &amp; 1B controllers are in the gas compressor building. AH 3 controller is in the chiller plant electric room. AH 2 &amp; 4 controllers are above the GT Plant control/electric room. Indoor environments are not anticipated (ducts, etc. are insulated). Building or electrical changes should be limited to one floor between locations.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Robert Hueser</td>
<td>ABB</td>
<td><a href="mailto:Bob.Verzi@us.abb.com">Bob.Verzi@us.abb.com</a></td>
<td>12/18/2019</td>
<td>Request ABB be included in specifications 262200 Transformers, 262413 Switchboards, and 262416 Panelboards. ABB’s FC bus assemblies, switchboard, switchboard enclosure bus assemblies, and switchboard enclosure switchboards. ABB’s FF-160 is listed of approved manufacturers in each of the specifications in question.</td>
<td>Matt Stapf Burns &amp; McDonnell Add “ABB” to list of approved manufacturers in each of the specifications in question.</td>
<td>12/20/2019</td>
</tr>
<tr>
<td>Sean Buffett</td>
<td>Everfab</td>
<td><a href="mailto:sean.buffett@everfab.com">sean.buffett@everfab.com</a></td>
<td>12/18/2019</td>
<td>Is the intent for the bidders to confirm all design details of the specified components of the project similar to a Design-Build project?</td>
<td>Kenneth Keane University of Missouri The intent for bidders to confirm all design details of the specified components of the project similar to a Design-Build project?</td>
<td>12/20/2019</td>
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</table>
SECTION 07 72 73 – MEMBRANE LEAK DETECTION SYSTEM

PART 1 - GENERAL

1.01 RELATED DOCUMENTS:
   A. Drawings and general provisions of the Contract, including General and Special Conditions and Division 01 Specification Sections, apply to this Section.

1.02 SUMMARY:
   A. This Section includes: Waterproofing membrane leak detection system, including the following:
      1. Detection system conductor cable and accessories.
      2. Measurement grid for leak detection system.
      3. Leak detection testing of installed membrane.

1.03 RELATED SECTIONS
   A. Division 07 Cold Fluid-Applied Waterproofing section for coordination and quality assurance provisions.

1.04 ADMINISTRATIVE REQUIREMENTS:
   A. Coordination: Integrate layout of membrane leak detection test system with rooftop structures and equipment and roof penetrations for building utilities and services.
   B. Coordinate membrane leak detection system with work of other Sections.
   C. Preinstallation Meetings: Conduct preinstallation meeting in coordination with the waterproofing preinstallation conference to verify project requirements, manufacturer’s installation instructions, and coordination with installation requirements for roof system.

1.05 ACTION SUBMITTALS:
   A. Product Data: For each type of product required for a complete leak detection system.
   B. Shop Drawings: Showing the following: Diagram of proposed system showing complete test area, rooftop structures and equipment, and roof penetrations for building utilities and services. Show location of the leak detection system test conductor cable, measurement grid, and connection boxes.

1.06 INFORMATIONAL SUBMITTALS:
   A. Qualifications: For manufacturer and installing and testing firm.
   B. Field Quality Control Reports: Digital drawings, digital photographic documentation, and written report detailing location and nature of membrane breaches, defects found, and verification of corrective actions taken.

1.07 CLOSEOUT SUBMITTALS:
   A. Record Drawings: Digital drawings, photographic documentation, and written report detailing installed location of components of membrane integrity test system.

1.08 QUALITY ASSURANCE:
   A. Manufacturer's Qualifications: Manufacturer of membrane leak detection systems with minimum ten-year record of satisfactory manufacturing and support of installed systems comparable to system required as Work of this Section.
   B. Installing and Testing Firm Qualifications: Approved or certified by membrane leak detection system manufacturer, with minimum five-year record of satisfactory experience.
PART 2 - PRODUCTS

2.01 MANUFACTURERS:
   A. Basis-of-Design Manufacturer: Subject to compliance with requirements, provide membrane integrity test system and service from a single manufacturer with the following characteristics

2.02 SYSTEM DESCRIPTION:
   A. Membrane Leak Detection System: Conductor cable, placed on top of membrane, delivering direct current tension to membrane surface, enabling inspection and isolation of points of moisture infiltration through membrane to conductive substrate under membrane.
   B. Measurement Grid: Highly conductive stainless-steel wire measurement grid located under membrane and above non-conductive membrane substrate, connected through contact plate and cable to connection box accepting applied low-voltage charge from portable pulse generator.

2.03 MATERIALS:
   A. Conductor Cable: Nine strands of 0.06-inch (1.5 mm) diameter highly conductive stainless-steel wire interwoven with braided polyethylene strands, placed on weather side of membrane:
   B. Measurement Grid: Highly conductive, corrosion resistant, geometrically stable mesh placed between membrane and protected building components.
      1. Stainless steel grid: 2 by 2-inch (50 by 50 mm) screen mesh in 47-inch by 160-foot (1.2 by 50 m) rolls.
   C. Conductor Wire Assembly: Provide grounding plate for connection to measurement grid, suitable for connection to terminals at connection box.
   D. Connection Box: Weatherproof, corrosion-resistant electrical enclosure with permanent terminal connections for connecting diagnostic and testing equipment, NEMA 4X with the following characteristics:
      1. Permanent connections for attachment of diagnostic and testing equipment without opening contact box.
      2. Weatherproof cover to seal terminals when membrane integrity test system is not in use.
      3. Hardware, brackets, and fittings required to permanently mount contact box to building structure.

2.04 ACCESSORIES:
   A. Provide corrosion-resistant fasteners and hardware, electrical terminations, sealants, and other items required to provide complete installation.
   B. Lap Joint Tape: Provide self-adhesive aluminum tape, minimum 2 inch (50 mm) wide.

PART 3 - EXECUTION

3.01 EXAMINATION:
   A. Examination: Verify that substrate complies with roofing manufacturer's and integrity test manufacturer's requirements. Proceed with installation once substrate complies with requirements.

3.02 INSTALLATION:
   A. Measurement Grid: Install measurement on membrane substrate immediately under membrane and immediately prior to installation of membrane.

07 72 73 - 2
1. Verify that location of measurement grid fasteners does not interfere with or cause damage to membrane.
2. Fasten measurement grid in accordance with leak detection system manufacturer's requirements.
3. Do not place measurement grid where it will be in continuous direct contact with structural components.
4. Provide minimum 2 inch (50 mm) overlap where adjacent sheets meet, including side laps and end laps.
5. Cut measurement grid as close as possible to the perpendicular strand at both end and side edges

B. Conductor Wire: Install conductor wire on top of membrane at spacing and layout indicated on approved shop drawings.
1. Secure conductor wire using method recommended by manufacturer.
C. Installation Testing: Verify continuity and functioning of conductor wire and measurement grid upon completion of installation.

3.03 FIELD QUALITY CONTROL:
A. Contractor shall engage qualified Installation and Testing Firm to perform membrane integrity testing. Perform testing in accordance with membrane integrity test system manufacturer's recommendations.
1. Perform testing following adequate precipitation or wet membrane and membrane overburden adequately to enable accurate testing.
2. Identify locations of membrane leaks; record locations and document with photographs. Submit test reports to Architect.
3. Confirm completed repair of identified leaks and retest to verify water tightness of membrane.
B. Initial Membrane Test: Perform initial membrane integrity test upon completion of membrane and integrity test system installation and prior to installation of above-membrane components.
C. Assembly Test: Repeat membrane integrity test following installation of above-membrane components.
D. Final Testing: Repeat membrane integrity test if roof assembly is exposed to traffic or construction operations prior to Substantial Completion.

3.04 PROTECTION:
A. Protect tested membrane according to requirements of Division 07 Cold Fluid-Applied Waterproofing section.
B. Prevent construction traffic and activities on completed and tested membrane. Retest membranes exposed to construction activities

END OF SECTION 07 72 73
Re: Addendum 1, Drawings Item #1.b.