

**VIRGINIA RAILWAY EXPRESS**



**Rolling Road Station Improvements**

**IFB 021-005**

**Technical Specifications**

**August 14, 2020**

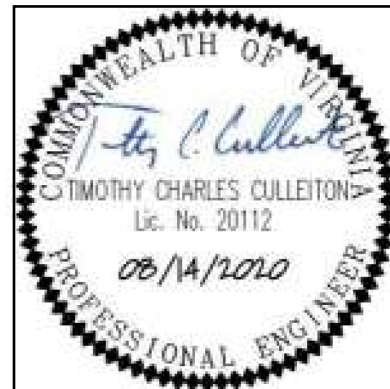
**Invitation for Bid (IFB)**

**Technical Specifications**  
**Seals Page****DESIGNER OF RECORD**

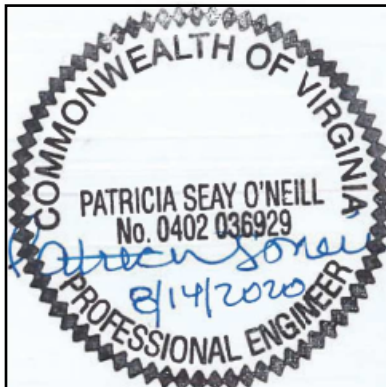
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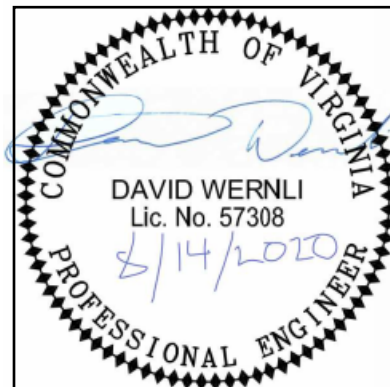
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**TABLE OF CONTENTS**

<b><u>SECTION</u></b>	<b><u>TITLE</u></b>	<b><u>PAGE</u></b>
00 01 07	Seals	1
00 01 10	Table of Contents	2
 <b><u>Division 01</u></b>	 <b><u>General Requirements</u></b>	
01 11 00	Summary of Work	6
01 22 00	Unit Prices	13
01 24 00	Value Engineering	19
01 25 00	Substitution Procedures	24
01 26 00	Change Order Procedures	27
01 29 00	Payment Procedures	46
01 31 00	Project Management and Coordination	54
01 32 00	Construction Progress Documentation	67
01 32 33	Photographic Documentation	80
01 33 00	Submittal Procedures	85
01 35 13	Host Railroad Coordination	98
01 35 23	Safety and Security Requirements	102
01 42 00	Definitions, Abbreviations, and Acronyms	106
01 45 00	Quality Assurance and Quality Control	113
01 50 00	Temporary Facilities and Controls	125
01 73 00	Execution of Work	136
01 77 00	Closeout Procedures	149

**Division 02****Existing Conditions**

02 41 19	Selective Demolition	167
----------	----------------------	-----

**Division 03****Concrete**

03 30 00	Cast-In-Place Concrete	171
03 41 00	Precast Structural Concrete	177

**Division 05****Metals**

05 12 00	Structural Steel Framing	187
05 12 13	Architecturally Exposed Structural Steel Framing	192
05 50 00	Metal Fabrications	198
05 52 13	Pipe and Tube Railings	202
05 55 01	Aluminum Stair Nosing	208

**Division 06****Woods**

06 15 33	Timber Crossing	210
----------	-----------------	-----

**Division 07****Thermal and Moisture Protection**

07 41 13	Metal Roof Panel	213
07 60 00	Sheet Metal Gutters and Downspouts	221
07 62 00	Sheet Metal Flashing and Trim	225
07 92 00	Joint Sealants	229

**Division 9****Finishes**

09 10 00	Tactile Detectable Warning Surface and Striping Tape	236
09 90 00	Painting	243



<b><u>Division 26</u></b>	<b><u>Electrical</u></b>	
26 00 00	Electrical	246
26 00 10	General Requirements	251
26 00 70	Schedule of Submittal Data	273
26 05 19	Low-Voltage Electrical Power Conductors and Cables	276
26 05 26	Grounding and Bonding for Electrical Systems	283
26 05 30	Division 26 Demolition	286
26 05 33	Raceway and Boxes for Electrical Systems	291
26 05 48	Vibration and Seismic Controls for Electrical Systems	302
26 05 53	Identification for Electrical Systems	309
26 05 90	Miscellaneous Equipment	314
26 05 93	Testing	316
26 24 16	Panelboards	319
26 27 26	Wiring Devices	324
26 28 00	Low-Voltage Circuit Protective Devices	328
26 50 00	Lighting	336
 <b><u>Division 31</u></b>	 <b><u>Earthwork</u></b>	
31 10 00	Site Clearing	342
31 10 20	Erosion and Sediment Controls	345
31 20 00	Earth Moving	351
31 23 19	Dewatering	359
31 33 00	Concrete Repair	361
31 50 00	Excavation Support and Protection	367
31 63 29	Drilled Concrete Piers and Shafts	370

**Division 32****Exterior Improvements**

32 13 13	Concrete Paving	375
32 92 00	Turf and Grasses	379

**Appendices**

Appendix 1	Geotechnical Report	383
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**SECTION 01 11 00****Summary of Work****PART 1 - GENERAL****1.01 SUMMARY**

- A. This section includes the following:
1. Work included in Contract Documents
  2. Restrictions and Quality Control
  3. Damages and Pre-Existing Conditions
  4. Type of Contract
  5. Sequence of Work
  6. Work by Others
  7. Use of Premises
  8. Occupancy Requirements
  9. Utility Location, Protection and Relocation
  10. Utility Outages

**1.02 RELATED SECTIONS**

- A. Drawings, General Provisions, General Conditions, Special Provisions and other Division 01 Specifications apply to this Section.

**1.03 WORK INCLUDED IN CONTRACT DOCUMENTS**

- A. This section includes requirements for the construction of Rolling Road Station Improvements. The project consists of a 291-foot extension of the VRE Rolling Road Station passenger platform and rehabilitation of the existing passenger platform and access stair.
1. Project Location: 9016 Burke Road, Burke VA 22015
- B. Engineer-of-Record (EOR): The Contract Documents, August 14, 2020 were prepared by Dewberry Engineers, Inc. 8401 Arlington Boulevard, Fairfax VA 22031
- C. Construction Manager: STV, Inc. has been engaged as Construction Manager for this Project to serve as an advisor to VRE and to provide assistance in administering the Contract for Construction between VRE and the Contractor, according to a separate contract between the VRE and Construction Manager.
- D. Project Manager: When a Construction Manager has not been engaged, VRE will designate a Project Manager (PM) to represent VRE and assist in monitoring the work under the Contract.

In these instances, any reference to the Construction Manager, where it occurs in the Technical Specification documents, shall be understood to mean the Project Manager.

E. The delivered project shall:

1. Meet and/or exceed the requirements set forth elsewhere in the Contract Documents.
2. Be capable of safe and reliable operation meeting and/or exceeding industry standards and practices.

F. This Section outlines the main features of the Work to be performed under this Contract and is not a complete description. Work addressed in this Section but not addressed in other portions of the design shall still be considered part of the overall Work. The general details of the Work to be performed under this Contract are indicated more specifically in the other Specification sections, other documents of the design and other Contract Documents.

The Work includes:

1. Mobilize and demobilize all labor and equipment necessary to complete the Work.
2. Prepare and deliver all required submittals to the satisfaction of the CM and Owner.
3. Identify, protect and avoid all onsite utilities.
4. Establish and maintain temporary erosion and sediment controls.
5. Establish temporary traffic controls in accordance with the VDOT entrance permit.
6. Establish temporary barriers and demolish and remove noted materials as necessary.
7. Install concrete foundations.
8. Install concrete platform extension including tactile warning surface and other appurtenances.
9. Erect and paint structural steel for canopies.
10. Install electrical and communication conduit.
11. Install platform and canopy lighting and speakers.
12. Install signage.
13. Install timber crossing.; remove existing crossing.
14. Perform rehabilitation of the existing platform work including:
  - a. Canopy roof replacement and painting.
  - b. Replace stair and complete stair repairs maintaining two points of platform access, one of which is ADA compliant at all times.
  - c. Concrete sidewalk repairs.
  - d. Replace tactile warning surface.
  - e. Handrail / guardrail repairs.

- f. Electrical and communication conduit replacement.
- g. Install platform and canopy replacement lightings.
- h. Install speaker replacement
- i. Existing signage replacement
- j. Chain link fence replacement

G. Ownership of Materials:

- 1. Materials furnished by the Contractor under this contract shall become the property of VRE.
- 2. VRE-furnished materials shall remain the property of VRE.

**1.04 RESTRICTIONS AND QUALITY CONTROL**

- A. The overall site plan and facilities configurations as depicted in the design are mandatory and shall not be altered except as approved by the Engineer.
- B. All site features and the facility shall be in accordance with Virginia Railway Express' requirements as defined herein.

**1.05 DAMAGES AND PRE-EXISTING CONDITIONS**

- A. Contractor shall be responsible for all damages caused by Contractor's construction activities. Provide all labor, materials, etc. to return any damaged areas, systems or equipment to their original condition at no additional cost to VRE.
- B. Perform a survey of pre-existing conditions in the vicinity of Contractor's construction activities, utilizing photographs and other means as necessary to document existing damage or conditions. Submit two copies of this survey to the CM within 21 calendar days after Notice-to-Proceed. Survey shall be approved by VRE prior to submission of first invoice by the Contractor. This survey will assist in resolving any damage claims against the Contractor during and after construction.
- C. Unless noted otherwise preserve all facilities and portions thereof including but not limited to roadways, pedestrian and directional signage. Deliver all removed facilities not required for reinstallation to VRE as directed by the CM.
- D. Replace or repair lost or damaged facilities or portion thereof, to the satisfaction of VRE, at no cost to VRE.

**1.06 TYPE OF CONTRACT**

- A. This project will be constructed under a general construction contract.

**1.07 SEQUENCE OF WORK**

- A. Conduct the Work in one continuous operation. If phased construction is required, the Contractor shall arrange the sequence of construction, unless noted otherwise on the Contract Plans.

- B. Work shall be performed in accordance with the Contractor's "CPM Construction Schedule" as specified in Division 01 Section "Construction Progress Documentation: and as approved by the Construction Manager.

#### **1.08 WORK BY OTHERS**

- A. General: Cooperate fully with other entities (e.g. Host Railroad, Utility Owner) so their work may be performed without interfering or delaying work within this Contract. Coordinate the Work of this Contract with work performed by other entities with the CM.
- B. Preceding Work: VRE will award separate contract(s) for the following construction operations at the Project site. Those operations are scheduled to be substantially complete before work under this Contract begins.
1. No separate contracts are known for work preceding this Contract.
- C. Concurrent Work: VRE may award separate contract(s) for the following construction operations at the Project site. Those operations will be conducted simultaneously with work under this Contract.
1. Separate contracts for TVM relocation, VMS and camera installation.
- D. Future Work: VRE will award separate contract(s) for the following additional work to be performed at the Project site after Substantial Completion. Completion of that work will depend on successful completion of preparatory under this Contract.
1. No separate contracts are known for work following this Contract.
- E. For additional requirements for Cooperation Among Contractors, see Division 01, Section 01 73 00 "Execution of Work."

#### **1.09 USE OF PREMISES**

- A. Use of Site: Confine use of premises to work in areas indicated. Do not disturb portions of site beyond limits of construction areas in which the Work is indicated.
1. Limits: Confine construction operations to areas where work and staging is shown on plans.
  2. VRE Access: Allow VRE and their designees to have unencumbered access to areas designated for VRE. Access to areas, restricted due to construction, shall be coordinated by the Construction Manager, for VRE personnel involved in the performance of the construction contract. The remainder of the site, including newly constructed areas, shall be restricted to only VRE personnel involved in the performance of the construction contract, as designated by the Construction Manager, until VRE establishes occupancy of the project site.
  3. Contractor shall have full use of premises for construction operations within the designated Limits of Construction as indicated on the Contract Plans, during the hours indicated and as directed by the Construction Manager.

4. Unless noted otherwise, the Contractor shall keep the site free from accumulation of waste materials. When the project is complete, the Contractor must remove from and about the project site, waste materials, tools, construction equipment, machinery and surplus materials. If a dispute arises regarding maintenance or clean-up of the premises, VRE may maintain and clean the site and assess actual damages to the Contractor.
  5. The Contractor must remain aware that the areas of work are active rail lines. Extreme caution and safety must be exercised at all times.
- B. Utilize areas designated for Contractor staging, storage and parking as indicated on the Contract Drawings. For additional requirements, see Division 01, Section 01 50 00.
- C. Use of Existing Facilities: Maintain existing facilities in a weather tight condition throughout construction period. Repair damage caused by construction operations. Protect facilities and their occupants during construction period.
- D. Use of Explosives: Explosives shall not be used on site, unless approved in writing by VRE.

#### **1.10 OCCUPANCY REQUIREMENTS**

- A. Partial VRE Occupancy: VRE reserves the right to occupy, use and/or to place and install equipment in any completed or partially completed areas of the site/building, before Substantial Completion, provided such occupancy does not interfere with completion of the Work. Such placement of equipment and partial occupancy shall not constitute acceptance of the total Work. Partial VRE occupancy requirements are as follows:
1. Construction Manager will prepare a Certificate of Substantial Completion for each specified portion of the Work to be occupied before VRE occupancy.
  2. Before partial VRE occupancy, mechanical and electrical systems shall be fully operational and required tests and inspections shall be successfully completed. On occupancy, VRE will operate and maintain mechanical and electrical systems serving occupied portions of the building/site.
  3. On occupancy, VRE will assume responsibility for maintenance and custodial service for occupied portions of building.

#### **1.11 UTILITY LOCATION, PROTECTION AND RELOCATION**

- A. Coordinate utility location services to identify and mark the location of all utility lines, that may be impacted by construction activities, including but not limited to the following:
1. Electric power lines
  2. Natural gas lines
  3. Sanitary sewers
  4. Stormwater/drainage
  5. Water supplying piping
  6. Petroleum/Fuel lines

7. Telephone lines
  8. Data and Communication/ Fiber Optic Lines
  9. Underground Storage Tanks
  10. Steam/water lines
  11. Underground utilities and lines abandoned in place
- B. The information in the Contract Documents concerning the type and location of utilities is neither guaranteed nor inclusive. The Contractor is responsible for determining the type and location of utilities, regardless of whether such utilities are indicated or not, so as to avoid damage thereto.
- C. Check and verify the horizontal and vertical location (coordinates and elevation) of all utility lines that may exist within the limits of new work, regardless of whether such utilities are indicated or not, by use of a Subsurface Utility Engineering company. Reconfirm such locations and verification of utilities discovered, regardless of whether such utilities are indicated or not, and submit to the Project Manager a dimensional survey with such notations.
- D. Test pits shall be accomplished by means of non-destructive testing in the vicinity of the discovered utilities, as indicated on the Contract Plans. Additional test pits may be performed by the Contractor, at their expense, in coordination with the CM and applicable utility.
- E. Repair any damage to discovered utility lines due to construction operations at no expense to VRE. VRE will assist the Contractor by making available any known information.
- F. If utilizing an independent subsurface utility engineering company, submit the name of firm and qualifications to the CM, for written approval.
- G. Within 60 calendar days of Notice to Proceed, submit to the CM a survey of all utility location results.
- H. For additional requirements for Cooperation with Utility Companies, see Division 01, Section 01 73 00 "Execution of Work."

#### **1.12 UTILITY OUTAGES**

- A. Prior to any utility outage/interruption, prepare a schedule of such outage. Include in outage schedule duration, identification of the service affected, temporary utility service to be provided, identification of available service alternative, and the action to be taken in the event of any emergency. Apply for all outages of utility systems in writing. Fully coordinate outage requests with the Construction Manager. Schedule shall include date, time, and duration of outage. Obtain approval in writing by the Construction Manager.

## **PART 2 - PRODUCTS**

Not Used.



**PART 3 - EXECUTION**

Not Used.

**END OF SECTION**

**SECTION 01 22 00****Unit Prices****PART 1 - GENERAL****1.01 SUMMARY**

Section includes administrative and procedural requirements for unit prices and only applies to Unit Price contracts.

**1.02 RELATED SECTIONS**

- A. Drawings
- B. General Provisions
- C. General Conditions for Construction
- D. Special Provisions
- E. Section 01 26 00 – Change Order Procedures
- F. Section 01 29 00 – Payment Procedures

**1.03 DEFINITIONS**

**Pay Item:** A specifically described unit of work for which a Unit Price is provided in the Contract.

**Unit Price:** An amount proposed by bidders, stated on the Bid or Proposal Form, incorporated in the Agreement and applicable during the duration of the Work as a price per unit of measurement for materials, equipment, or services, or a portion of the Work, added to or deducted from the Contract Sum by appropriate modification, if the scope of Work or estimated quantities of Work required by the Contract Documents are increased or decreased.

**1.04 PROCEDURES**

- A. Unit prices include all necessary material, cost for delivery, installation, insurance, applicable taxes, overhead, and profit. The sum of all extended unit prices in the Bid or Proposal Form, shall be deemed to include all work described in the Contract Documents including Contract Plans and Specification.
- B. Payments to the Contractor will be made for the actual quantities of Contract items performed in accordance with the plans and the requirements of the Specifications and other Contract documents. If, upon completion of the Work, the actual quantities vary, either by an increase or decrease from the estimated quantities shown in the Contract, the Contract unit prices shall prevail and payment will be made for actual quantities performed at such unit prices, unless the unit prices have been modified by a Contract Amendment.
- C. No allowance or other adjustment will be made for any increased expense, loss of expected reimbursement, or loss of anticipated profits suffered or claimed by the Contractor resulting directly from such variance, or from the Contractor's unbalanced allocation among the Contract

- items of overhead expense and subsequent loss of expected reimbursements therefore, or from any other cause.
- D. Quantities appearing on the bid sheet are estimated quantities for the basic design shown on the plans. With VRE's approval, the Contractor may furnish other design(s) that may involve changes in quantities or the use of different materials. However, payment will be made for the original quantities listed in the Contract only and in the units of measure given in the Contract for the basic design unless the dimensions for the basic design are changed by an authorized change order to conform to field conditions encountered. In this event, the original quantities listed will be modified based on the change in dimension, and the modified quantities will be used for paying quantities at Contract unit prices for the items listed on the bid sheet.
- E. In the event the actual quantity of Work performed exceeds or is below the estimated quantity by more than 10%, a Contract Amendment will be issued.
- F. When the accepted quantity of a unit price pay item increases or decreases more than 25% of the original Contract quantity, an equitable adjustment in the unit price may be negotiated if requested by the Contractor or VRE. The equitable adjustment shall be made upon any increase or decrease in cost due solely to the variation less than 75% or in excess of 125% of the estimated quantity and shall apply to the actual amount of work performed.
- G. If the quantity variation is such as to cause an increase in time necessary for completion, the Contractor may request, in writing, an extension of time, to be received by the CM within ten (10) calendar days from the beginning of the delay, or within such further period as may be granted by VRE before the date of final settlement of the contract. Upon the receipt of a written request for an extension, VRE shall ascertain the facts and make an adjustment for extending the completion date as, if in the judgement of VRE, is warranted.
- H. The Contractor shall accept the compensation provided for in the Contract as full payment for the following:
1. Furnishing all materials, labor, tools, equipment, and incidentals necessary to complete the Work according to the Contract.
  2. Performing all work specified in the Contract.
  3. All loss or damage arising from the nature of the Work or from action of the elements or any other unforeseen difficulties that may be encountered during prosecution of the Work and until its final acceptance.
  4. Any license, use, or infringement of a patent, trademark, or copyright.
  5. The completion of the Work in accordance with the Contract requirements.
- I. The Contractor shall notify the Construction Manager (CM) when items of work are ready for measurement. The Contractor and CM or Inspector shall coordinate on site to measure the work in place for payment according to the requirements of this Specification Section. The CM may question or reject the Contractor's measurement of work-in-place if the Contractor and CM have not measured the work together or come to an agreement on the measured quantities.

VRE reserves the right to reject the Contractor's measurement of work-in-place that involves the use of established unit prices and to have this work measured, at VRE's expense, by a qualified independent 3rd party acceptable to the Contractor.

- J. At the discretion of VRE, payment may be reduced for any Work which is not in full compliance with the Contract Documents or which has been damaged or repaired by the Contractor. Such action may be used when the end product may have a reduced service life or less than desirable aesthetic characteristics.

#### **1.05 MEASUREMENT OF QUANTITIES**

##### **A. General**

1. Work specified in the Contract will be measured by the CM in accordance with U.S. Standard Measure. The methods of measurement and computations to be used to determine quantities of material furnished and work performed will be those generally recognized as conforming to good engineering practice.
2. Specific methods of measurement shall be as indicated in the specific Section for the Contract item.
3. Longitudinal measurements for surface area computations will be made along the surface (horizontally), and transverse measurements will be the surface measure shown on the plans or ordered in writing by the CM. Individual areas of obstructions with a surface area of 9 square feet or less will not be deducted from surface areas measured for payment.
4. Structures will be measured in accordance with the neat lines shown on the plans or as otherwise approved in writing.
5. Items that are measured by the linear foot will be measured parallel to the base or foundation upon which they are placed.
6. Allowance will not be made for surfaces placed over an area greater than that shown on the plans or for any material moved from outside the area of the cross-section and lines shown on the plans.
7. When standard manufactured items are specified, and are identified by weights or dimensions, such identification will be considered nominal. Unless more stringently controlled by tolerances in cited specifications, manufacturing tolerances established by the industries involved will be accepted.

##### **B. Measurement by Weight**

1. Materials that are measured or proportioned by weight shall be weighted on accurate scales as specified in this Section.
2. The Contractor shall have the weigh person perform the following:
  - a. Furnish a signed weigh ticket for each load that shows the date, load number, plant name, size and type of material, project number, schedule or purchase order number, and the weights specified herein.

- b. Maintain sufficient documentation so that the accumulative tonnage and distribution of each lot of material, by Contract, can be readily identified.
  - c. Submit by the end of the next working day a summary of the number of loads and total weights for each type of material by Contract.
3. Trucks used to haul material shall be equipped with a cover suitable to protect the material and to protect the traveling public.
4. The truck tare to be used in the weighing operation shall be the weight of the empty truck determined with full tank(s) of fuel and the operator seated in the cab. The tare weight of trucks shall be recorded to the nearest 20 pounds. At the option of the Contractor, a new tare may be determined for each load. When a new tare is obtained for each load, the requirement for full tank(s) of fuel will be waived.
5. Net rail shipment weights may be used for pay quantities when evidenced by railroad bills of lading. However, such weights will not be accepted for pay quantities of materials that subsequently pass through a stationary mixing plant.
6. Scales shall conform to the requirements for accuracy and sensitivity as set forth in the National Institute of Standards and Technology Handbook No. 44 for Specification Tolerances and Requirements for Commercial and Weighing Devices. Scales used in the weighing of materials paid for on a tonnage basis shall be approved and sealed in accordance with the requirements of the policies of the Bureau of Weights and Measures of the Department of Agriculture and Consumer Services, or other approved agencies, at least once every six months and upon being moved. Hopper and truck scales shall be serviced and tested by a scale service representative at least once every six months. Hopper scales shall be checked with a minimum 500 pounds of test weights and truck scales shall be checked with a minimum 20,000 pounds of test weights.
7. Copies of scale test reports shall be maintained on file at the scale location for at least 18 months, and copies of all scale service representative test reports shall be forwarded to VRE upon request.
8. The quantity of materials paid for on a tonnage basis shall be determined on scales equipped with an automatic printer. Truck scale printers shall print the net weight and either the gross or tare weight of each load. Hopper scale printers shall print the net weight of each load. The weigh ticket shall also show the legal gross weight for material weighed on truck scales and the legal net weight for material weighed on hopper scales.
9. If the automatic printer becomes inoperative, the weighing operation may continue for 48 hours provided satisfactory visual verification of weights can be made. The written permission of the VRE shall be required for the operation of scales after 48 hours.
10. If significant discrepancies are discovered in the printed weight, the ultimate weight for payment will be calculated on volume measurements of the materials in place and unit weights determined by the CM or by other methods deemed appropriate to protect the interests of VRE.

C. Measurement by Volume (e.g. Cubic Yard)

1. Material that is measured by the cubic yard, loose measurement or vehicular measurement, shall be hauled in approved vehicles and measured therein at the point of delivery. Material measured in vehicles, except streambed gravel, silt cleanout, or other self-consolidating material will be allowed at the rate of 2/3 the volume of the vehicle. The full volume of the vehicle will be allowed for streambed gravel. Such vehicles may be of any size or type acceptable to the Engineer provided the body is of such shape that the actual contents can be readily and accurately determined. Unless all approved vehicles are of uniform capacity, each vehicle shall bear a plainly legible identification mark indicating the specific approved capacity. Each vehicle shall be loaded to at least its water level capacity.
2. When approved by the CM in writing, material specified to be measured by the cubic yard may be weighed and such weights converted to cubic yards for payment purposes. Factors for conversion from weight to volume measurement will be determined by the CM and shall be agreed to by the Contractor before they are used.

D. Measurement by Lump Sum

1. When used as an item of payment, the term lump sum will mean full payment for completion of the corresponding item of work described in the Contract. When a complete structure or structural unit is specified as a Contract item, the unit of measurement will be lump sum, and shall include all necessary fittings and accessories. The quantities may be shown on the plans for items for which lump sum is the method of measurement. If shown, the quantities are approximate and are shown for estimating purposes only and no measurement of quantities will be made for payment. Items that are to be measured as complete units will be counted by the VRE Representative in the presence of a representative of the Contractor.

E. Measurement by Length (e.g. Linear Foot or Vertical Linear Foot)

1. When used as an item of payment, the term of length will mean full payment for completion of the corresponding item of work described in the Contract. When a pay item unit is specified as a Contract item, the unit of measurement designated as a unit of length shall include all necessary fittings and accessories. The quantities may be shown on the plans for items for which length is the method of measurement. Items that are to be measured as complete units will be counted by the Inspector in the presence of a representative of the Contractor.

F. Measurement by Area (e.g. Square Feet)

1. When used as an item of payment, the term of area will mean full payment for completion of the corresponding item of work described in the Contract. When a pay item unit is specified as a Contract item, the unit of measurement designated as a unit of area shall include all necessary fittings and accessories. The quantities may be shown on the plans for items for which are is the method of measurement. Items that are to be measured as complete units will be counted by the Inspector in the presence of a representative of the Contractor.

**G. Measurement by Item or Count (e.g. Each)**

1. When used as an item of payment, the term of item or count will mean full payment for completion of the corresponding item of work described in the Contract. When a pay item unit is specified as a Contract item, the unit of measurement designated as a unit of item or count shall include all necessary fittings and accessories. The quantities may be shown on the plans for items for which are is the method of measurement. Items that are to be measured as complete units will be counted by the Inspector in the presence of a representative of the Contractor.

**1.06 PLAN QUANTITIES**

- A. When specified in the Contract, Contract items will be measured and paid for on the basis of plan quantities. The quantities allowed for compensation will be those shown on the plans with deductions from or authorized additions to such quantities resulting from authorized deviations from the plans.
- B. In the case of excavation, only excavation within the cross-section prism will be paid for on a plan quantity basis.
- C. If the Contractor believes that any plan quantity is incorrect, they may solicit, at their own expense, the aid of a Professional Engineer licensed to practice engineering in the State, Commonwealth, or District where the project is physically located to check the quantity or they may ask the CM in writing to check computations of the quantity. Written requests for a quantity check by the CM shall be accompanied by calculations, drawings, or other evidence indicating why the plan quantity is believed to be in error. If any item of the Contract is found to be in error and so verified by the CM, payment will be made in accordance with the corrected plan quantity.
- D. If the CM or VRE determines during construction that there is an error in the plan quantity, or that conditions vary from those anticipated in the design to the extent that an actual measurement of a plan quantity item is warranted, the CM will make such measurement and will notify the Contractor, in writing, of the rationale for adjustment. Payment will then be based on the measured quantity in lieu of the plan quantity.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 24 00****Value Engineering****PART 1 - GENERAL****1.01 SUMMARY**

Section includes procedures and requirements related to Value Engineering Proposals.

**1.02 RELATED SECTIONS**

- A. Section 01 25 00 – Substitution Procedures
- B. Section 01 33 00 – Submittal Procedures

**1.03 VALUE ENGINEERING PROPOSALS**

- A. The Contractor may submit to VRE written Value Engineering Proposals (VEP) for modifying the plans, Specifications, or other Contract requirements for the purpose of reducing the total cost and/or Contract time without reducing the design capacity, intended purpose, or quality of the finished product. If VRE accepts the VEP, VRE and the Contractor will divide the net savings as enumerated in section 1.05., Contract time or both. The requirements herein apply to each VEP initiated, developed, and identified as such by the Contractor at the time of its submission to VRE. However, nothing herein shall be construed as requiring VRE to approve a VEP.

**1.04 VEP REQUIREMENTS**

- A. The Contractor's VEP shall clearly demonstrate that changing the contract requirements would:
  - 1. Result in a net reduction in the total contract amount;
  - 2. Not impair, in any manner, the essential functions or characteristics of the project, including but not limited to, service life, economy of operation ease of maintenance, desired appearance, design and safety standards; and
  - 3. Not detrimentally affect the project completion schedule.
  - 4. VEPs will not be considered if proposed materials cannot be procured and delivered within the approved construction schedule.
- B. Each VEP shall result in a net savings over the Contract cost or Contract time, or both, without impairing essential functions and characteristics of the item(s) or of any other part of the project, including, but not limited to, service life, reliability, economy of operation, ease of maintenance, aesthetics, and safety. At a minimum the following information shall be submitted with each VEP:
  - 1. Statement that the proposal is submitted as a VEP;
  - 2. A description of both existing contract requirements for performing the work and the VEP, with a discussion of the comparative advantages and disadvantages of each;



3. Statement concerning the basis for the VEP benefits to VRE and an itemization of the pay items and contract requirements affected by the VEP, if adopted;
4. Detailed estimate of the cost of performing the work under the existing Contract and under the VEP;
5. A statement of the effect adoption of the VEP will have on the time for completion of the contract.
6. Proposed specifications and recommendations as to the manner in which the VEP changes are to be accomplished;
7. Statement as to the time by which a Contract Amendment adopting the VEP must be issued so as to obtain the maximum cost-effectiveness. Said date shall be selected so as to preclude all schedule impacts to the project regardless of whether work proceeds as specified in the contract or as specified in the VEP;
8. A statement from the Contractor predicting any effects the proposed VEP will have on the life-cycle cost of the work to include and identify separately the cost for increased or decreased maintenance and operations.
9. A description and estimate of costs VRE may incur in implementing the VEP, such as redesign, evaluation, tests and operating and supporting costs.

**1.05 VEP SAVINGS SHARING BETWEEN THE CONTRACTOR AND VRE**

- A. If VRE accepts the VEP, an equitable adjustment in the contract amount shall be determined in accordance with the following:
  1. Net savings shall be shared between VRE and the Contractor will be divided on the basis of sixty percent (60%) for the Contractor and forty percent (40%) for VRE.
  2. Net savings shall be determined by (1) deducting from the estimated gross savings, the Contractor's cost of implementing the VEP (including subcontractor costs, if applicable) and (2) adding the estimated amount of increased costs to VRE resulting from the change, such as testing, redesign, implementation, and related items.
  3. Estimated gross savings shall include the Contractor's labor, material, equipment, overhead, profit and bonds.
  4. When an accepted VEP includes Contract time savings, one-half of such time savings shall be used to reduce the Contract time and the remaining one-half of such time savings shall be used exclusively by the Contractor as extra time. A Revised Baseline Schedule shall be prepared, in which the Contractor shall identify a VEP contractor float activity for each accepted VEP that includes Contract time savings. The VEP extra time may be used by the Contractor to mitigate its delays on the project.
  5. The contract amount shall be reduced by VRE's share of the net savings.
- B. VRE will be the sole judge of the acceptability of a VEP and of the estimated net savings from the adoption of all or any part of such proposal. In determining the estimated net savings, VRE

may disregard the contract line item prices, if in VRE's judgement such prices do not represent a fair measure of the value of the work to be performed or deleted.

#### **1.06 VEP SUBMISSION AND PROCESSING**

- A. The Contractor shall submit three (3) copies of the VEP along with all supporting information to the CM. The CM shall notify the Contractor of the status of the VEP within 30 calendar days after receipt. If additional time is required for evaluation, the CM shall notify the Contractor within the 30-day period and provide the reason for the delay.

Unless this notification specifically states otherwise, the provisions of paragraph C below and the following shall prevail:

1. The Contractor shall continue to perform the work in accordance with the requirements of the contract; and
  2. Failure of VRE to adopt the VEP by the date specified in the VEP, or the date subsequently specified in writing, shall be deemed rejection of the VEP.
- B. Final VEP submittals shall contain calculations and drawings signed and sealed by a professional engineer licensed in the Commonwealth of Virginia or District of Columbia.
- C. VRE will process the VEP in the same manner as prescribed for any other proposal that would necessitate issuance of a Contract Amendment. VRE may accept a VEP in whole or part by issuing a Contract Amendment that will identify the VEP on which it is based. The Contract Amendment will provide for an equitable adjustment in the contract amount and will revise any other affected provisions of the contract documents.
- D. VRE will not be liable to the Contractor for failure to accept or act on any VEP submitted pursuant to these requirements or for delays in the work attributable to any VEP. Until a VEP is put into effect by a Contract Amendment, the Contractor shall remain obligated to the terms and conditions of the existing Contract. If an executed Contract Amendment has not been issued by the date on which the Contractor's proposal specifies that a decision should be made or such other date as the Contractor may subsequently have specified in writing, the VEP shall be deemed rejected.
- E. The Contract Amendment effecting the necessary modification of the Contract will establish the net savings agreed on and provide for adjustment of the Contract prices or Contract time, or both. The Contractor shall absorb all costs incurred in preparing a VEP. Costs for reviewing and administering a VEP will be borne by VRE. VRE may include in the agreement any conditions it deems appropriate for consideration, approval, and implementation of the VEP. The Contractor's 50 percent share of the net savings or Contract time, or both, shall constitute full compensation for effecting all changes pursuant to the VEP Contract Amendment.
- F. Unless specifically provided for in the Contract Amendment authorizing the VEP, acceptance of the VEP and performance of the work thereunder will not change the Contract time limit.
- G. VRE may adopt a VEP for general use in contracts VRE administers if it determines that the VEP is suitable for application to other contracts. VEPs identical with or similar to previously submitted VEPs will be eligible for consideration and compensation under these provisions if VRE has not previously adopted the VEPs for general application to other contracts VRE

- administers. When a VEP is adopted for general use, compensation pursuant to these requirements will be applied only to those awarded contracts for which the VEP was submitted prior to the date of adoption of the VEP.
- H. Proposed changes in the basic design of the Project or those changes that require different right of way limits will not normally be considered an acceptable VEP. If a VEP is based on, or is similar to, a change in the plans, Specifications, or Special Provisions VRE has adopted prior to submission of the VEP, VRE will not accept the VEP.
- I. Subject to the provisions herein, VRE or any other public agency shall have the right to use all or part of an accepted VEP without obligation or compensation of any kind to the Contractor.

#### **1.07 PRELIMINARY VEPS**

- A. The Contractor may submit a Preliminary value engineering proposal (Preliminary VEP) to VRE to determine whether an idea is considered feasible and to assist the Contractor in determining whether a formal VEP should be developed and submitted.
- B. A Preliminary VEP shall be brief, one to two pages if possible, and comprehensive. At a minimum, it should:
1. Describe the technical concept being contemplated;
  2. Describe other, non-technical factors critical to analysis of the potential VEP such as schedule impacts, aesthetic considerations, operational and maintenance impacts, etc.
  3. Provide an order-of-magnitude estimate of the net cost savings which may be realized for the potential VEP; and
- C. Submitting a Preliminary VEP:
1. Does not establish ownership of a value engineering idea;
  2. Does not establish a right to share in any resultant savings;
- Ownership of a value engineering idea is not established until a fully documented formal VEP is submitted.
- D. VRE will review the Preliminary VEP within fifteen (15) business days and indicate if the idea(s) presented:
1. Have potential;
  2. Could be modified to have potential; or
  3. Have little or no chance of being accepted.
- E. Indication by VRE that a preliminary VEP has potential does not guarantee that the subsequent formal VEP will be accepted. VRE shall be the sole judge of the acceptability of a formal VEP and reserves the right to reject a VPE for any reason including technical, nontechnical, financial or contractual reasons.
- F. Submittal of Preliminary VEPs is not a requirement and is strictly optional. However, submittal of a Preliminary VEP can reduce the Contractor's risk by identifying those ideas that have little or no chance of being accepted.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 25 00**  
**Substitution Procedures****PART 1 - GENERAL****1.01 SUMMARY**

Section includes administrative and procedural requirements for major material substitutions after Notice of Award of Contract.

**1.02 RELATED SECTIONS**

- A. General Conditions for Construction
- B. Section 01 33 00 – Submittal Procedures

**1.03 GENERAL**

- A. The Contract is based on the materials, equipment and methods described in the Contract documents that allow for compliance to all Federal, State, and Local rules and regulations. No substitutions or cancellations shall be permitted after award without the written approval of VRE. VRE will consider requests for substitutions of materials, equipment and methods only when requests are accompanied by full and complete technical data and all other information required to evaluate the proposed substitution.
- B. Substitutions, if approved, shall be without any additional compensation except when provisions for SECTION 01 24 00 Value Engineering are applicable or extension of contract time from VRE, unless approved otherwise.

**1.04 SUBMITTALS**

- A. Timing:
  - 1. Submit substitution requests within a maximum of 45 calendar days after Notice to Proceed or as otherwise necessary and coordinated with the CM . Requests received after that time may be considered or rejected at the sole discretion of VRE. Substitutions will not be considered if they cannot be procured and delivered within the approved construction schedule.
- B. Conditions:
  - 1. VRE will consider Contractor's request for substitution only when the following conditions are satisfied. If the following conditions are not satisfied, the CM will return requests without action, except to record noncompliance with these requirements:
    - a. Requested substitution does not require extensive revisions to the Contract Documents.
    - b. Requested substitution is consistent with the Contract Documents and will produce indicated results.
    - c. Substitution request is fully documented and properly submitted.

- d. Requested substitution will not adversely affect Contractor's Construction Schedule.
  - e. Requested substitution has received necessary approvals of authorities having jurisdiction.
  - f. Requested substitution is compatible with other portions of the Work.
  - g. Requested substitution has been coordinated with other portions of the Work.
  - h. Requested substitution provides specified warranty.
  - i. If requested substitution involves more than one Contractor, requested substitution has been coordinated with other portions of the Work, is uniform and consistent, is compatible with other products, and is acceptable to all Contractors involved.
- C. Identify specified product or fabrication or installation method to be replaced. Include Specification Section number and title and Drawing numbers and titles.
- D. Show compliance with requirements for substitutions and the following, as applicable:
- 1. Statement indicating why specified product or fabrication or installation cannot be provided, if applicable.
  - 2. Coordination information, including a list of changes or revisions needed to other parts of the Work that will be necessary to accommodate proposed substitution.
  - 3. Detailed comparison of significant qualities of proposed substitution with those of the Work specified. Significant qualities include attributes such as performance, weight, size, durability, visual effect, sustainable design characteristics, warranties, and specific features and requirements indicated.
  - 4. Indicate deviations, if any, from the Work as specified.
  - 5. Detailed information regarding any change in cost or contract time, including the cost of additional engineering required to properly incorporate proposed substitution.
  - 6. Product Data, including drawings and descriptions of products and fabrication and installation procedures.
  - 7. Samples, where applicable or requested.
  - 8. Certificates and qualification data, where applicable or requested.
  - 9. Material test reports from a qualified testing agency indicating and interpreting test results for compliance with requirements indicated.
  - 10. Drawings as required to demonstrate details of the proposed product.
  - 11. Technical specification for the proposed product, if not included in the original contract.
  - 12. Contractor's certification that proposed substitution complies with requirements in the Contract Documents except as indicated in substitution request, is compatible with related materials, and is appropriate for applications indicated.

13. Contractor's certification waiving rights to additional payment or time that may subsequently become necessary because of failure of proposed substitution to produce indicated results.
- E. If necessary, the CM will request additional information or documentation for evaluation within 15 days of receipt of a request for substitution. The CM will provide written acceptance or rejection of proposed substitution within 30 days of receipt of request, or 30 days of receipt of additional information or documentation, whichever is later.
- F. Do not use the RFI process for submittal of Substitution Requests.
- G. Contractor's submittal and VRE's review or approval Shop Drawings, Product Data or Samples related to a substitution does not itself constitute a final approval of the requested substitution, nor does it relieve the Contractor from fulfilling existing Contract requirements.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 26 00**  
**Change Order Procedures**

**PART 1 - GENERAL**

**1.01 SUMMARY**

Section includes procedures and requirements related to handling and processing Change Orders to include:

- A. Change Order Procedures
- B. Preparation of Proposed Change Orders
- C. Lump Sum Change Orders
- D. Unit Price Change Orders
- E. Time and Material Change Orders
- F. Contract Time Extensions
- G. Change Orders for Compensable Delay
- H. Differing Site Conditions
- I. Payment for Contract Amendment Work

**1.02 RELATED SECTIONS**

- A. 01 22 00 – Unit Prices
- B. 01 29 00 – Payment Procedures
- C. 01 32 00 – Construction Progress Documentation
- D. General Conditions for Construction

**1.03 MINOR CHANGES IN WORK**

- A. VRE shall have authority to make minor changes in the Work by supplemental instructions when such changes do not involve extra cost and are not inconsistent with the purpose of the Project. Otherwise, except in an emergency endangering life or property, no extra Work or change shall be made unless in pursuance of a written Construction Change Directive or Change Order and no claim for an addition to the Contract Amount or Contract Time shall be valid unless so ordered. If the Contractor believes a cost is associated with the supplemental instructions, the Contractor is to provide written notice to the CM within seven (7) days of receipt of instructions.



**1.04 CHANGE ORDER PROCEDURES****A. Changes to the work can be by:**

1. Change Order issued by VRE to the Contractor.
2. Contractor proposing a Potential Change Order (PCO) to VRE.
3. Time and Material

Specific requirements for a VRE ordered change or preparation and submission of a Contractor PCO are detailed in the following subsections of this specification.

**B. If any change causes an increase or decrease in the Contractor's cost of, or time required for, the performance of any part of the Work under the Contract, the Contracting Officer shall make an equitable adjustment and amend the Contract in writing. Approval may be contingent on funding agency or VRE Board authorization. VRE will issue a Contract Amendment all-inclusive of the terms of the Change Order (s) to the Contractor for signature. Once the Contract Amendment has been signed by the Contractor and VRE, it is considered executed.**

1. VRE may require additional bond protection when a Contract price is increased. Such change will require notice to sureties and require that Performance and Payment Bonds be increased by the Contractor. The increase in protection shall generally equal one hundred percent (100%) of the increase in Contract price.
2. A copy of the revised Payment and Performance Bonds shall be provided by the Contractor to the Purchasing and Contracts Office within 14 calendar days of VRE's approval of such change. The Contractor shall execute change orders with the consent of the surety or sureties on the Payment and Performance Bond unless otherwise directed by the sureties. All such work shall be executed under the conditions of the original Contract, except that modification of the Time for Completion caused thereby shall be made at the time of approving such change.
3. Upon the Contractor's request, VRE may decrease bond amounts as deliverables are received.

**C. Work may be invoiced for payment only once the Contractor possesses a fully executed Contract Amendment.****D. The Construction Manager is not authorized to approve Change Orders or authorize extra work without written concurrence of the VRE Contracting Officer.****1.05 VRE CHANGE ORDERS****A. VRE, without invalidating the Contract, may order extra Work or make changes by addition, deletion or revision in the Work, with the total Contract Amount being adjusted accordingly if applicable. Changes shall include:**

1. A detailed description of a proposed change,
2. Supplementary or revised drawings and specifications,

3. A change in Contract Time for executing the change work required,
  4. The period of time during which the requested price will be considered valid.
  5. Contractor will prepare and submit an estimate in a timely manner in order to not cause delay to the project schedule. VRE may further issue a directive to proceed with additional work under Time and Material basis.
- B. The Contractor shall review any VRE requested or directed change and shall respond in writing within 14 calendar days after receipt of the proposed change stating the effect of the proposed change upon Contractor's work, including any increase or decrease in Contract time and price. The Contractor shall furnish VRE an itemized breakdown of the quantities and prices used in computing the proposed change. The Contractor shall also furnish any sketches, drawings, and/or pictures to properly explain the change or impact to VRE. It is the sole responsibility of the Contractor to provide adequate change order backup to satisfy VRE.
1. The value of any such extra work or change shall be proposed by VRE in one or more of the following ways: (a) by estimate in a lump sum; (b) by cost and fixed fee; (c) by unit price additions or deletions of quantities stated in the Contract; or (d) any other method permitted under VRE's Procurement Manual.
  2. If none of the aforementioned methods is agreed upon the Contractor shall proceed with the work without delay under Time and Materials, provided the Contractor receives a Construction Change Directive. In such case, the Contractor shall keep and present in such form as the CM may direct, a correct account of the cost, together with vouchers. The CM shall be permitted to verify such records on a daily basis and may require such additional records as are necessary to determine the cost of the change to the Work. The CM shall include a firm Not-to-Exceed ceiling price that the Contractor may not exceed except at its own risk. A complete accounting of the extra cost shall be made within 14 days after completion of the work involved in the claim. Refer to Time and Materials (Force Account) Change Orders, below for a description of allowable costs when work is performed under force account.
- C. Once the scope, cost and schedule impacts, if any, are agreed upon, the CM will prepare the Change Order, possibly combining with other approved Change Orders, and submit to VRE for Processing. Approval may be contingent on funding agency or VRE Board authorization. Once processed, a Contract Amendment will be issued for signature by the Contractor. Once the Contract Amendment has been signed by the Contractor and VRE, it is considered executed. VRE may require additional bond protection as described above.

#### **1.06 PREPARATION OF CONTRACTOR PROPOSED CHANGE ORDERS**

- A. The Contractor may propose a change by submitting a Potential Change Order (PCO) commonly known as Request for Change (RFC) to the Construction Manager, describing the proposed change and its full effect on the Work, with a statement describing the reason for the change, the effect on the Contract Sum and Contract Time with full documentation and a statement describing the effect on Work by separate or other contractors.

- B. Contractor shall provide written notice of intent to claim additional cost or time within 14 days of their knowledge of such. Failure to do so will result in automatic rejection of claims.
- C. Submit a description of work that is considered beyond the scope of the contract for review and approval prior to start of work. VRE must be allowed sufficient time to review and make a determination of entitlement for additional compensation or time. The Contractor's submittal shall be in sufficient detail to enable VRE to determine the basis of entitlement.
- D. PCO must be signed and dated by the Contractor in order to be accepted by VRE.
- E. Failure to furnish sufficient documentation or to qualify their reason for failure to do so may delay the project. If such delay occurs, it will in no way relieve the Contractor of their obligation to meet the time limits or other requirements established for the contract or constitute basis for a delay claim on part of the Contractor.
- F. Maintain detailed records of related work performed, including photos if they help demonstrate the work. Provide complete information required for evaluation of proposed changes and to substantiate costs of changes in the Work.
- G. Document each quotation for a change in itemized cost or time with sufficient data to allow evaluation of the quotation. Provide itemized breakdown of cost.
- H. At a minimum, provide the following data and/or documentation to support computations:
  - 1. Quantities of products, labor, and equipment
  - 2. Insurance and bonds
  - 3. Overhead and profit
  - 4. Justification for any change in Contract Time and revision to project schedule to clearly identify critical path
  - 5. Credit for deletions from Contract, similarly documented
- I. Support each claim for additional costs, and for work performed under time and material basis, with additional information:
  - 1. Origin and date of claim
  - 2. Dates and times work was performed, and by whom reviewed and approved
  - 3. Time records and wage rates paid
  - 4. Invoices and receipts for products, equipment, and subcontracts, similarly documented
  - 5. Prior approval and signoff by VRE
- J. VRE shall review the Contractor initiated change and respond in writing as follows:
  - 1. Agree with Contractor's cost proposal;
  - 2. Request for additional information;
  - 3. Reject the Proposal.

- K. If additional information is requested by VRE, Contractor shall respond in writing within fourteen (14) days of request.
- L. If the scope, cost, and schedule impacts, if any, are agreed upon, the PCO will be incorporated into a Change Order, possibly combined with other approved PCOs. The Change Order will be prepared by the CM with all required documentation from all included PCOs and submit to VRE for processing. Approval may be contingent on funding agency or VRE Board authorization. Once processed, a Contract Amendment will be issued for signature by the Contractor. Once the Contract Amendment has been signed by the Contractor and VRE, it is considered executed. VRE may require additional bond protection as described in paragraph above.

## **1.07 TERMS OF CHANGE ORDERS**

### **A. Lump Sum Change Orders**

- 1. Based on Proposal Request and Contractor's fixed price quotation or Contractor's request for a Change Order as approved by VRE.
- 2. A cost proposal for a change in the Work shall provide a complete breakdown itemizing the estimated quantities and costs of labor, materials, and equipment (base cost) required in addition to any markup used. The allowable percentage markups for overhead and profit for a change to the Work performed by the Contractor's own forces or performed by the Subcontractor shall not exceed the percentages for each category listed below.
  - a. Contractor's markup for overhead for work it performs in a change to the Work shall be ten percent (10%) of the Base Cost.
  - b. Subcontractor's markup for overhead for the work it performs in a change to the Work shall be a maximum of five percent (5%) of the Base Cost.
  - c. Contractor's markup for overhead for work performed by a Subcontractor in a change to the Work shall be a maximum of five percent (5%) of the Base Cost. The Contractor's 5% for overhead shall be calculated using the Base Cost only, and not calculated on top of the Subcontractor's overhead and profit.
  - d. The markup for overhead of a Sub-subcontractor at any tier on a change to the Work it performs shall be a maximum of five percent (5%). The Contractor's and all intervening tiers of Subcontractors' markup on such Sub-subcontractor's base cost in the change to the Work shall not exceed a total of five percent (5%).
  - e. Profit: The Contractor and sub-contractors shall be allowed up to a ten (10%) markup for profit on all properly documented and approved costs for all profit associated with labor costs. Where profit is a negotiated element of price, a reasonable profit will be negotiated considering factors such as, but not limited to:
    - i. Degree of Risk
    - ii. Relative Difficulty of Work

- iii. Size of Job
- iv. Period of Performance
- v. Subcontracting

3. Base Cost is defined as the total of labor, material, and equipment costs; it does not include markup for overhead and profit. The labor costs include only the costs of employees directly constructing or installing the change in the Work and exclude the costs of employees coordinating or managing the work.
4. The allowable percentage markups for overhead and profit stated above shall compensate the Contractor, Subcontractor, and Sub-subcontractor(s) for all other costs associated with or relating to the change to the Work including by way of illustration and not limitation, general conditions, field supervision, field engineering, coordination, insurance, bond(s), use of small tools, incidental job costs, and all other general and administrative home and field office expenses.
5. Allowable costs for changes in the Work shall not include Home Office expenses including payroll costs for the Contractor's officers, executives, administrators, project managers, estimators, clerks, timekeepers, and other administrative personnel employed by the Contractor, whether at the Site or in the Contractor's principal or branch office for general administration of the Work. These costs are deemed overhead included in the percentage markups in Subsection (B) above.

B. Unit Price Change Orders

1. This subsection only applies to Unit Price contracts.
2. For pre-determined unit prices and quantities, the Change Order will be executed on a fixed unit price basis. VRE may elect to negotiate unit price based on revised item quantity.
3. Overrun of estimated quantities will only be allowed as approved by VRE. See Section 01 22 00, "Unit Prices," for additional details regarding payment for unit price items and overrun of quantities. Contractor shall notify VRE, prior to performing the work, in writing for work that may occur beyond the item quantity provided in the contract.
4. Confirm in-place quantities with the field representative on a daily basis as work is completed. Unless otherwise noted, work will be paid for based on in place quantities.
5. For items which do not have unit prices pre-determined by the Contract, a PCO must be submitted in accordance with the requirements in this Section. New unit price items included in the PCO shall contain all labor, materials, and equipment necessary to perform the Work in accordance with the Contract Documents. The Contractor's and Subcontractor's overhead and profit, as defined above, shall be included in these unit prices.

C. Time and Material Change Orders

1. Should circumstances dictate that changed work be started immediately, VRE may direct the Contractor to proceed with the work on a Time and Material (T&M) basis pending a contract modification. T&M Change Orders may be used at VRE's discretion and only when either:
  - a. Agreement on the valuation of a change cannot be made using the methods described in the preceding paragraphs; or
  - b. VRE cannot firmly establish an applicable and estimate for the cost of the work because the level of effort necessary to perform and complete the work cannot be reasonably estimated or anticipated but can only be determined by performing the work.
2. Because of the significant burden on VRE to monitor and control the work, T&M work is not a preferred method, and it shall be the responsibility of the Contractor to provide all necessary documentation and justification of costs. The rates for labor, equipment and materials to be used in cases of work performed on a T&M basis will be compensated as documented below. No costs other than those explicitly listed below shall be allowed.
3. T&M contracts are only to be used after a documented determination that no other type of contract is suitable. When issuing a T&M change order, VRE shall include a firm Not-to-Exceed (NTE) ceiling price that the Contractor may not exceed except at its own risk.
4. Upon request, VRE may require Contractor to submit an estimate of cost and time impacts on Time and Material work prior to authorizing the work.
5. Contractor shall maintain detailed records of work performed on Time and Material basis. Confirm in-place quantities with the field representative on a daily basis as work is completed. Unless otherwise noted, work will be paid for based on in place quantities. Review Time and Material records with the field representative to obtain daily agreed upon quantities.
  - a. As the Work progresses, the Contractor is to monitor its costs. If their costs will exceed the NTE prior to completing the work, the Contractor is to stop work and notify the CM. A decision will be made by VRE to stop the change at the time or to authorize an increase in the NTE amount.
6. The Contractor is not to proceed with the Work until a written T&M directive has been signed by the Contractor and VRE.
7. The Contractor shall be paid for all labor, materials, equipment, services, supplies, taxes, overhead, profit, and miscellaneous costs or expenses for extra work performed on a Time and Materials basis in the following manner:
  - a. **Labor:** Labor costs shall be composed of direct labor cost plus labor burdens. Before any T&M work begins, the Contractor shall submit for approval to the CM the proposed hourly rates and associated labor costs (benefits and payroll burden) for all

laborers and forepersons to be engaged in the work. The number of laborers and forepersons engaged in the work will be subject to approval by the CM as justified by the nature of the work. For all labor and forepersons in direct charge of the T&M work, excluding general superintendence, compensation as listed below. Direct labor cost shall not be higher than those regularly paid the employee. The Contractor shall provide certified payroll records for audit purposes.

- i. **Certified Pay Rate:** Unless otherwise approved, the Contractor will receive the actual rate of wage or scale as set forth in their most recent payroll for each classification of laborers, and forepersons who are in direct charge of the specific operation. The time allowed for payment will be the number of hours such workers are actually engaged in the work. If overtime work is authorized by VRE, payment will be at the normal overtime rate set forth in the Contractor's most recent payroll. If workers performing the class of labor needed have not been employed on the project, mutually agreed on rates will be established. However, the rates shall be not less than those predetermined for the project, if applicable.
- ii. **Benefits:** The Contractor will be entitled to receive the actual cost for any fringe benefits that are regularly provided to the classes of laborers and forepersons engaged in the work and that are not included in the certified pay rate.
- iii. **Payroll Burden:** The Contractor will be entitled to receive the actual cost for all costs associated with required payroll taxes and payroll benefits not covered in the previous paragraph including:
  1. Social Security Tax
  2. Medicare Tax
  3. Unemployment Tax
  4. Worker's Compensation Insurance
  5. Contractor's Public Liability Insurance
  6. Contractor's Property Damage Liability Insurance

If the Contractor is unable to provide the necessary documentation for Benefits and Payroll Burden as identified above, the Contractor will be entitled to an additive of 20% of the Certified Hourly Pay Rate as full and final compensation for Benefits and Payroll Burdens.

- iv. **Overhead:** The Contractor shall be entitled to an additive of ten (10%) on all properly documented and approved costs established in paragraphs i, ii, and iii for all administrative overhead associated with labor costs.
- v. **Profit:** The Contractor shall be allowed up to a ten (10%) markup for profit on all properly documented and approved costs established in paragraphs i, ii, iii and iv above for all profit associated with labor costs. Where profit is a negotiated

element of price, a reasonable profit will be negotiated taking into account factors such as, but not limited to:

1. Degree of Risk
2. Relative Difficulty of Work
3. Size of Job
4. Period of Performance
5. Subcontracting

- b. **Materials:** The Contractor will receive the actual cost of materials accepted by VRE that are delivered and used for the work including taxes, transportation, and handling charges paid by the Contractor, not including labor and equipment rentals as herein set forth. The Contractor shall make every reasonable effort to take advantage of trade discounts offered by material suppliers. Any discount received shall pass through to the VRE. The appropriate salvage value of salvageable temporary construction materials shall be credited to VRE.
- i. Vendor's and/or supplier's invoices accompanied by evidence of payment shall be provided to the CM to establish the Contractor's cost of materials. Payment will only be made for the material consumed during the performance of the Time & Material Work or for approved material which is incorporated as part of the finished work.
- c. **Equipment:** The Contractor shall provide VRE a list of all equipment to be used in the work. For each piece of equipment, the list shall include the serial number; date of manufacture; location from which equipment will be transported; and, for rental equipment, the rental rate, and name of the company from which it is rented. The number and types of equipment engaged in the work will be subject to approval by the CM as justified by the nature of the Work. Compensation for equipment shall be as follows:
- i. **Hourly Base Equipment Rental Rates (Owned Equipment):** For machinery, equipment, and attachments, necessary for prosecution of the work that are owned by the Contractor and approved for use by VRE, the Contractor will be paid an Hourly Base Rental Rate as detailed in the following paragraphs.
1. **Equipment referenced in "Rental Rate Blue Book for Construction Equipment":** Equipment rental will be measured by time in hours of actual time engaged in the performance of the work and necessary traveling time of the equipment within the limits of the project or source of supply and the project. Hourly rates will not exceed 1/176 of the monthly rates of the schedule shown in the "Rental Rate Blue Book" modified in accordance with the "Rental Rate Blue Book" rate adjustment tables that are current at the time the Time and Materials work is authorized. Equipment rental rates not modified



by the adjustment factors or rate modifications indicated in the “Rental Rate Blue Book” will not be considered unless submitted by the Contractor and approved by VRE.

2. **Equipment not referenced in “Rental Rate Blue Book for Construction Equipment”:** The rates for equipment not listed in the *Rental Rate Blue Book* schedule, a monthly rental rate may be computed on the basis of an amount that is equivalent of 6 percent of the manufacturer’s list price of the sale (new) of such equipment. The hourly rate in such cases may be determined by dividing the monthly rate by 176 when actually operating.
- ii. **Hourly Base Equipment Rental Rates (Rented Equipment):** If the Contractor does not possess or have readily available equipment necessary for performing the T&M work and such equipment is rented from a source other than a company that is an affiliate of the Contractor, payment will be based on actual invoice rates when the rates are reasonably in line with established rental rates for the equipment in question and are approved by the CM.
- iii. **Hourly Operating Rates:** – Hourly Operating Rates shall be as established in the Blue Book estimated operating cost per hour. This operating cost will be full compensation for fuel, lubricants, repairs, servicing (greasing, fueling, and oiling), small tools, and any and all incidentals. If rental rates for the equipment being used in the work are not listed in the Blue Book or otherwise readily available, the Hourly Operating Cost will be 15% of the established Hourly Base Rental Rate. If invoices for Rental Equipment include the furnishing of fuel, lubricants, repair, and servicing, then the Contractor will not be entitled to any Hourly Operating costs for that equipment.
- iv. **Equipment Usage:** An amount, as described above, will be paid for all hours the equipment is engaged in performing the work. The Contractor shall be entitled to the applicable Hourly Base Equipment Rental Rate and Hourly Operating Rate for all approved equipment usage. No compensation will be paid for the use of machinery or equipment not authorized by VRE.
- v. **Equipment Standby:** For the purposes herein “standby time” is defined as the period of time equipment ordered to the jobsite by VRE is available on-site for the work but is idle for reasons not the fault of the Contractor or normally associated with the efficient and necessary use of that equipment in the overall operation of the work at hand. Hourly rates for equipment on standby will be at 50 percent (50%) of the rate paid for equipment performing work. Operating costs shall not be included in the standby rate.
- vi. Payment will be made for the total hours the equipment is performing work. When equipment is performing work less than 40 hours for any given week and is on standby, payment for standby time will be allowed for up to 40 hours, minus hours performing work. Payment for Standby will be allowed only for working days.

Payment will not be made for the time that equipment is on the project in excess of 24 hours prior to its actual performance in the Time and Materials work.

- d. **Transportation Costs:** When it is necessary to obtain equipment exclusively for T&M work from sources beyond the Project limits and the CM authorizes the transporting of such equipment to the Project site, the cost of transporting the equipment will be allowed as an expense. The Contractor will be paid freight cost covering the moving of equipment to and from the specific Time and Materials operation provided such cost is supported by an invoice showing the actual cost to the Contractor.
- i. Where the transport requires the use for a hauling unit, the allowable expense will consist only of the actual cost incurred for the use of the hauling equipment, or the applicable Blue Book cost, whichever is less.
  - ii. When equipment is transferred under its own power, the allowable Transporting cost shall be 50% of the Hourly Base Equipment Rental Rate.

However, such payment will be limited to transportation from the nearest source of available equipment. If equipment is not returned to the nearest equipment storage lot but is moved to another location, the freight cost paid will not exceed the cost of return to the nearest storage lot.

- e. **Compensation:** The compensation as set forth in this Section shall be accepted by the Contractor as payment in full for work performed on a Time and Materials basis. At the end of each day, the Contractor's representative and the Inspector shall compare and reconcile records of the hours of work and equipment, labor and materials used in the work as ordered on a Time and Materials basis. Such accounting may not include actual costs or labor rates where these are not available but shall be used to verify quantities, types of materials or labor, and number and types of equipment. No compensation will be allowed for equipment which is inoperable due to mechanical failure.
- f. **Overhead:** The Contractor shall be entitled to an additive of up to ten percent (10%) on all appropriate and approved Equipment Rental, Operating, and Transporting costs as defined above.
- g. **Profit:** The Contractor shall be allowed up to a ten (10%) markup for profit on all properly documented and approved Equipment Rental, Operating, and Transporting costs as defined above. Where profit is a negotiated element of price, a reasonable profit will be negotiated taking into account factors such as, but not limited to:
- i. Degree of Risk
  - ii. Relative Difficulty of Work
  - iii. Size of Job
  - iv. Period of Performance
  - v. Subcontracting

- h. **Meals and Lodging Allowance:** Meals and lodging allowance may be allowed by the CM at the actual and documented costs for lodging and meals if the following conditions are met and the applicable rates and authorization for such costs are established prior to beginning the work. No additives for overhead, administrative, profit, or any other costs will be permitted for subsistence and lodging.
- i. The specific T&M work requires mobilization of a separate crew not intended to be used on the original contract, and the Contractor's base location is more than 50 miles from the work site, or
  - ii. Forces which have been working on the Contract will be used for the T&M work and have been routinely staying overnight during the life of the Project, and the T&M work will warrant an extension of the contract time, and the distance from the Contractor's base location to the work site is more than 50 miles.
- i. **Miscellaneous:** No additional allowance will be made for attachments that are common accessories for equipment as defined in the Rental Rate Blue Book, general superintendents, timekeepers and secretaries, or other costs for which no specific allowance is herein provided.
- i. Small Tools: No payment will be made for the use of small hand-held tools. Small tools are defined as any individual piece of equipment or tools having a new value \$1,000 or less.
  - ii. Insurance and Bonds: The Contractor will receive compensation equal to the cost of the bond, special railroad insurance premiums, and other additional costs necessary for the specific Time and Materials work as determined by the VRE. The Contractor shall supply documented evidence of such costs.
- j. **Subcontracting:** If all or a portion of the Time and Materials work is performed by an approved subcontractor, the sub-contractor shall receive the cost of work performed as determined in (a through i) above. In addition, the Contractor will be paid up to 10 percent of the subcontract net Time and Materials costs to cover the Contractor's profit and administrative cost per the schedule below.

Total Cost of Subcontract Work: Rate Schedule

\$0 - \$10,000	10%
>\$10,000	\$1,000 + 5% above \$10,000

The amount resulting will not be subject to any further additives. The itemized statements of costs as required below shall be submitted on a form that separates the subcontracted portions of the Time and Materials labor, materials, and equipment from the other Time and Materials costs.

- k. **Statements:** Payments will not be made for work performed on a Time and Materials basis until the Contractor has furnished VRE duplicate itemized statements of the cost of such work detailed as follows:

- i. Payroll indicating name, classification, date, daily hours, total hours, rate, and extension of each laborer, foreperson. Contractor's superintendent and/or Project Manager shall not be included.
  - ii. Designation, dates, daily hours, total hours, rental rate, and extension for each unit of equipment.
  - iii. Quantities of materials, prices and extensions.
  - iv. Transportation of materials.
  - v. Statements shall be accompanied and supported by invoices for all materials used and transportation charges. However, if materials used on the T&M work are not specifically purchased for such work but are taken from the Contractor's stock, then in lieu of the invoices, the Contractor shall furnish an affidavit certifying that such materials were taken from their stock; that the quantity claimed was actually used; and that the price, transportation, and handling claimed represented their actual cost.
8. Provide documentation for overall project schedule impacts in the form of Gantt Chart with clearly identified critical path items.
  9. Time and Materials work will be included in a subsequent Change Order.

#### **1.08 CONTRACT TIME EXTENSIONS**

##### **A. Time Extensions Due to Weather Events**

VRE may give consideration for extension of time when a delay occurs due to unforeseen causes beyond the control of or without the fault or negligence of the Contractor. However, consideration will not be given to extensions of time attributable to normal adverse weather conditions or conditions resulting from normal adverse weather. For the purposes of this Section, normal adverse weather is defined as that which is not considered extraordinary or catastrophic and is not reasonably conducive to the Contractor progressively prosecuting critical path work under the Contract. Weather events considered extraordinary or catastrophic include, but are not limited to, tornados, hurricanes, earthquakes, and floods that exceed a 25-year storm event as defined by National Oceanic and Atmospheric Administration (NOAA) for the NOAA data gathering location that is nearest the project site. The Contractor shall make the request within the written PCO in accordance with the applicable portions of this Section and 01 32 00 "Construction Progress Documentation."

##### **B. Time Extensions Due to Additional Work**

If the Contractor believes a particular scope of work associated with a PCO warrants a Contract time extension, the Contractor shall make the request within the written PCO in accordance with the applicable portions of this Section. The Contractor shall provide written supporting data for any request for extension of time due to additional Work.

The written supporting data shall include the particular construction operations affected, their criticality to project milestones or overall Contract completion, and the significant dates that

encompass the period of the requested time extension. The Contractor shall furnish any additional information requested by the CM or VRE as necessary for VRE to make an adequate evaluation of the request.

#### **1.09 CHANGE ORDERS FOR COMPENSABLE DELAY**

- A. The Contractor may be entitled to compensation for a compensable delay. Compensable delays are critical delays that are not the Contractor's fault or responsibility and are VRE's fault or responsibility. The Contractor shall prepare and submit documentation and request for any such Change Order for review by the CM and VRE. Compensation may include extension of Contract term and not necessarily payment. Compensable delays may include, but are not limited to:
1. Delays due to alteration of quantities or character of work
  2. Delays due to differing site conditions
  3. Delays due to a VRE-ordered suspension not prompted by Contractor actions
  4. Delays due to the acts or omissions of VRE or its failure to act in a timely manner
- B. The following delays are not compensable:
1. Acts or omissions of the Contractor, its agents, employees, subcontractors or suppliers or causes within their control or conditions that the Contractor could reasonably have foreseen or avoided
  2. Floods, tidal waves, tornadoes, hurricanes, lightning strikes, earthquakes, fires, epidemics, or similar natural phenomena
  3. Normal adverse weather
  4. Extraordinary, unforeseen, and unavoidable delays in material deliveries
  5. Acts of government entities other than VRE
  6. Unforeseen and unavoidable industry-wide labor strikes affecting the Contractor or its subcontractors' or suppliers' workforce that are beyond the Contractor's control
  7. Actions of third parties that are not the responsibility of the Contractor or within it's or VRE's control
  8. Civil disturbances or sovereign acts of the State, including but are not limited to states of emergency or epidemic or quarantine restrictions
  9. Time period following Notice of Award to the Contractor and prior to Notice to Proceed to the Contractor
- C. If Contractor requests compensable delays or an extension to the Time for Completion due to changes in the Work it must provide to the CM adequate documentation substantiating its entitlement for the time extension. The documentation must demonstrate an anticipated actual increase in the time required to complete the Work beyond that allowed by the Contract as

- adjusted by prior changes to the Work, not just an increase or decrease in the time needed to complete a portion of the total Work.
- D. No extension to the Time for Completion or compensable delay shall be granted unless the additional or change to the Work increases the length of the critical path beyond the Time for Completion as demonstrated on the approved CPM schedule or bar chart schedule. Any Float belongs to VRE. A written statement in addition to an Impact Analysis Schedule shall be prepared explaining how no other sequence of work activities could have been performed to decrease the impact or eliminate the impact altogether. If requested by the CM the Contractor must provide alternate documentation detailing the claim to VRE's satisfaction
- E. To request payment for a compensable delay, the Contractor shall within 14 days after the end date of a delay event, unless directed otherwise in writing by VRE, submit a written PCO to the CM, for review and approval. With the request, the Contractor shall submit an Impact Analysis Schedule and all supporting data to objectively substantiate its request. VRE will evaluate the Contractor's Impact Analysis Schedule and all supporting data to determine entitlement and the appropriate amount of compensation, according to the following Site direct overhead expenses:
1. Field Office Overhead (FOOH)
    - a. FOOH is the extended project field office overhead and site costs and expenses that are not attributable to specific Contract pay items, but are incurred in support of the project as a result of a delay, which include:
      - i. Extended site supervision costs such as salaries for project field superintendent and administrative staff.
      - ii. Extended site office costs such as utilities (heat, electricity, water, heat, etc.), trailers, field office, office equipment, and sanitary and toilet facilities.
      - iii. Extended site costs that are not used for specific Contract pay items.
    - b. All other direct and indirect overhead expenses are considered covered by and included in Section 1.07 above. In no case shall subcontractor extended overhead be submitted or considered. VRE does not have a direct contractual relationship with any subcontractor or supplier and therefore will not direct, discuss or negotiate with subcontractors employed by the Contractor.
    - c. The Contractor is entitled to FOOH only for compensable delays for which VRE has granted a Contract time extension. The Contractor is not entitled to additional compensation for FOOH for delays that are caused by extra work performed on a Force Account (Time and Materials) basis or for increased quantities.
    - d. The Contractor's agreed amount of compensation for FOOH shall be based on the project daily FOOH rate derived from the Contractor's Itemized Project FOOH Costs set out on VRE's form or other format acceptable to VRE. The Contractor shall submit the form to VRE no later than 30 days after the Notice to Proceed date or on a date

approved by VRE. On the form, the Contractor shall list each project FOOH item, the total estimated costs or expenses for each FOOH item for the original Contract time, the total project FOOH, and the project daily FOOH rate based on the total project FOOH divided by the original Contract duration. The compensation for FOOH will be calculated as follows:

$$\begin{aligned} & (\text{Daily FOOH Rate}) \times (\text{No. of Days of Compensable Delay}) = \\ & (\text{Amount of FOOH}) \end{aligned}$$

## 2. Home Office Overhead (HOOH)

- a. HOOH is the Contractor's allowable home office overhead costs and expenses that cannot be attributed and are not billed to a particular project but are incurred in support of all of the Contractor's projects, including but not limited to rent, office equipment and furnishings, insurance, office supplies, depreciation, taxes, and utilities, as well as executive salaries, administrative, staff salaries, project support staff salaries, and accounting and payroll services.
- b. The Contractor is entitled to payment of HOOH only for compensable delays for which VRE has granted a Contract time extension and only when the Contractor could not reasonably recoup its HOOH while its workforce was idled by the delay because the Contractor was required to remain on standby, ready to resume work, and unable to perform other work at the project or elsewhere during the delay.
- c. The Contractor is not entitled to compensation for HOOH for delays that are caused by extra work performed on a Force Account basis or by increased quantities.
- d. The agreed amount of compensation for extended or unabsorbed HOOH for a compensable delay will be determined as follows:

$$(A \times C) / B = D \text{ and } D \times E = F$$

Where:

A = Original total Contract amount

B = Original Contract duration (number of calendar days between and inclusive of the Contract Notice to Proceed (NTP) date and the original Contract Completion Date)

C = 6% (Agreed allowable HOOH percentage)

D = Daily allowable HOOH rate

E = Number of days of compensable delay

F = Agreed amount of compensation for HOOH

- e. In no case shall subcontractor extended overhead be submitted or considered. VRE does not have a direct contractual relationship with any subcontractor or supplier and therefore will not direct, discuss or negotiate with subcontractors employed by the Contractor.
3. When to Audit to Determine FOOH and HOOH
- a. The Contractor may propose a higher rate determined according to Federal Acquisition Regulations 48 CFR § 31 or other accounting standard if the Contractor determines that the agreed allowable HOOH percentage is insufficient.
  - b. The Itemized Project FOOH Costs (IPFC) and FOOH shall be subject to field verification and VRE audit, at any time, as determined by VRE, if VRE determines that the rate the Contractor submits is not an accurate representation of the Contractor's actual FOOH at the time of occurrence of the delay. If VRE determines the daily FOOH rate is not an accurate representation of the Contractor's actual FOOH, the Contractor shall submit its actual project FOOH records at the time of occurrence of the delay, as requested by VRE. VRE may perform an audit of the Contractor's records as necessary to verify the Contractor's actual project FOOH. Adjustments to the daily FOOH rate may be made upon verification or VRE audit of the Contractor's actual project FOOH. The project daily FOOH rate will then be calculated utilizing the rate determined by the audit. VRE may also elect to perform an audit of the Contractor's actual project FOOH at the completion of the Contract, as determined by VRE, in which case the project FOOH paid previously by change order may be adjusted based on the rate determined by the audit.
  - c. The Contractor's actual extended FOOH are defined to be those costs and expenses incurred from the original Contract time limit to the actual final acceptance of the project as documented by timesheets, payroll records, accounting records, contracts, invoices, bills, receipts, tickets, cancelled checks, and similar business records showing the costs and expenses actually incurred for the project field supervision and administrative staff, project field office, and overhead items submitted in accordance with this provision; and the records must be accurate and auditable.
  - d. If the total sum of the extended project FOOH and unabsorbed or extended HOOH for all approved change orders exceeds 20 percent of the original Contract amount, VRE may at its option calculate the amount of FOOH and HOOH based on a VRE audit of the Contractor's actual project FOOH and HOOH records. In such event, VRE will perform the audit according to Section 103.08 at VRE's expense. The VRE audit may begin on 10-days notice to the Contractor, its subcontractors, and suppliers. The Contractor, subcontractors, and suppliers shall make a good faith effort to cooperate with the auditors.

#### **1.10 DIFFERING SITE CONDITIONS**



- A. VRE recognizes two types of Differing Site Conditions as defined below. Contractor is responsible for identifying the presumed type of differing site conditions when submitting a request for change. The type of differing site conditions shall be confirmed by the CM.

1. Type I

During the progress of the Work, if subsurface or latent physical conditions differing materially from those indicated in the Contract are encountered at the site, the Contractor shall promptly notify VRE in writing of the specific differing conditions before the site is disturbed further and before the affected work is performed.

2. Type II

During the progress of the Work, if unknown physical conditions of an unusual nature, differing materially from those ordinarily encountered and generally recognized as inherent in the work provided for in the Contract, are encountered at the site the Contractor shall promptly notify VRE in writing of the specific differing conditions before the site is disturbed further and before the affected work is performed.

- B. Upon receipt of such written notification, VRE will acknowledge receipt and investigate the conditions. If it is determined by VRE that the conditions materially differ and cause an increase or decrease in the cost or time required for the performance of any work under the Contract, an equitable adjustment, excluding anticipated profits, will be made and the Contract may be modified in writing accordingly. VRE will notify the Contractor of the determination whether or not an equitable adjustment of the Contract is warranted.

No equitable adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

**1.11 PAYMENT FOR CONTRACT AMENDMENT WORK**

- A. Revise Schedule of Values and Application for Payment forms to record each executed Contract Amendment as a separate category. Further define line items within each Contract Amendment category exactly as defined in the executed Contract Amendment and adjust the Contract Sum as shown on the Contract Amendment. Submit the revised Schedule of Values and related forms with the next Application for Payment following execution of the Contract Amendment.
- B. Revise progress schedules to reflect any change in Contract time, revise sub-schedules to adjust time for other items of work affected by the change. Submit the revised schedules on the next previously agreed upon submittal date following execution of the Contract Amendment.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 29 00****Payment Procedures****PART 1 - GENERAL****1.01 SUMMARY**

The Section includes administrative and procedural requirements necessary to prepare and process Applications for Payment. Sub-sections include:

- A. Submittal Procedures
- B. Preparation of Application for Payment
- C. Supporting Documentation
- D. Payment for Mobilization
- E. Payment for Stored Materials
- F. Certified Payroll Records
- G. Application for Payment at Substantial Completion
- H. Final Application for Payment

**1.02 RELATED SECTIONS**

- A. General Provisions
- B. Special Provisions
- C. Section 01 22 00- Unit Prices
- D. Section 01 32 00- Construction Progress Documentation
- E. Section 01 77 00 – Closeout Procedures

**1.03 DEFINITIONS**

- A. **Schedule of Values:** A statement furnished by the Contractor allocating portions of the Contract Price to various portions of the Work and once accepted, to be used as the basis for reviewing the Contractor's Applications for Payment. In the event of a Unit Price Contract, the Schedule of Values shall contain pay items exactly as described in section 1.04 below.

**1.04 SUBMITTALS****A. Coordination**

- 1. Coordinate preparation of the Schedule of Values with preparation of the Contractor's Construction Schedule.

**B. Schedule of Values**

- 1. Submit draft Schedule of Values to the Construction Manager for review and approval within 7 days following Notice to Proceed. The Schedule of Values shall be organized to the satisfaction of VRE so that line items contain specific areas of work based on physical

location and what can be visually verified by the Contractor and the CM. Acceptance of the Schedule of Values shall not forfeit VRE's right to require substantiating data to verify the value of work delivered prior to processing payments.

2. Submit final approved Schedule of Values prior to submittal of first progress payment.
3. Provide a breakdown of the Contract Price in enough detail to facilitate continued evaluation of Applications for Payment and progress reports. Provide line items for principal subcontract amounts, where applicable. The value assigned to the total of the following line items, if applicable, shall be five percent (5%) of the Contract Price:
  - a. Testing and Commissioning Activities
  - b. Operation and Maintenance Manuals
  - c. Punch List Activities
  - d. Project Record Documents
  - e. Bonds and Warranties
  - f. Demonstration and Training
4. Round amounts to the nearest whole dollar. Total shall equal the Contract Price.
5. Provide separate line items in the Schedule of Values for initial cost of materials, for each subsequent stage of completion and for total installed value of that part of the Work.
6. Each item in the Schedule of Values and Application for Payment shall be complete. Include total cost and proportionate share of general overhead and profit for each item.
7. VRE may elect to provide the Contractor with a Schedule of Values format based on the proposed construction and / or Pay Items, detailing the breakdown of payment for Work desired by VRE. If provided, the Contractor shall utilize the VRE format and fill in the cost for each line item. The draft with the costs included shall be returned to the CM for approval prior to the first monthly Application for Payment.
8. In the event of a Unit Price Contract, the Schedule of Values shall contain, at a minimum, all pay items exactly as shown on the Contractor's accepted bid sheet, part of the Agreement with VRE. Schedule of values shall incorporate the items 1-7 listed above.

#### **C. Schedule Updating**

Update and resubmit the Schedule of Values with the next Application for Payment when Contract Modifications result in a change in the Contract Price.

### **1.05 PREPARATION OF APPLICATION FOR PAYMENT**

- A. Each Application for Payment shall be consistent with previous applications and payments as paid by VRE.
- B. Format shall be AIA G702 (Application and Certificate for Payment) & AIA G703 (Continuation Sheet). The Schedule of Values shall be identical to the approved draft Schedule of Values.

- C. The payment period shall be based on the calendar month, starts on the day following the end of the preceding period and shall not exceed one calendar month, unless otherwise approved by the CM. Application for Payment shall coincide with CPM schedule monthly update or as otherwise indicated in the Agreement with VRE and the Contractor. Maintain payment schedule throughout duration of project.
- D. Five percent (5%) of monthly progress payments will be held as retainage by VRE.
- E. Application for Payment shall match data on the Schedule of Values and Contractor's Construction Schedule. Use updated schedules if revisions were made.
- F. List each authorized Contract Amendment as an extension on the continuation sheet, listing the Contract Amendment number, a brief description, and the dollar amount as for an original item of Work. Break down Contract Amendment totals into separate line items as they are shown in the Contract Amendment to track separate work activities. Only include amounts of Contract Amendments issued before the last day of the construction period covered by the application.
- G. Each month, the Contractor shall prepare a draft Application for Payment and submit electronically to the CM for preliminary approval. The Contractor is not required to have draft version signed or notarized, but it must contain all supporting documentation. The draft Application for Payment will be returned and not reviewed by the CM if it is not accompanied by all required supporting documentation, which may result in delay of payment.
- H. The draft Application for Payment shall include a transmittal or cover letter, listing all documents attached to the Application submitted for preliminary approval by the CM.
- I. Submit the draft Application for Payment to the CM no later than the 10<sup>th</sup> calendar day of the following month.
- J. Preliminary approval by the CM does not guarantee approval for payment by VRE.
- K. Once preliminary approval is provided by the CM, the Contractor shall prepare the signed and notarized Application for Payment, including attachments such as release of liens or affidavit of payments, as required by VRE. The Application must be executed by notarized signature of the Contractor's authorized officer. Application for Payment with original signatures and attachments shall be submitted directly to the VRE Project Manager (PM) for final review, approval, and payment. One (1) electronic copy (.pdf format) of the Application for Payment with signatures and attachments shall be submitted to the CM for record.

#### **1.06 SUPPORTING DOCUMENTATION**

The following supporting documentation must be included with each Application for Payment or submitted separately prior to the Application for Payment:

1. Monthly CPM Schedule Update
2. Certified Payroll Records
3. Contractor Daily Construction Reports
4. Contractor Monthly Construction Reports
5. Monthly Safety Report (can be combined with item 4 above)

6. Monthly Construction Photographs
7. Delivery Tickets for Permanent Materials
8. Inventory Statement and evidence of payment for on-site Stored Materials, if such reimbursement is being requested
9. Subcontractor Payment Form
10. Update of Construction Progress Documentation listed in other sections of Division 1 (i.e. 01 32 00, 01 35 23)
11. Other Contract deliverables to be submitted on a monthly basis, as requested by the CM or VRE

#### **1.07 PAYMENT FOR MOBILIZATION**

- A. Mobilization consists of performing preliminary operations, including moving personnel and equipment to the project site; paying bonds and insurance premiums; and establishing the Contractor's offices, buildings, and other facilities necessary to allow work to begin on a substantial phase of the Contract.
- B. Mobilization will be paid for at the contract lump sum price for this pay item. This price shall include demobilization.
- C. Payment for mobilization will be made in two separate installments. The first installment of 50 percent of the contract lump sum price pay item will be made on the first monthly Application for Payment following partial mobilization and initiation of construction work. The second installment will be made on the next monthly Application for Payment following completion of substantial mobilization, including erection of the Contractor's offices and buildings. Completion of erection of processing plants, if any, will not be required as a condition for the release of the second installment.
  1. The value assigned to Mobilization shall be as follows:
 

a. \$0 - \$200,000	10% of Total Contract Amount
b. \$200,000 - \$1,000,000	\$20,000 plus 7.5% (of total contract amount minus \$200,000)
c. Greater than \$1,000,000	\$80,000 plus 5% (of Total Contract Amount minus \$1,000,000)
- D. No additional payment will be made for demobilization and remobilization because of shutdowns, suspensions of work, or other mobilization activities.
- E. The Contractor may not submit their first monthly Application for Payment until the end of the first calendar month after receiving Notice to Proceed from VRE and mobilized to the project.

#### **1.08 PAYMENT FOR STORED MATERIALS**

- A. When requested in writing by the Contractor, partial payment allowances may be made for materials secured for use on the project and required to complete the project. Such material payments will be made for only those actual quantities of materials identified in the Contract,

Drawings, Specifications, executed Contract Amendments, or otherwise authorized and documented by the CM based on delivery tickets, bills of lading, or paid invoices. Materials shall be delivered to acceptable sites where the work is being performed or at other sites in the vicinity that are acceptable to VRE.

Such delivered costs of stored or stockpiled materials may be included in the next payment application after the following conditions are met:

1. CM accepts the manner in which the material has been stored at or on an approved site.
2. Contractor provides the CM with acceptable evidence of quantity and quality of the materials.
3. Contractor provides the CM with acceptable evidence that the material and transportation costs have been paid.
4. Contractor provides VRE legal title, free of lines or encumbrances of any kind, to the material so store and stockpiled.
5. Contractor provides VRE evidence that the material so stored or stockpiled is insured or bonded against loss by damage to or disappearance of such materials at any time before use in Work.
6. Contractor provides VRE with manufacturer's installation and maintenance information.

Such payments will only be made for materials scheduled for incorporation into the work within ninety (90) days.

- B. It is understood and agreed that the transfer of title and VRE's payment for such stored or stockpiled materials shall in no way relieve the Contractor of responsibilities for furnishing and placing such materials according to the requirements of the Contract Documents.
- C. In no case will the amount of payments of materials on hand exceed the Contract price for the materials or the Contract price for the Contract item in which the material is intended to be used.
- D. Contractor bears all costs associated with the payment for stored or stockpiled materials according to this Section.

Additionally, all payments shall be in accordance with the following terms and conditions:

**E. Structural Steel or Reinforcing Steel**

An allowance of 100 percent of the cost to the Contractor for structural steel or reinforcing steel materials secured for fabrication not to exceed 60 percent of the Contract price may be made when such material is delivered to the fabricator and has been adequately identified for exclusive use on the project. The provisions of this section for steel reinforcement will only apply where the quantity of steel reinforcement is identified as a separate and distinct bid item for payment.

An allowance of 100 percent of the cost to the Contractor for structural steel and reinforcing steel, not to exceed 90 percent of the Contract price, may be made when fabrication is

complete. Prior to the granting of such allowances, the materials and fabricated units shall have been tested or certified and found acceptable to the CM and shall have been stored in accordance with the requirements specified herein. Allowances will be based on invoices, bills, or the estimated value as approved by the CM and will be subject to the retainage requirements noted in Subsection 1.05.D above. For the purposes of this section, fabrication is defined as any manufacturing process such as bending, forming, welding, cutting, or coating with paint or anti-corrosive materials which alters, converts, or changes raw material for its use in the permanent finished work.

#### **F. Other Materials**

For aggregate, pipe, guardrail, signs, sign assemblies, and other nonperishable material, an allowance of 100 percent of the cost to the Contractor for materials, not to exceed 90 percent of the Contract price, may be made when such material is delivered to the project and stockpiled or stored in accordance with the requirements specified herein. Prior to the granting of such allowances, the material shall have been tested and found acceptable to the CM. Allowances will be based on invoices, bills, or the estimated value of the material as approved by the CM and will be subject to the retainage requirements noted in Subsection 1.05.D above.

#### **G. Excluded Items**

No allowance will be made for fuels, form lumber, falsework, temporary structures, or other work that will not become an integral part of the finished construction. Additionally, no allowance will be made for perishable material such as cement, seed, plants, or fertilizer.

#### **H. Storage**

Contractor shall deliver, store and handle materials using means and methods that will prevent damage, deterioration, theft and other losses. Material for which payment allowance is requested shall be stored in an approved manner in areas where damage is not likely to occur. VRE accepts no responsibility for materials stored on or off site.

If any of the stored materials are lost or become damaged, the Contractor shall repair or replace them at no additional cost to VRE. This damage can be, but not limited to, weather, oxidization, mold, mildew, warping and rust. Repair or replacement of such material will not be considered the basis for any extension of Contract time. If payment allowance has been made prior to such damage or loss, the amount so allowed or a proportionate part thereof will be deducted from the next monthly Application for Payment and withheld until satisfactory repair or replacement has been made.

When it is determined to be impractical to store materials within the limits of the project, the CM may approve storage on private property or, for structural units and reinforcing steel, on the manufacturer's or fabricator's yard. Contractor shall provide photographs of materials stored off site. Requests for payment allowance for such stored material shall be accompanied by a release from the owner or tenant of such property or yard agreeing to permit the removal of the materials from the property without cost to VRE. VRE must be allowed access to the materials for inspection during normal business hours.



**I. Materials Inventory**

If the Contractor requests a payment allowance for properly stored material, they shall submit an itemized inventory statement to the CM along with the monthly Application for Payment. The statement shall be accompanied by supplier's or manufacturer's invoices or other documents that will verify the material's cost. The statement shall also include photos of the material in its stored location, marked with the Contractor's name and the project name.

With each subsequent monthly Application for Payment, the Contractor shall submit to the CM a monthly update of the itemized inventory statement. The updated inventory statement shall show additional materials received and stored with invoices or other documents and shall list materials removed from storage since the last certified inventory statement, with appropriate cost data reflecting the change in the inventory.

**1.09 CERTIFIED PAYROLL RECORDS**

- A. If this project is identified to be funded in whole or in part by federal grants, the Contractor is required to comply with the Davis Bacon requirements as described in the Contract Documents.
- B. These certified payroll records shall be submitted weekly to the Construction Manager for record. It is the responsibility of the Contractor and Subcontractors to submit electronic (.pdf format) certified payroll records directly to the CM no later than one week following the end of each pay period.
- C. Incorrect or incomplete certified payroll records may delay processing of the monthly Application for Payment.

**1.10 APPLICATION FOR PAYMENT AT SUBSTANTIAL COMPLETION**

- A. After issuance of the Certificate of Substantial Completion, Contractor may submit an Application for Payment showing 100 percent completion for portion of the Work claimed as substantially complete.
  - 1. Include documentation supporting claim that the Work is substantially complete and statement showing an accounting of changes to the Contract Price.
  - 2. This application shall reflect any Certificates of Partial Substantial Completion that may have been issued previously by VRE.
- B. A list of required Contract substantial completion submittals can be found in Section 01 77 00, "Closeout Procedures."

**1.11 FINAL APPLICATION FOR PAYMENT**

- A. The Final Application for Payment shall be submitted in the same format as monthly Applications for Payment, as described in Subsection 1.05 above.

- B. Prior to submitting the Final Application for Payment, the Contractor must have provided all required Contract closeout submittals to the CM along with the signed VRE Contract Closeout Checklist. Checklist will be provided to the Contractor by the CM upon request.
- C. A list of required Contract closeout submittals can be found in Section 01 77 00, "Closeout Procedures."
- D. Other items which must be complete prior to final payment and release of retainage shall include, but not be limited to the following:
  - 1. Project Punch List complete and accepted by the CM
  - 2. Demobilization and removal of temporary facilities
  - 3. Final cleaning
  - 4. Commissioning of new systems, as required
  - 5. Training and demonstration of new systems, as required
  - 6. Insurance certificates for products and completed operations where required and proof that taxes, fees and similar obligations were paid.
  - 7. Resolution and execution of final Contract Amendment, if necessary
- E. Contractor must complete all punch list items to the satisfaction of the CM and VRE before Final Completion. Retainage will be withheld until punch list is completed and all submittals have been received and approved. Failure to complete the punch list work within 60 calendar days of issuance, may result in VRE ordering the work to be completed by others at the cost to Contractor and deducting the value of such from retainage withheld.
- F. Release of retainage will be allowed once all Contract closeout submittals are received and accepted by VRE.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 31 00****Project Management and Coordination****PART 1 - GENERAL****1.01 SUMMARY**

Section includes administrative provisions for coordinating construction operations on Project including, but not limited to, the following:

- A. Submittals
- B. Project Management Information System (PMIS)
- C. Authority of VRE Field Representatives
- D. General Coordination Procedures
- E. Requests for Information (RFIs)
- F. Project Meetings

**1.02 RELATED SECTIONS**

- A. General Conditions for Construction
- B. Section 01 26 00 – Change Order Procedures
- C. Section 01 32 00 – Construction Progress Documentation
- D. Section 01 33 00 – Submittal Procedures
- E. Section 01 35 23 – Safety and Security Requirements
- F. Section 01 45 00 – Quality Assurance and Quality Control
- G. Section 01 73 00 – Execution of Work
- H. Section 01 77 00- Project Closeout

**1.03 SUBMITTALS**

- A. Coordination Drawings

Before start of the Work, prepare Coordination Drawings, as needed and directed by the CM, for areas with limited space availability that necessitates maximum utilization of space for efficient installation of different components and areas requiring coordination for installation of products and materials fabricated by separate entities.

1. Indicate relationship of components shown on separate Shop Drawings
2. Indicate all dimensions provided on Contract Drawings and make specific note of dimensions that appear to be in conflict with submitted equipment, minimum clearance requirements, amounts of equipment and material to be installed, or other requirements. Provide alternate sketches for resolution of such conflicts to CM for review.

3. Indicate required installation sequences.
4. Comply with requirements contained in Division 01 Section 01 33 00 "Submittals"
5. Prepare coordination drawings of involved trades in a scale of not less than 1/4 inch = 1 foot or larger for integration of different construction elements. Show sequence and relationships of separate components to avoid conflicts in use of space. Any Work installed prior to review of coordination drawings will be at the Contractor's risk and subsequent relocation required to avoid interference shall be made at no additional cost to VRE.

**B. Subcontract List**

The Contractor shall prepare a written summary identifying individuals or firms proposed for each portion of the Work, including those who are to furnish products or equipment fabricated to a special design. Include the following information in tabular form:

1. Name, address, and telephone number of entities performing subcontract or supplying products
2. Description of Work to be performed

All subcontractors are subject to approval by the CM and VRE prior to such subcontractors performing any Work on the project. If subcontractors need to be added to the list as the project progresses, a revised list shall be submitted to the CM for approval, noting changes or additions.

Rejection of a subcontractor by the CM or VRE does not constitute grounds for additional monetary compensation to the Contractor.

**C. Key Personnel Names**

No later than 14 calendar days prior to the scheduled date of the Preconstruction Conference, the Contractor shall submit a list of key personnel assignments. Key personnel shall include but not necessarily be limited to Project Manager, Project Superintendent, Safety Manager (if applicable) and Quality Control Manager (if applicable). Identify individuals and their duties and responsibilities. For each person, list office address and telephone number, if applicable, mobile telephone number, and e-mail address. Provide names, and telephone numbers of individuals assigned as alternates in the absence of individuals assigned to Project.

Key personnel are subject to approval by VRE.

**1.04 PROJECT MANAGEMENT INFORMATION SYSTEM**

- A. A Project Management Information System (PMIS) or Project Controls System is a generic term for a proprietary file management collaborative system intended for internet-connected device use. The intent of this application is to enable dispersed users access to shared documents for storage, organization, retrieval, editing, tracking, reporting, or other functions, with such access usually controlled by invitation and security protocols. More than one such application type or specific programs may be used, depending on VRE preferences.

VRE currently employs a well-known PMIS known as eBuilder as their Project Controls system and will not accept any requests for substitution for this program. The Contractor will be required to utilize eBuilder for all project correspondence and coordination, including

submittals, invoices and other functions as directed by VRE. Use of the E-builder Project Management System will not replace or change any contractual responsibilities of the Contractor. The system has been implemented to enhance and expedite team communication.

**B. Contractor Responsibilities**

1. The Contractor shall provide, at the Contractor's Temporary Site Office, and home office if required, the computer hardware and software to provide access to the E-builder Project Management System.

**C. VRE Responsibilities**

1. VRE has established the project document management database for this project. VRE will provide management, license(s), training, etc. of the database and interface with the system provider.
2. Any required technical support regarding E-builder shall be directed to the VRE Project Manager.

**D. Project Correspondence**

1. All Contractor Project correspondence shall be either created electronically or digitized so that it can be issued, administered, stored and tracked by the E-builder Project Management System.
2. The Contractor shall use the VRE provided web-based E-builder Project Management System to transmit, at a minimum, each of the following to the VRE Project Manager:
  - a. Requests for Information (RFI's) and attachments
  - b. Submittals
  - c. Requests for Changes
  - d. Change Orders
  - e. Invoice Approval (Payment Applications)

Responses of the VRE Project Manager's review and action, of the above documents, shall be transmitted to the Contractor through E-builder.

**1.05 AUTHORITY OF VRE FIELD REPRESENTATIVES**

**A. Construction Manager**

1. During prosecution of the Work, the CM will answer all questions that may arise as to the quantity, quality, and acceptability of materials furnished and work performed; rate of progress of the Work; interpretation of the plans and Specifications; the Contractor's acceptable fulfillment of the Contract; disputes and mutual rights between contractors; and the Contractor's compensation.
2. The CM has the authority to suspend the Work wholly or in part if the Contractor has created conditions that are unsafe or fails to correct conditions that are unsafe for workers or the general public or fails to carry out the provisions of the Contract. The CM may also suspend the Work for such periods as they may deem necessary because of catastrophic or

extraordinary weather as defined in Section 01 26 00, "Change Order Procedures," conditions considered unsuitable for prosecution of the Work, or any other condition or reason deemed to be in the public interest.

3. The CM may issue written clarifications or field directives that enhance or clarify the intent of the plans and/or specifications. The CM may offer guidance or issue written orders for such work as may be necessary to complete the Contract satisfactorily.
4. If guidance or directives, noted above, by the CM, result in a change to the Contract, VRE will provide written concurrence with the CM for Contract Changes. VRE concurrence must be provided prior to the Contractor performing any Work not in accordance with the Contract Documents.

**B. Inspector**

1. Inspectors representing VRE and/or the CM are authorized to inspect all work performed and materials furnished. Inspection may extend to all or any part of the Work and to the preparation, fabrication, and manufacture of the materials to be used. The Inspectors are not authorized to alter or waive the provisions of these Specifications or make changes in the plans.
2. The Inspectors are not authorized to make final acceptance of the project, approve any operation or item, or act as foreman for the Contractor. However, the Inspectors will have the authority to reject defective work and material and suspend work that is being improperly performed, subject to the concurrence of the CM. Such inspections shall not relieve the Contractor of any obligation to furnish acceptable materials or provide completed construction that is in accordance with the Contracts requirements.
3. The Inspector will exercise only such additional authority as the CM may delegate.

**1.06 GENERAL COORDINATION PROCEDURES**

- A. Coordinate construction operations included in different Sections of the Specifications to ensure efficient and orderly installation of each part of the Work. Coordinate construction operations, included in different Sections that depend on each other for proper installation, connection, and operation.
- B. Schedule construction operations in sequence required to obtain the best results where installation of one part of the Work depends on installation of other components, before or after its own installation.
- C. Coordinate installation of different components to ensure maximum performance and accessibility for required maintenance, service, and repair.
- D. Make adequate provisions to accommodate items scheduled for later installation.
- E. Administrative Procedures

Coordinate scheduling and timing of required administrative procedures with other construction activities to avoid conflicts and to ensure orderly progress of the Work. Such administrative activities include, but are not limited to, the following:

1. Preparation of Contractor's construction schedule
  2. Preparation of the schedule of values
  3. Installation and removal of temporary facilities and controls
  4. Delivery and processing of submittals
  5. Progress meetings
  6. Pre-activity meetings
  7. Project closeout activities
  8. Startup, adjustment and final acceptance of systems
- F. Conservation
- Coordinate construction activities to ensure that operations are carried out with consideration given to conservation of energy, water, and materials. Coordinate use of temporary utilities to minimize waste. Salvage materials and equipment involved in performance of, but not actually incorporated into, the Work. See other Sections for disposition of salvaged materials that are designated as Owner's property.

#### **1.07 REQUESTS FOR INFORMATION**

- A. Immediately on discovery of the need for additional information or interpretation of the Contract Documents, Contractor shall prepare and submit an RFI electronically to the CM, either utilizing a PMIS if directed by VRE, or via email if a PMIS is not being utilized by VRE on the project.
- B. The CM will not accept RFIs submitted by other entities controlled by Contractor (subcontractors, suppliers, etc.). Subcontractor's RFI's shall first be reviewed by the Contractor prior to submission to the CM. All RFIs must be routed through the Contractor to the CM for proper documentation.
- C. The Contractor shall coordinate and submit RFIs in a prompt manner so as to avoid delays in Contractor's work or work of Subcontractors.
- D. The CM will not receive or review RFIs submitted via fax or verbal requests.
- E. Preparation of RFI
  1. Submit one (1) electronic (.pdf) version of the RFI to the CM for review and response.
  2. Include a detailed, legible description of the item needing information or interpretation and the following:
    - a. Contract/Project name
    - b. Contract/Project number
    - c. Date
    - d. Name of Contractor
    - e. RFI number, numbered sequentially

- f. RFI subject
- g. Specification Section number and title and related paragraphs, as appropriate
- h. Drawing number and detail references, as appropriate
- i. Field dimensions and conditions, as appropriate
- j. Contractor's suggested resolution. If Contractor's suggested resolution impacts the Contract Time or the Contract Sum, Contractor shall state impact in the RFI.
- k. Contractor's signature
- l. Attachments: Include sketches, descriptions, measurements, photos, Product Data, Shop Drawings, coordination drawings, and other information necessary to fully describe items needing interpretation.
  - i. Supplementary drawings/sketches prepared by the Contractor shall include dimensions, thicknesses, structural grid references, and details of affected materials, assemblies, and attachments on attached sketches.

F. Construction Manager Review and Response

The CM will review each RFI, with the Engineer of Record, determine action required, and respond. Allow seven (7) calendar days for the CM's response to each RFI. RFIs received by the CM after 5:00 p.m. will be considered as received the following business day.

1. The following Contractor-generated RFIs will be returned without action:
  - a. Requests for approval of submittals
  - b. Requests for approval of substitutions
  - c. Requests for approval of Contractor's means and methods
  - d. Requests for coordination information already indicated in the Contract Documents
  - e. Requests for adjustments in the Contract Time or the Contract Sum
  - f. Requests for interpretation of the Engineer's actions on submittals
  - g. Incomplete RFIs or inaccurately prepared RFIs
2. The CM's response may include a request for additional information, in which case the CM's time for response will date from time of receipt of additional information.
3. The CM's response on RFIs that may result in a change to the Contract Time or the Contract Sum may be eligible for the Contractor to submit a PCO according to Section 012600 "Change Order Procedures."
4. Upon receipt of the CM's response, the Contractor shall review the response and notify the CM within seven (7) calendar days if the Contractor disagrees with the response.
5. VRE's response to an RFI, does not constitute a change in the Contract.



6. If the Contractor thinks the RFI response warrants a change notify the CM, in writing, within 10 days of receipt of the RFI response.
7. Upon receipt of the CM's action, update the RFI log and immediately distribute the RFI response to affected parties.

G. RFI Log

A Project RFI Log will be maintained by the CM and distributed for review at regular Project Progress Meetings. The Contractor shall maintain an identical RFI Log utilized in assigning numbers to new RFIs and managing RFIs in review or in preparation. The following information will be included in the RFI Log:

1. Project name
2. Name of Contractor
3. RFI number including RFIs that were returned without action or withdrawn
4. RFI description
5. Date the RFI was submitted
6. Date Construction Manager's response was received
7. Status of RFI (In Review, Closed, etc.)
8. Identification of related Field Work, Work Change Directive and Proposal Request, as appropriate.

**1.08 PROJECT MEETINGS**

A. General Information for All Meetings

1. The Construction Manager will schedule and conduct meetings and conferences at Project Field Office unless otherwise indicated.
2. A safety briefing must be conducted prior to beginning all meetings.
3. The CM shall inform participants and others involved, and individuals whose presence is required, of date and time of each meeting.
4. The CM shall prepare the meeting agenda and distribute the agenda to all invited attendees, in advance of the meeting as necessary.
5. The CM shall be responsible for conducting the meeting and will record significant discussions and agreements achieved. The CM shall distribute the meeting minutes to everyone concerned within three business days of the meeting.

B. Preconstruction Conference

1. Within twenty-one (21) calendar days after award of a contract or after notification of award, issued by the Purchasing Department, and prior to the Notice to Proceed date, the Contractor shall attend a preconstruction conference scheduled by VRE to discuss the Contractor's planned operations for prosecuting and completing the Work in accordance

with the Contract. The meeting will review the parties' responsibilities and personnel assignments.

2. Submittals to be provided to the CM no later than seven (7) calendar days prior to the preconstruction conference include, but are not limited to, the following:
  - a. Preliminary Construction Schedule (see Section 01 32 00, "Construction Progress Documentation," for detailed submittal requirements)
  - b. Contractor's Safety Plan (see Section 01 35 23, "Safety and Security Requirements," for detailed submittal requirements)
  - c. Contractor's Quality Management Plan (see Section 01 45 00, "Quality Assurance and Quality Control," for detailed submittal requirements)
  - d. Coordination Drawings (see section 1.03A above)
  - e. Work Plan (see Section 01 32 00, "Construction Progress Documentation," for detailed submittal requirements)
3. The Contractor, the CM, and VRE shall be prepared to discuss key issues and project specific requirements necessary for preparation and submittal of the Baseline Schedule.
4. The CM will be responsible for setting the conference agenda, conducting discussions, and ensuring that minutes of the conference are taken and later distributed to all attendees. The conference agenda may include, but not be limited to:
  - a. Safety and security briefing
  - b. Designation of responsible personnel representing VRE, the CM, Contractor, and others, as appropriate
  - c. Coordination with Host Railroad Operations
  - d. Review of critical work sequencing and draft project schedule prepared by the Contractor
  - e. Designation of key personnel
  - f. Discussion of Construction Schedule, starting, ending and Milestone dates, damages, and bonus & penalty provisions, if any
  - g. Project coordination
  - h. Use of premises
    - i. VRE's requirements regarding ongoing operations
    - ii. Office and storage areas
    - iii. Temporary facilities and controls
    - iv. Temporary utilities
    - v. Contractor's Work area
    - vi. Contractors access and parking

- vii. Work days and Work hours
- viii. Permits
- ix. Right of Entry by Railroad, if any
- i. Procedures for:
  - i. Submittals
  - ii. Substitutions and “or equal” Products
  - iii. Maintaining record documents
  - iv. Applications for payment
  - v. Field Orders, Work Change Directives, Change Orders and Contract Amendments
  - vi. Partial Utilization
  - vii. Emergencies
  - viii. Housekeeping
  - ix. Safety and Security
  - x. Testing and prior notification
  - xi. Identify point of contact
- 5. Attendance: Listed below are invited attendees. Contractor’s required attendees are noted.
  - a. VRE
  - b. Construction Manager
  - c. Contractor Project Manager (required)
  - d. Contractor Superintendent (required)
  - e. Contractor’s Safety Representative (required)
  - f. Major Subcontractors and Suppliers (required)
  - g. Host Railroad representative, as required
  - h. Jurisdictional representative, as required
  - i. Funding partner representatives
  - j. Other major stakeholders, including utilities and impacted adjacent property owners, along with other interested parties as selected by VRE or the CM

C. Project Progress Meetings

- 1. Project Progress Meetings will be scheduled regularly throughout the duration of the project, or as directed otherwise by VRE. At a minimum, progress meetings shall be held monthly. Progress meetings are in addition to specific meetings held for other purposes, such as coordination and special pre-activity meetings. Additionally, discussion will

address administrative and technical issues of concern, determining resolutions, and development of deadlines for resolution within allowable time frames.

2. Attendance required:
  - a. VRE
  - b. Construction Manager
  - c. Contractor Project Manager
  - d. Contractor Superintendent
  - e. Subcontractors as pertinent to agenda
  - f. Suppliers and/or manufacturers' representative as pertinent to agenda
3. Agenda:
  - a. Safety briefing
  - b. Review and approval of minutes of previous meetings
  - c. Review safety and security
  - d. Review work progress and planned work
  - e. Discuss field observations, potential conflicts and decisions
  - f. Identification of problems which impede planned progress
  - g. Review of submittals schedule and status of submittals
  - h. Review of off-site fabrication and delivery schedules
  - i. Two Week Look-Ahead Schedule
  - j. Coordination of projected progress
  - k. Status of proposed changes and any effect on progress schedule and coordination
  - l. Other business relating to work
4. Minutes will be prepared by the CM and distributed to attendees. Should any attendee disagree with the contents of the minutes as prepared, they shall identify the information they feel is inaccurate and forward it, with corrections, to the author of the minutes, within seven (7) calendar days of receipt of the minutes.
5. The Project Progress Meetings will be held at the Project Field Office, unless otherwise directed by the CM or VRE.
6. Contractor's Construction Schedule: Review progress since last meeting. Determine whether each activity is on time, ahead of schedule, or behind schedule, in relation to Contractor's Construction Schedule. Determine how construction behind schedule will be expedited; secure commitments from parties involved to do so. Discuss whether schedule revisions are required to ensure that current and subsequent activities will be completed within the Contract Time.

7. Two-Week Look Ahead Schedule: Contractor shall submit at the progress meeting, or as requested by the CM, a two-week look-ahead schedule. This schedule shall include a three-week period, one week showing actual progress from the previous week and two weeks showing planned work for the two weeks after the meeting date. Include in the schedule all activities in sufficient detail as approved by the CM. A two-week look ahead schedule format will be discussed at the pre-construction schedule.
8. Schedule Update: Revise Contractor's Construction Schedule after each progress meetings where revisions to the schedule have been made or recognized. Issue revised schedule concurrently with the report of each meeting.

D. Pre-Activity Meetings

1. When required by individual specifications sections, or requested by the CM, the Contractor shall hold a pre-activity meeting at the site or field office prior to commencing work of the section. Work may or may not require coordination with other construction. Arrange sufficiently in advance to allow attendance by indicated parties.
2. Attendance:
  - a. VRE
  - b. Construction Manager
  - c. Contractors and subcontractors directly affecting or affected by the work of the section
  - d. Material suppliers and/or manufacturer's representatives as required by the individual section
3. Agenda: Review progress of other construction activities and preparations for the particular activity under considerations, including requirements for the following:
  - a. Contract Documents
  - b. Possible conflicts
  - c. Safety briefing
  - d. Review conditions of installation
  - e. Review preparation and installation procedures
  - f. Review coordination with related work
  - g. Where Coordination Drawings are required (See Section 1.03 above)
  - h. Time Schedules
4. Do not proceed with installation if the meeting cannot be successfully concluded. Initiate whatever actions are necessary to resolve impediments to performance of the Work and reconvene the meeting at the earliest feasible date.

E. Project Closeout Meeting:

1. Schedule and conduct a Project closeout conference, at a time convenient to Owner and Architect, but no later than 30 days prior to the scheduled date of Final Completion.

Conduct the meeting to review requirements and responsibilities related to Project closeout.

2. Attendance:
  - a. VRE
  - b. Construction Manager
  - c. Designer of Record
  - d. Contractor Project Manager
  - e. Contractor Superintendent
  - f. Contractors, subcontractors and suppliers directly affecting or affected by the work of the section
  - g. Participants at the meeting shall be familiar with the Project and authorized to conclude matter relating to the Work.
3. Agenda: Discuss items of significance that could affect or delay Project closeout, including but not limited to the following:
  - a. Closeout Checklist
  - b. Preparation of record documents
  - c. Procedures required prior to inspection for Substantial Completion and for final inspection for acceptance
  - d. Submittal of written warranties
  - e. Requirements for preparing sustainable design documentation
  - f. Requirements for preparation operations and maintenance data
  - g. Requirement for demonstration and training
  - h. Preparation of Contractor's punch list
  - i. Procedures for processing Application for Payment at Final Completion and final payment
  - j. Submittal procedures
  - k. Owner's partial occupancy requirements
  - l. Responsibility for removing temporary facilities and controls.

## **PART 2 - PRODUCTS**

Not Used

## **PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 32 00****Construction Progress Documentation****PART 1 - GENERAL****1.01 SUMMARY**

Section includes administrative and procedural requirements for documenting the progress of construction during performance of the Work, including but not limited to, the following:

- A. Construction Schedule
- B. Workplan (Narrative)
- C. Contractor Daily Reports
- D. Contractor Monthly Reports

All costs incurred by Contractor to correctly implement and update the schedule shall be borne by the Contractor and are part of this Contract.

**1.02 RELATED SECTIONS**

- A. Section 01 26 00 – Change Order Procedures
- B. Section 01 29 00 – Payment Procedures
- C. Section 01 33 00 – Submittal Procedures
- D. Section 01 35 23 – Safety and Security Requirements
- E. Section 01 77 00 – Closeout Procedures

**1.03 DEFINITIONS**

**Activity:** A discrete part of a project that can be identified for planning, scheduling, monitoring, and controlling the construction project. Activities included in a construction schedule consume time and resources. Each activity is assigned a unique description, activity number and activity code .

**Critical Activity:** An activity on the critical path that must start and finish on the planned early start and finish times.

**Predecessor Activity:** An activity that precedes another activity in the network.

**Successor Activity:** An activity that follows another activity in the network.

**Calendar Day:** Any day shown on the calendar, including Saturday and Sunday, beginning at 12:01 a.m. and ending at midnight.

**CPM:** Critical path method, which is a method of planning and scheduling a construction project where activities are arranged based on activity relationships. Network calculations determine when activities can be performed and the critical path of Project.

**Critical Path:** The longest connected chain of interdependent activities through the network schedule that establishes the minimum overall Project/Contract duration and contains no float.



**Critical Path Work:** Any work on the critical path. A delay to any critical path work is expected to delay completion of the project.

**Day:** A Calendar Day, unless specifically stated otherwise.

**Event:** The starting or ending point of an activity.

**Final Completion:** For the purpose of the Construction Schedule only, Final Completion shall be the date in which all Work at the site is complete, including punch list activities, final inspections, final cleaning, and demobilization.

**Float:** The measure of leeway in starting and completing an activity.

**Free Float:** The amount of time an activity can be delayed without adversely affecting the early start of the successor activity.

**Total Float:** The measure of leeway in starting or completing an activity without adversely affecting the planned Project completion date.

**Milestone:** An event or a date that marks the start or completion of a specified portion of the Work. If provided for in the Contract, milestones are used to specify when the Work or a specified portion thereof must be completed in accordance with the Contract Documents. The Contract may provide for one or more Completion milestones.

**Preliminary Schedule:** A CPM schedule covering all Contractor activities to be started and/or completed within the first 30 calendar days of the Project/Contract duration.

**Project/Contract Duration:** The total time, in calendar days identified in the Contract Documents, representing the duration necessary for completion of all physical and administrative requirements under this Contract and any authorized extension thereof.

**Record As-Built CPM Contract Schedule:** A Record Contract Schedule accurately reflecting actual progress of Work and is submitted as part of this Contract's Record Documents. All activities shall have actual dates that are true and accurate.

#### **1.04 PRELIMINARY CONSTRUCTION SCHEDULE**

- A. The Contractor shall submit a Preliminary Construction Schedule to the CM for information no later than seven (7) calendar days prior to the scheduled date of the Preconstruction Conference. Within 7 calendar days, the CM will respond with approval or direction to change and the Contractor shall resubmit within 7 calendar days, if required.
- B. The preliminary schedule shall be utilized by the CM and VRE to coordinate initial work until a Baseline CPM Construction Schedule is submitted and approved. The preliminary schedule shall include all activities planned for the first 30 calendar days following Notice to Proceed and the format shall be horizontal bar-chart style (Gantt) and demonstrate the anticipated critical path.
- C. One electronic file copy of the working schedule which can be opened in the construction scheduling software used to prepare the schedule. For example, a ".xer" file for Primavera P6 and ".mpp" file for Microsoft Project. VRE employs Microsoft Project and generally prefers

delivery in this format. The Contractor shall be prepared to discuss his planned operations relative to the Contract requirements at the Pre-Construction Conference.

- D. The preliminary schedule shall include, but not be limited to, the following:
  - 1. Mobilization
  - 2. Permitting
  - 3. Major construction activities
  - 4. Milestone events as required by the Contract Documents
- E. The Preliminary Construction Schedule is not required if the Baseline Construction Schedule is submitted for approval no later than seven (7) calendar days prior to the scheduled date of the Preconstruction Conference. It shall include the Contractor's work plan (narrative) for mobilization, procurement and completion within the Contract Duration. The work plan shall elaborate on the basis for durations, production rates, major equipment to be used and shall identify all major assumptions used to develop the preliminary schedule.

#### **1.05 WORK PLAN (NARRATIVE)**

- A. The Contractor shall prepare a work plan, as indicated in this document, to complete the Work within the Contract Duration and complete those portions of works related to each intermediate milestone date, if applicable, and other Contract requirements.
- B. The Work Plan shall, at a minimum, include: an explanation of the basis for the Contractor's determination of construction logic, estimated durations, hours per shift, workdays per week and types, numbers, capacities and placement of major construction equipment to be used, construction access, MOT for vehicles, pedestrians and trains, staging and laydown areas, parking for construction personnel, temporary field office location and security of these items. A listing of nonworking days and holidays incorporated into the schedule shall be provided.
- C. The Work Plan shall be reviewed and approved by the CM and Project Stakeholders, which may include Host Railroad, Utility Owners, Local Jurisdiction or Adjacent Property Owners.
- D. Specific work activities (such as crane and steel erection or heavy equipment/load placement) may require specific submittals and approval along with applicable pre-activity coordination.

#### **1.06 CPM CONSTRUCTION SCHEDULE, BASELINE**

- A. The Contractor shall submit the Baseline Construction Schedule to the CM for review and acceptance within seven (7) calendar days following Notice to Proceed. The Baseline Construction Schedule submittal shall be a computerized time-scaled CPM schedule in PDF format that includes the following:
  - 1. A transmittal letter to the CM listing the items, date, and number of copies of items being submitted.
  - 2. One printed legible color copy of the schedule according to Early Start of all activities. The schedule shall be printed on 11"x17" paper or larger as required to display the entire schedule for the entire construction period in a legible manner.

3. One electronic (.pdf) copy of a narrative (work plan) that presents the construction approaches and explains the schedule logic.
  4. One electronic (.pdf) copy of the schedule.
  5. One electronic file copy of the working schedule which can be opened in the construction scheduling software used to prepare the schedule. For example, a “.xer” file for Primavera P6 and “.mpp” file for Microsoft Project. VRE employs Microsoft Project and generally prefers delivery in this format.
- B. Each electronic file submittal shall have a unique file name indicating the Project name, submission type and number, and data date of the submission (e.g. ProjectName\_Baseline01\_2016.12.01.pdf).
- C. The Baseline Construction Schedule shall represent the Contractor’s overall work plan to accomplish the entire scope of work in accordance with the requirements of the Contract. The Baseline Schedule shall include all work including, as applicable, the work to be performed by sub-contractors, VRE, or others.
- D. The Baseline Schedule shall employ CPM using retained logic for the planning, scheduling, and reporting of the work to be performed under the Contract. The Critical Path shall be shown clearly on the schedule.
- E. Each construction activity shall be part of a logic diagram. The logic diagram shall show a documentable critical path. Each activity should have a predecessor and a successor with the exception of NTP and Final Completion.
- F. The construction schedule shall show a detailed order of construction activities based on predecessor and successor activities and shall be developed using Primavera P6 or Microsoft Project.
- G. When preparing the Baseline Schedule, the Contractor shall consider all known constraints and restrictions such as holidays, seasonal, weather, traffic, utility, railroad, right-of-way, environmental, permits, or other known or specified limitations to the work. Schedule shall include work performed by VRE or utility agencies and other third parties that may affect or be affected by Contractor’s activities.
- H. Extend schedule from date established for the Notice to Proceed to date of Final Completion.
- I. Contract completion date(s) shall not be changed by submission of a schedule that shows late completion date, unless specifically authorized by a Contract Amendment.
- J. Treat each Work element as a separate numbered activity. Grouping of activities is acceptable provided the items are closely related and will be constructed in conjunction with one another. Include the following as separate activities and milestones as shown:
1. Notice to Proceed (milestone)
  2. Mobilization
  3. Review Period for General Submittals
  4. Review Period for Major Material Submittals

5. Fabrication and Delivery of Major Materials
  6. Construction and Installation of Specific Work Items
  7. Work by Others that may affect Contractor Work
  8. Startup and Testing
  9. Commissioning
  10. Demonstration and Training
  11. Completion of Work Phases, as defined in the Contract
  12. Substantial Completion (milestone)
  13. Punch List
  14. Final Completion (milestone)
- K. Include a separate activity for each portion of the Work performed by VRE or Others. Dates and durations are to be inserted as directed by the CM or VRE.
- L. Each construction activity shall contain a start date, a finish date, and duration not in excess of fourteen (14) calendar days.
- M. The Baseline Schedule submittal shall include a written Workplan/Narrative to describe the Contractor's proposed general sequence to accomplish the work in terms of the major operations, routes, or segments of work as delineated in the Contract or in the absence of such delineations, as agreed to by the Contractor and VRE.
- N. Critical Path Activities
- The Contract CPM Schedule shall be prepared to include the data for the total Contract and the critical path activities shall be identified, including critical paths for interim completion dates. Scheduled start or completion dates imposed on the schedule by Contractor shall be consistent with Contract milestone dates. Milestone dates shall be the scheduled dates specified in the Contract Documents, if applicable, and shall be prominently identified. The Contract CPM Schedule shall accurately show all as-built activities completed from the issuance of the Notice to Proceed up to the submittal of this schedule.

#### **1.07 CPM CONSTRUCTION SCHEDULE, MONTHLY UPDATE**

- A. Following acceptance of the Baseline Construction Schedule by the CM, the Contractor shall submit the Monthly Update Construction Schedule every month to the CM for review and approval along with the Contractor's monthly Application for Payment. Approval of Contractor's monthly Application for Payment shall be contingent, among other factors, on the submittal of a satisfactory monthly schedule update. The Monthly Update Construction Schedule submittal shall include the following:
1. One printed legible color copy of the schedule according to Early Start of all activities. The schedule shall be printed on 11"x17" paper or larger as required to display the entire schedule for the entire construction period in a legible manner.
  2. One electronic (.pdf) copy of a Narrative (Work Plan)

3. One electronic (.pdf) copy of the schedule
  4. One electronic file copy of the working schedule which can be opened in the construction scheduling software used to prepare the schedule
- B. Each electronic file submittal shall have a unique file name indicating the Project name, submission type and number, and data date of the submission (e.g. ProjectName\_Update01\_2016.12.01.pdf).
- C. The Monthly Update Schedules shall be prepared in the same manner as the Baseline Schedule and shall reflect actual construction progress and activities. Monthly schedule updates shall be the product of joint review meetings, of a draft updated schedule, between the Contractor, CM and applicable active subcontractors. The joint review shall focus on actual progress for the preceding month, planned progress for the upcoming month supported a Contractor-prepared Two-Week Look-Ahead Schedule, impact to schedule if any due to change notices issued, adverse weather and any affect changes to the Construction CPM Schedule. The agreed-on progress, and changes, if any, shall be incorporated into the schedule update to be submitted. The update shall always represent the actual history of accomplishment of all activities and will form the basis for Contractor's Application for Payment.
- D. All requirements for the Baseline Schedule described above in this Specification section also apply to the Monthly Update Schedules.
- E. The Data Date for each Monthly Update Schedule shall be the first calendar day of every month.
- F. As the Work progresses, indicate completion percentage for each activity.
- G. The Monthly Update Schedule submittal shall include a written Narrative to:
1. List and describe schedule activities progressed during the previous calendar month
  2. List and describe schedule activities planned to be progressed during the upcoming calendar month
  3. Describe all changes to logic, durations, actual starts and finishes, and added or deleted activities
- H. Changes to schedule logic are subject to approval by the CM.
- I. Failure by the Contractor to include any element of work required for performance of the Contract shall not relieve the Contractor from completing all work within the Contract time. Such omission or error, when detected by the Contractor or the CM, shall be corrected prior to the next issue of the Monthly Update, without increasing the project's performance time.
- J. If critical activities of the schedule are delayed and such delay is not excusable as defined in this Section, the remaining sequence of activities and/or duration thereof shall be adjusted by Contractor through measures such as additional manpower, additional shifts or the implementation of concurrent operations until the schedule produced indicates Work will be completed on schedule. Except as provided elsewhere in the Contract, all costs incurred by Contractor to recover from inexcusable delays shall be borne by the Contractor.

- K. The monthly schedule update shall support the Contractor's Application for Payment. The progress payment for an activity shall be based on its agreed percentage of completion. On unit-priced contracts, the approval of Contractor's monthly requisition is contingent on the submittal of a satisfactory monthly schedule update; however, the basis of payment will be the actual measurement of CM-accepted, in-place units of work.

#### **1.08 TWO WEEK LOOK-AHEAD SCHEDULE**

- A. The Contractor shall submit a Two Week Look-Ahead Schedule in electronic (.pdf) format to the CM for information on a weekly basis. The submittal day shall be at the progress meeting, unless otherwise directed by the CM. The Two Week Look Ahead schedule may be a horizontal bar-chart style schedule, in lieu of a CPM schedule, if desired. The Contractor shall be prepared to discuss his planned operations for the upcoming two weeks at each Project Progress Meeting.
- B. The Two Week Look-Ahead Schedule shall provide a detailed list of operations to indicate the type of operation, locations of the work, proposed working days and hours, and the start and finish dates for any work planned, started, in progress, or scheduled for completion during the two-week period. The Two Week Look-Ahead Schedule shall also indicate any critical stages of work requiring VRE oversight or inspection.
- C. The Contractor may revise his Two Week Look-Ahead Schedule at his discretion. However, the Contractor shall notify the CM at least 24 working hours in advance of any changes in the Contractor's planned operations or critical stage work requiring VRE oversight or inspection. In the event of extenuating circumstances deemed by VRE to be beyond the Contractor's control, VRE may grant verbal concurrence of changes in the Contractor's planned operations with less advance notice, as the need arises.

#### **1.09 CPM CONSTRUCTION SCHEDULE, REVISIONS**

- A. The Contractor may revise his overall plan of operations at any time; however, the Contractor shall submit a Revised Baseline Schedule to reflect any changes in his overall sequence of operations or general schedule if directed by the CM.
- B. When required by the CM, the Revised Baseline Schedule shall be submitted within seven (7) calendar days of receipt of the CM's written request. The Revised Baseline Schedule shall be submitted in the form of the initial Baseline Schedule as defined in this Specification section, to reflect the changes in the Contractor's overall work plan. The accepted Revised Baseline Schedule will replace any previously accepted Baseline Schedule for the remainder of the work.

#### **1.10 RECOVERY SCHEDULE**

If, in the opinion of the CM, the Contractor falls twenty-one (21) or more calendar days behind the approved Baseline Schedule, the Contractor shall take any and all steps necessary to improve progress. The CM may require the Contractor to submit a Recovery Schedule, for review and acceptance by the CM, detailing the specific operational changes to be instituted to regain the accepted Baseline Schedule, all without additional cost to VRE. Indicate changes to working hours, working days, crew sizes, and equipment required to achieve compliance, and date by which recovery will be accomplished.

**1.11 DELAYS AND REQUEST FOR TIME EXTENSION**

- A. The determination for an extension of the Contract Time will be made by VRE. VRE will not allow time extensions for the normal and seasonal weather conditions considered typical for a given month in accordance with the National Oceanic and Atmospheric Administration (NOAA) thirty year mean for Washington National Airport.
- B. Contractor acknowledges and agrees that delays in activities, irrespective of the party causing the delay, which does not affect any critical activity or milestone dates on the Critical Path, at the time of the delay, shall not become the basis for an extension of the Contract Time. The only basis for any extension of time will be the demonstrated impact of an excusable delay on the critical path. In demonstrating such impact, Contractor shall provide adequate detail as required by the Contract, and Contractor shall prove that:
  - 1. An event occurred.
  - 2. Contractor was not responsible for the event in that the event was beyond the control of Contractor, and was without fault or negligence of Contractor, subcontractor, or supplier, and the event was unforeseeable.
  - 3. Activities on the Critical Path of the Work were delayed.
  - 4. The event in fact caused the delay of the Work.
  - 5. The requested additional time is an appropriate and reasonable extension of the Contract Time, given the actual delay encountered.
- C. Time Extensions for Unusually Severe Weather:
  - 1. If unusually severe weather conditions are the basis for a request for an extension of the Contract Time, such request shall be documented by data substantiating that weather conditions were abnormal for the period of time and could not have been reasonably anticipated, and that weather conditions had an adverse effect on the Critical Path activities of the scheduled construction. The Contractor may request extension to the Time for Completion if it can demonstrate unusual and disruptive weather conditions per the requirements below:
    - a. That one or more of the adverse weather conditions listed below was encountered.
    - b. The occurrence of the adverse weather condition(s) resulted in an inability to prosecute critical work which would have otherwise been performed on the day(s) the Weather Condition(s) occurred.
    - c. The work which was not able to be completed was on the Critical Path and could not be completed **only** due to the adverse weather condition(s) claimed.
      - 1. It shall be the Contractor's responsibility to provide the necessary documentation to satisfy the CM that the weather conditions claimed were encountered, which may include daily reports by the Contractor, copies of notification of weather days to the CM, NOAA backup, and pictures from each day claimed.

2. The Contractor must provide notice of delay to the CM no later than five (5) calendar days after the onset of the delay which satisfies the criteria listed above. A fully documented claim for a time extension under this section shall be submitted no later than thirty (30) calendar days after the cessation of the delay. It shall be the Contractor's responsibility solely to provide the necessary documentation to satisfy the CM that the Weather Condition(s) claimed were encountered.
3. The schedule of anticipated monthly adverse weather condition(s) below will constitute the base line for monthly (or a prorated portion thereof) weather/time evaluation by the Contracting Officer. On issuance of the Notice to Proceed and continuing throughout the Contract on a monthly basis, actual adverse weather days will be recorded by Contractor on a calendar day basis (include weekends and holidays) and compared to the monthly anticipated adverse weather days set forth below.
  - a. For purposes of this clause, the term "actual adverse weather days" shall include days that can be demonstrated to have been impacted by adverse weather.
  - b. The adverse weather conditions listed below will be the only basis for consideration by VRE, based upon the requirements listed above, as an extension of the Time for Completion due to inclement weather or weather-related site conditions.
  - c. Unusually Heavy Precipitation

The Monthly Anticipated Adverse Weather Calendar Days listed below illustrates anticipated monthly inclement weather due to precipitation (Rain and Snow Days). If the number of days with precipitation in excess of 0.10", as recorded at Washington Reagan National Airport, exceeds the Monthly Anticipated Adverse Weather Calendar Days, the Contractor will be entitled to an extension of one (1) day on the Time for Completion for every day in excess of the Monthly Anticipated Adverse Weather Calendar Days illustrated below. The anticipated value of Rain/Snow Days for partial months at the beginning and end of the Contract shall be evaluated on a pro-rated basis.

Weather days are not exclusive to the individual months that they represent in Monthly Anticipated Adverse Weather Calendar Days illustrated below. If weather days are not used in a previous month(s) they can be used to offset weather delays in subsequent months. This will be reviewed on a case by case basis and is subject to reconciliation.

- d. Temperature

The Contractor may be entitled to an additional day for every day that the recorded high temperature at Washington Reagan National Airport is 32 degrees Fahrenheit or less, that has not already been incurred under Monthly Anticipated Adverse Weather Calendar Days listed below. This condition does not apply to vertical construction.



- e. Monthly Anticipated Adverse Weather Calendar Days:
- January – 7, February – 5, March – 6, April – 6, May – 8, June – 6, July – 6,  
August – 7, September – 5, October – 5, November – 5, December - 6.
- f. The number of actual adverse weather days shall be calculated chronologically from the first to the last day in each month. Contractor shall not be entitled to any claim for time extension based on adverse weather unless the number of actual adverse weather days exceeds the number of anticipated adverse weather days. In preparing the Contract Schedule, Contractor shall reflect the above anticipated adverse weather days on all weather-dependent activities. Weather-caused delays shall not result in any additional compensation to Contractor.
1. On days where adverse weather is encountered, Contractor shall list all critical activities under progress and shall indicate the impact adverse weather had, if any, on the progress of such activities. This information shall be presented at the end of the adverse weather day to the CM or its authorized representative for its review and approval.
  2. The CM will determine the Contractor's entitlement to an extension of the Time for Completion. A time extension of no more than one (1) day will be granted for one (1) day of lost work which satisfies the requirements above, regardless of the number of adverse Weather Conditions encountered. The Contractor's sole relief shall be an extension of the Time for Completion and no claim for an increase in Contract Amount will be allowed.
  3. If Contractor is found eligible for an extension of the Contract Time, the Contracting Officer will issue a modification extending the time for Contract completion. The extension of time will be made on a calendar day basis.

#### **1.12 IMPACT ANALYSIS SCHEDULE FOR TIME EXTENSION REQUESTS**

- A. The Contractor shall submit an Impact Analysis Schedule for all time extension requests in order to determine the impact on the project schedule of a change in the Work or condition, or of a delay event, for the purposes of quantifying and apportioning the effects to the party responsible for the impact.
- B. Time-impact analysis shall illustrate impact during update period in which event occurred, that event has been mitigated to greatest possible extent, and that event still impacts overall completion of Project. No extension to the Time for Completion shall be granted unless the additional or change to the Work increases the length of the critical path beyond the Time for Completion as demonstrated on the approved CPM schedule or bar chart schedule.
- C. Include with request, two copies of submittal of impacted schedule, in electronic format, and photocopies of all relevant documents that support the claim.
- D. Submit all required items within the following time periods:
1. 14 calendar days of event occurrence.
  2. 14 calendar days of Contractor's knowledge of impact.

3. 14 calendar days of written request by CM.
- E. Expiration of time periods without submittal shall constitute forfeiture of rights for these specific impacts.

#### **1.13 FINAL AS-BUILT CPM CONSTRUCTION SCHEDULE**

- A. Upon completion of the Project, the Contractor shall submit a Final As-Built CPM Construction Schedule. The As-Built CPM Construction Schedule shall include the following:
  1. One printed legible color copy of the schedule showing actual start and finish dates for all work activities and milestones, based on the accepted monthly updates. . The schedule shall be printed on 11"x17" paper or larger as required to display the entire schedule for the entire construction period in a legible manner.
  2. One electronic (.pdf) copy of the schedule
  3. One electronic file copy of the working schedule which can be opened in the construction scheduling software used to prepare the schedule
- B. The As-Built Schedule shall be prepared in the same manner as the Baseline Schedule and Monthly Update Schedules and shall reflect actual start and finish dates of all activities through Substantial Completion, Punchlist, and Final Completion. All requirements for the Baseline Schedule and Monthly Update Schedules described above in this Specification section also apply to the As-Built Schedules.

#### **1.14 SCHEDULE REVIEW AND ACCEPTANCE**

- A. The CM will review the Baseline Schedule, Monthly Updates, and any Revised or Recovery Schedules submitted and provide a written response to the Contractor noting acceptance or rejection and applicable comments. Review and acceptance by the CM will be based on conformance with the requirements of this provision and the Contract.
- B. The accepted Baseline Schedule and subsequent Monthly Updates will be used by the CM and VRE for planning and coordination of VRE activities, resources, and expenditures, and for evaluation of the Contractor's rate of progress and the effects of time-related impacts on the project.
- C. Review and acceptance by the CM will not constitute a waiver of any Contract requirements and will in no way assign responsibilities of the work plan, scheduling assumptions, and validity of the work plan or schedule to VRE. Failure of the Contractor to include any element of work required by the Contract for timely completion of the Contract in the Construction Schedule shall not excuse the Contractor from his contractual obligations.
- D. If requested by the CM, the Contractor shall meet with the CM to present and discuss the Monthly Update Schedule.

#### **1.15 FAILURE TO COMPLY WITH SCHEDULE SUBMISSION REQUIREMENTS**

- A. If the Contractor fails to comply with any of the Construction Schedule submission requirements within the time and in the manner specified, VRE may withhold approval of the Contractor's ensuing monthly application for payment until the Contractor has satisfied the

- submission requirements. If the Contractor fails to submit the Final As-Built Schedule in the time and manner required, VRE may withhold approval of the final payment until the Contractor satisfies the submission requirement.
- B. VRE shall not be responsible for any delays, costs, or damages resulting from the Contractor's failure to submit the schedule submittals in accordance with the requirements of the Contract.
  - C. Failure to include any work item required for performance of this Contract shall not excuse the Contractor from completing all work within applicable completion dates, regardless of CM approval of the Schedule.

#### **1.16 DAILY CONSTRUCTION REPORTS**

- A. The Contractor shall submit written Daily Reports in electronic (.pdf) format to the CM for information on a weekly basis. Submit copies to the CM by noon on the day following the date of actual progress, or as otherwise determined by the CM.
- B. The Contractor Daily Report format shall be acceptable to the CM. A standard VRE format will be provided to the Contractor by the CM, if required.
- C. Daily Reports shall include, at minimum, the following information concerning events at Project site:
  - 1. Approximate count of Contractor personnel at Project site (e.g. 1 Superintendent, 2 Foremen, 3 Carpenters, etc.)
  - 2. List of Subcontractors at Project site
  - 3. Approximate count of Subcontractor personnel
  - 4. Beginning and ending time of Work
  - 5. Equipment at Project site, noting whether in use or idle (include make and model of equipment as well as general description (e.g. John Deere 330 LC Excavator)
  - 6. High and low temperatures and general weather conditions, including presence of precipitation
  - 7. Locations of Work
  - 8. Description of Work performed
  - 9. Specific Tests or Inspections completed, including results (pass/fail)
  - 10. Material deliveries
  - 11. Meetings and significant decisions
  - 12. Directives provided by VRE if differing from the Contract
  - 13. Stoppages, delays, shortages, and losses
  - 14. Accidents
  - 15. Visitors to site (including VRE)
  - 16. Safety compliance or issues

## 17. Other problems on site

**1.17 MONTHLY CONSTRUCTION REPORTS**

- A. The Contractor shall submit written Monthly Reports in electronic (.pdf) format to the CM for information along with each monthly Application for Payment.
- B. The Contractor Monthly Report format shall be acceptable to the CM. A standard VRE format will be provided to the Contractor by the CM, if required.
- C. Monthly Reports shall include, at minimum, the following information:
  - 1. All basic project information
  - 2. A brief written summary of major construction performed or completed in the period.
  - 3. Construction photos showing before and after conditions during the period.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 32 33****Photographic Documentation****PART 1 - GENERAL****1.01 SUMMARY**

Section includes administrative and procedural requirements for the following:

- A. Preconstruction Photographs
- B. Monthly Construction Progress Photographs Contractor
- C. Substantial/Final Completion Construction Photographs
- D. Significant Activity Time Lapse Sequence Photographs or Video Records
- E. Additional Photographs

**1.02 RELATED SECTIONS**

- A. General Provisions, General Conditions and Special Provisions
- B. Section 01 22 00 – Unit Prices
- C. Section 01 29 00 – Payment Procedures
- D. Section 01 33 00 – Submittal Procedures
- E. Section 01 77 00 – Closeout Procedures

**1.03 SUBMITTALS**

Submit a plan of the Project site including a detailed description of each project area with notation of vantage points marked for location and direction of each photograph. Include same label information as the corresponding set of photographs.

**1.04 PHOTOGRAPHS, GENERAL**

- A. Photographic Media
  - 1. Digital photos shall be taken on a Manual Single Lens digital camera with a minimum resolution of 8 megapixels. Use lenses with focal length of either 50 mm or 55 mm.
  - 2. Format: Minimum 3200 by 2400 pixels, in unaltered original files, with same aspect ratio as the sensor, uncropped, in a folder named by date of photograph.
  - 3. Date and Time Stamp: Unless otherwise indicated, date and time stamp each photograph as it is being taken so stamp is integral to photograph.
  - 4. Photos shall be submitted to the CM in electronic (.jpg) or other approved format. Each photo shall be captioned or labeled so that the following data is recorded for each photo:
    - 1. Contract number
    - 2. Project name
    - 3. Date and time of day photo taken

4. Photo number
5. Specific location of photo and direction facing (North, West, etc.)
6. Description of work in progress or problem encountered

B. Photographs General

1. Submit digital images exactly as originally recorded in the digital camera without alteration, manipulation, editing or modifications using image-editing software.
2. Take photographs using the maximum range of depth of field, and that are in focus, clear, well-lighted without obscuring shadows, to clearly show the Work. Photographs with blurry or out-of-focus areas will not be accepted.
3. Field Office Digital Photos: Retain one set of digital photos of progress photographs in the field office at Project site, available at all times for reference. Identify photographs the same as for those submitted to CM.
4. Vantage points, times and conditions for camera stations and photography shall be mutually agreed upon by the CM and Contractor.

**1.05 CONSTRUCTION PHOTOGRAPHS**

A. Preconstruction Photographs:

1. Prior to Mobilization, the Contractor shall take preconstruction photographs of the Project site and surrounding properties, including existing items to remain during construction, from different vantage points, to provide a visual record of the state of Project site prior to disturbance by the Contractor.
2. Pay special attention to existing structures, buildings, platforms, utilities, and adjacent roadways or railways either on or adjoining the project to accurately record the physical conditions at start of construction.
3. The number of preconstruction photos and locations shall be sufficient enough to show all areas within the Limits of Disturbance and adjacent properties, as necessary. The photos shall be coordinated with the CM to ensure proper coverage or areas.
4. Preconstruction photos shall be prepared and submitted as described below for monthly Construction Photographs.
5. Submit photos within one day of taking photographs.

B. Monthly Construction Progress Photographs:

1. Following Mobilization, the Contractor shall submit to the CM, for information, a series of digital photographs taken each month of progress and/or problems which affect his performance. These photos shall be submitted monthly with the Contractor's Application for Payment.
2. The number of photos and locations shall be based on the amount of progress and/or problems encountered each month but should be sufficient enough to show all areas of Work. The photos shall be coordinated with the CM to ensure proper coverage or areas to

best show status of construction and progress since the last photographs were taken. For informational purposes, each new stage of work shall be photographed to include major work areas and activities in progress.

a. Vantage points may be change as the Work progresses, at no additional cost to VRE.

3. Monthly Construction Photographs shall be taken within seven (7) calendar days before the last day of the calendar month. Submit photos within 1 day of taking photographs.

C. Substantial/Final Completion Construction Photographs:

1. Following Demobilization, the Contractor shall take ten (10) post-construction photographs of the Project site and surrounding properties from different vantage points to provide a visual record of the state of Project when all physical work is complete and the Contractor demobilizes from the site. CM will direct photographer for desired vantage point.
2. Do not include date stamp.
3. Submit photos within one (1) day of taking photographs.

D. Significant Activity Time Lapse Sequence Photographs or Video Records

1. At VRE's discretion, any activities that require pre-activity submittals and conference, VRE may request Time Lapse Photographs and/or Video Records of the entire activity.

a. Time Lapse Sequence Photographs

- i. Take photographs to show status of construction and progress. The number of photos and locations shall be sufficient enough to show all areas of Work.
- ii. The photos shall be coordinated with the CM to select best vantage points. Contractor shall take not less than two of the required shots from the same vantage point each time to create a time-lapse sequence of the activity.

b. Video Records

- i. Submit video recording in digital format acceptable to the CM.
- ii. Recording: Mount camera on tripod before starting recording unless otherwise necessary to show area of construction. Display continuous running time and date. At start of each video recording, record weather conditions and the actual temperature reading at Project site.
- iii. Narration: Describe scenes on video recording to include description of items being reviewed, recent events and planned activities. At each change in location, describe vantage point, location and direction (by compass point).
  1. Confirm date and time at beginning and end of recording.
  2. Begin each video recording with name of the Project, Contractor's name and Project location.

- iv. Transcript: Provide a type written transcript of the narration. Display images and running time captured from video recording opposite the corresponding narration segment.
- v. Time Lapse Sequence Video Recording: Record video recording to show status of construction and progress.
  - 1. Frequency: During each of the construction activities, set up video recorded to automatically record one frame of video recording every five (5) minutes, from same vantage point each time, to create a time-laps sequence of thirty (30) minutes in length.
  - 2. Vantage Points: The photos shall be coordinated with the CM to select best vantage points.

- 2. Payment for Time Lapse Photographs and/or Video Records shall be paid for by Contract Modification and are note included in the Contract Price.

E. Additional Photographs:

- 1. CM may issue requests for additional photographs, in addition to periodic photographs specified. Additional photographs will be paid for by Contract Modification and are not included in the Contract Price.
  - 1. Photographer will be given three (3) days' notice, where feasible.
  - 2. In emergency situations, photographer shall take additional photographs within twenty-four (24) hours of request.
  - 3. Circumstances that could require additional photographs include, but are not limited to, the following:
    - a. Special events planned at Project site.
    - b. Immediate follow-up when on-site events result in construction damage or losses.
    - c. Photographs to be taken at fabrication locations away from Project site.
    - d. Substantial Completion of a major phase or component of the Work.
    - e. Extra record photographs at time of final acceptance.
    - f. CM's request for special publicity photographs.

F. Usage Rights:

- 1. Obtain and transfer copyright usage rights from photographer and videographer to VRE for unlimited reproduction of photographic documentation.



**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 33 00****Submittal Procedures****PART 1 - GENERAL****1.01 SUMMARY**

Section includes general requirements and procedures for preparing and transmitting data to the Construction Manager for informational purposes or for review. Other requirements for submittals may be specified under applicable sections of these Specifications. This Section includes procedures for submittal of general items such as:

- A. Shop Drawings
- B. Coordination Drawings
- C. Product Data
- D. Samples
- E. Material Certificates
- F. Welding Certificates
- G. Qualification Data
- H. Installer Certificates
- I. Manufacturer Certificates
- J. Test Reports
- K. Manufacturer's Instructions
- L. Manufacturer's Field Reports

**1.02 RELATED SECTIONS**

- A. Section 01 31 00 – Project Management and Coordination
- B. Section 01 33 00 – Construction Progress Documentation
- C. Section 01 77 00 – Closeout Procedures
- D. All Technical Specifications provided as part of the Contract Documents.

**1.03 DEFINITIONS**

**Action Submittals:** Written or graphic information and physical samples that require review and responsive action by either the CM or the Engineer.

**Informational Submittals:** Written or graphic information and physical samples that do not require review and responsive action by the CM or the Engineer. Informational Submittals may be rejected for not complying with requirements.

**1.04 SUBMITTAL SCHEDULE**

- A. The Contractor shall submit an electronic and/or hard copy of the schedule of submittals, for review and approval by the CM, in tabular format arranged in chronological order by dates required per construction schedule within seven (7) days following Notice to Proceed, or prior to any other submittals being sent to the CM for review, whichever date is earlier. Each submittal item on the schedule shall include, but is not limited to, the following:
1. Specification Section number and title
  2. Submittal item number and descriptive title
  3. Submittal category (action or informational)
  4. Scheduled date for submittal
  5. Anticipated reviewer (Engineer, CM, or VRE)
  6. Scheduled date for final approval
- B. The Contractor may consult with the CM if additional information is needed to prepare the schedule of submittals.

**1.05 GENERAL PROCEDURES**

- A. General
1. CM will provide electronic copies of CADD electronic files of the Contract Drawings for Contractor's use in preparing submittals.
  2. Use of CADD files is at the Contractor's own risk and in no way alleviates Contractor's responsibility for the Work to conform to the Plans and Specifications.
  3. The use of Contract Drawings as shop drawings is not permissible.
- B. Processing Time
1. Allow enough time for submittal review, including time for re-submittals, as follows. Time for review shall commence on CM's receipt of submittal. No extension of the Contract Time will be authorized because of failure to transmit submittals enough in advance of the Work to permit processing, including re-submittals.
    - a. Initial Review: Allow 30 calendar days for initial review of each submittal. Allow additional time if coordination with subsequent submittals is required. CM will advise Contractor when a submittal processed must be delayed for coordination.
    - b. Intermediate Review: If intermediate submittal is necessary, process it in same manner as initial submittal.
    - c. Re-submittal Review: Allow 30 calendar days for review of each-resubmittal.

- d. No extension of the Contract Time will be authorized because of failure to transmit submittals to CM enough in advance of the Work to permit processing. Processing of incomplete or unacceptable submission by the CM shall not reduce the number of calendar days specified above for CM review. Resubmissions shall be treated the same as initial submissions relative to review time. CM cost for processing a submittal requiring more than two submissions due to incomplete or unacceptable submissions by the Contractor shall be the responsibility of the Contractor.
  - e. Notations on submittals that increase the Contract cost or time of completion shall be brought to the CM's attention before proceeding with the Work.
- C. Contractor's Responsibilities: Contractor is responsible for the scheduling and submission of all submittals. Submit to the CM all submittal, the CM will in turn forward submittals to the appropriate parties for review.
- D. Identification: Place a permanent label or title block on each submittal for identification.
- 1. Indicate name of firm or entity that prepared each submittal on label or title block.
  - 2. Provide a space approximately 6 by 8 inches on label or beside title block to record Contractor's review and approval markings and action taken by the CM and Engineer.
  - 3. Include the following information on label for processing and recording action taken:
    - a. Contract name and number
    - b. Date
    - c. Name and address of Engineer
    - d. Name and address of Contractor
    - e. Name and address of subcontractor, if applicable
    - f. Name and address of supplier, if applicable
    - g. Name of manufacturer, if applicable
    - h. Submittal number or other unique identifier, including revision identifier
      - i. Submittal number shall use Specification Section number followed by a decimal point and then a sequential number (e.g. 06 10 00.01). Resubmittal shall include an alphabetic suffix after another decimal point (e.g., 06 10 00.01.A)
    - i. Number and title of appropriate Specification Section
    - j. Drawing number and detail references, as appropriate
    - k. Location(s) where product is to be installed, as appropriate
    - l. Transmittal number

- E. Use for Construction: Use only final submittals with mark indicating “approved” by CM in connection with construction.
- F. Distribution: Contractor shall furnish copies of final submittals to manufacturers, subcontractors, suppliers, fabricators, installers and authorities having jurisdiction and others as necessary for performance of construction activities.
  - 1. Contractor shall bear all costs incurred for such reproduction and distribution. Prints of all reviewed Shop Drawings may be made from transparencies that carry the appropriate review stamps.

G. Submittal Preparation

- 1. Submit one (1) electronic (.pdf) version of all submittals, unless noted otherwise, required by individual Specification Sections and elsewhere in the Contract Documents to the CM.
- 2. A Contractor's transmittal letter shall accompany each submittal. The Contractor's transmittal letter and submittal shall be consecutively numbered and shall clearly and completely describe any variation from the contract requirements.
- 3. A sequential number (Submittal No. 1, 2, 3, etc.) shall be shown on each Shop Drawing submission. Re-submittals will be followed by a revision number (Submittal No. 1.1, 1.2, 2.1, etc.) and handled in the same manner as first submitted.
- 4. Resubmittals shall be submitted in the same format at initial submittals.
- 5. All submittals from subcontractors and suppliers shall be reviewed and approved by the Contractor prior to submittal to the CM. The Contractor's review and approval shall certify that the submittal has been reviewed by the Contractor and that based on his review, it conforms to the contract requirements. Further, the Contractor's approval shall certify that the intended product is compatible with all other products, to which it must integrate and to the overall project.
- 6. If Contractor has not checked the submittals carefully, even though certified as reviewed and approved, submittals shall be returned to Contractor for proper checking before further processing or review by CM regardless of any urgency claimed by Contractor. In such a situation, Contractor will be responsible for any resulting delays to the scheduled Contract completion. Furthermore, VRE may hold Contractor responsible for increased VRE costs resulting from Contractor's failure to comply with the requirements set forth herein.
- 7. Submittals not conforming to the requirements of this specification shall be similarly rejected.
- 8. Coordinate preparation and processing of submittals with performance of construction activities. Coordinate each submittal with fabrication, purchasing, testing, delivery, other submittals, and related activities that require sequential activity.

9. Coordinate transmittal of different types of submittals for related parts of the Work so processing will not be delayed because of need to review submittals concurrently for coordination.
10. The CM reserves the right to withhold action on a submittal requiring coordination with other submittals until related submittals are received.
11. Unless otherwise acceptable to the CM, submittals shall be submitted as one complete package for each specification section.
12. If submittals show variations from the Contract requirements because of standard shop practice or for other reasons, describe such variations in the letter of transmittal. If applicable, the CM may approve any or all such variations, subject to a proper adjustment in the Contract.

#### H. Review of Submittals

1. Prepare all submittals sufficiently in advance of construction requirements to permit no less than 30 calendar days for review and appropriate action by the CM.
  - a. The review of Shop Drawings and other submittals by the CM or the Engineer will be for general conformance with the Contract only, and the review shall not be interpreted as a checking of detailed dimensions, quantities, or approval of deviations from the Contract Documents. CM or the Engineer review shall not relieve Contractor of its responsibility for accuracy of Shop Drawings nor for the furnishing and installation of materials or equipment according to the Contract requirements.
  - b. VRE review and acceptance of submittals shall not relieve the Contractor from their responsibility for accuracy of submittals, for conformity of submittals to requirements of Contract Drawings and Specifications, for compatibility of the described product with contiguous products and the rest of the system, or for protection of completion of the Contract in accordance with the Contract Drawings and Specifications.
2. If submittals require approval from the Railroad, the Contractor shall allow an additional 30 calendar days for review.
3. Allow an additional 30 days for review of resubmittals.
4. Action Submittals

The Engineer will review each submittal, make marks to indicate corrections or modifications required, and return it. The Engineer will stamp each submittal with an action stamp and will mark stamp appropriately to indicate action taken, as follows:

- a. No Exceptions Taken: The Work covered by the submittal may proceed provided it complies with requirements of the Contract Documents. Final payment depends on that compliance.

- b. Approved As Noted: The Work covered by the submittal may proceed provided it complies with notations or corrections on the submittal and requirements of the Contract Documents. Final payment depends on that compliance.
- c. Revise And Resubmit: Do not proceed with Work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal according to the notations; resubmit without delay.
- d. Rejected: The Engineer has not completed a full review, because it is clear that the submittal does not reflect the requirements of the Contract Documents. Do not proceed with work covered by the submittal, including purchasing, fabrication, delivery, or other activity. Revise or prepare a new submittal that complies with the Contract Documents.

#### 5. Informational Submittals

The CM will review each submittal and will not return it, or will reject and return it if it does not comply with Contract Document requirements.

- I. Partial submittals are not acceptable, will be considered non-responsive, and will be returned without review.
- J. All work in and on the property of VRE or the Railroad, or work, which may affect operations, must be approved by VRE in advance. Where work involves VRE coordination, the Contractor shall submit a description of activities and impacts to VRE with a copy to the CM.
- K. The Contractor shall be responsible for and bear all cost of damages which may result from the ordering of any material or from proceeding with any part of the work prior to the approval by the Engineer of the necessary submittals. VRE may issue a Stop Work Order for noncompliant work or for work that has commenced without an approved submittal.
- L. The Contractor shall distribute copies of approved submittals to manufacturers, subcontractors, suppliers, fabricators, installers, and others as necessary for performance of construction activities.

### 1.06 **SUBMITTAL LOG**

- A. Prepare a log that contains a complete listing of all submittals required by Contract. Submit the log at the preconstruction meeting along with Contractor's 90-day preliminary schedule specified in Division 01 Section "Construction Progress Documentation." Organize the submittal log by Section number. Assign each submittal a sequential number for identification and tracking purposes.
  - 1. Coordinate the submittal log with Division 01 Section "Construction Progress Documentation." The submittal log shall be submitted for CM's review. Include the following information:
    - a. Title of submittal/description

- b. Submittal number (sequential)
- c. Schedule date for the first submittal
- d. Drawing number, if applicable
- e. Applicable section number
- f. Name of subcontractor/vendor
- g. Schedule date of CM's final release or approval

#### **1.07 ACTION SUBMITTALS**

##### **A. Shop Drawings**

###### **1. Shop Drawing Preparation**

- a. The Contractor shall prepare Shop Drawings as necessary or as required by the Contract to adequately perform the work.
- b. Shop Drawings shall be treated as Submittals and prepared in accordance with the requirements of the General Procedures section of this Specification, unless noted otherwise.
- c. Prepare Project-specific information, drawn accurately to scale. Do not base Shop Drawings on reproductions of the Contract Documents or standard printed data. Include the following information, as applicable:
  - i. Dimensions
  - ii. Identification of products
  - iii. Fabrication and installation drawings
  - iv. Roughing-in and setting diagrams
  - v. Shop work manufacturing instructions
  - vi. Schedules
  - vii. Design calculations
  - viii. Compliance with specified standards
  - ix. Notation of coordination requirements
  - x. Notation of dimensions established by field measurement
  - xi. Relationship to adjoining construction clearly indicated
  - xii. Seal and signature of professional engineer if specified
- d. Submit one (1) electronic (.pdf) version and two (2) printed color copies of Shop Drawings on 22" x 34" paper for review and approval by VRE.
- e. All Shop Drawings shall be to scale on sheets measuring 22" x 34". Each drawing shall have a blank area five inches by five inches adjacent to the title



block to provide space for Contractor and Engineer review stamps. The title block shall display the following:

- i. Contract Number and Name
  - ii. Number and Title of the Drawing
  - iii. Date of Drawing or revision
  - iv. Name of Contractor and Subcontractor submitting drawing
  - v. Clear identification of contents and location of work
- f. Electronic Files of Contract Drawings
- i. If requested, electronic digital data files of the Contract Drawings will be provided by VRE for the Contractor's use in preparing Shop Drawings. The use of Contract Drawings as shop drawings is not permissible.
  - ii. The Engineer makes no representations as to the accuracy or completeness of digital data drawing files as they relate to the Contract Drawings. The accuracy should be verified by the Contractor prior to use for Shop Drawings.
- g. Check and coordinate drawings with the work of all trades involved before they are submitted for the approval of the Engineer. Each drawing shall bear the Contractor's stamp of approval as evidence of such checking and coordination. Drawing submitted without this stamp of approval will be returned to the Contractor for resubmittal.
- h. Unless directed otherwise, all hard copies of Shop Drawings shall be sent to the CM directly from the Contractor, not from Subcontractors, fabricators or suppliers.
2. Engineer Review of Shop Drawings
- a. If approved, or approved as noted, by the Engineer, each sheet of the drawing set will be identified as having received such approval by being stamped as such.
  - b. Drawings that require corrections will be returned to the Contractor for correction and resubmittal. The Contractor shall make corrections required by the Engineer.
  - c. Following approval from the Engineer, the Contractor shall provide one (1) electronic (.pdf) version and two (2) printed color copies of Shop Drawings to the Engineer on 22" x 34" paper for field use. Field Use Drawings shall be provided to the Engineer prior to commencement of Work related to the Shop Drawings.
  - d. Engineer approval of Shop Drawings shall not be construed as:
    - i. Permitting any departure from the Contract requirements.

- ii. Relieving the Contractor of the responsibility for any errors, including details, dimensions, and materials.
- iii. Approving departures from details furnished by the Engineer, except as otherwise provided herein.
- iv. Notice to Proceed on a change to the contract that would result in additional time or cost to VRE.

B. Coordination Drawings

- 1. Coordination Drawings are Shop Drawings prepared by Contractor that detail the relationship and integration of different construction elements that require careful coordination during fabrication or installation. Preparation of Coordination Drawings is specified in Division 01 Section 01 31 00 "Project Management and Coordination."
- 2. Submit Coordination Drawings for integration of different construction elements. Show sequences and relationships of separate components to avoid conflicts in use of space.

C. Product Data

- 1. Submit one (1) electronic (.pdf) version of all Product Data submittals to the Engineer for review and approval.
- 2. Mark product data sheets to identify applicable products, models, options, and other data. Supplement manufacturers' standard data to provide information unique to this Project.
- 3. Identify options requiring selection by the Engineer.
- 4. Catalog cuts (product data) shall highlight the actual equipment/component to be used. Generic catalog cuts will not be accepted.

D. Product Samples

- 1. The Contractor shall submit Samples as necessary or as required by the Contract to adequately perform the work.
- 2. Samples shall be treated as Submittals and prepared in accordance with the requirements of the General Procedures section of this Specification, unless noted otherwise.
- 3. Deliver two (2) identical samples to the Construction Manager or location designated by the Construction Manager, for review and approval. Enclose a printed copy of the submittal documentation with the shipment of samples and send one (1) electronic (.pdf) copy of the submittal package to the Engineer, including photographic documentation of the sample.
- 4. Label each sample indicating:
  - a. Name of Project and Contract Number

- b. Name of Contractor and Subcontractor
  - c. Material or equipment represented
  - d. Name of producer and brand; include model number, style, color name, etc. if applicable.
  - e. Specification Section, Article or Paragraph
  - f. Location in project where product is to be utilized
5. Samples for Initial Selection
- Submit manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available.
6. Samples for Verification
- Submit full-size units or Samples of size indicated, prepared from the same material to be used for the Work, cured and finished in manner specified, and physically identical with the product proposed for use, and that show full range of color and texture variations expected. Samples include, but are not limited to, the following: partial sections of manufactured or fabricated components; small cuts or containers of materials; complete units of repetitively used materials; swatches showing color, texture, and pattern; color range sets; and components used for independent testing and inspection.
7. Submit Samples for review of kind, color, pattern, and texture for a final check of these characteristics with other elements and for a comparison of these characteristics between final submittal and actual component as delivered and installed.
- a. If variation in color, pattern, texture, or other characteristic is inherent in the product represented by a Sample, submit at least three sets of paired units that show approximate limits of the variations.
  - b. Refer to individual Specification Sections for requirements for Samples that illustrate workmanship, fabrication techniques, and details of assembly, connections, operation, and similar construction characteristics.

#### **1.08 INFORMATIONAL SUBMITTALS**

- A. Submit one (1) electronic (.pdf) version of all Informational Submittals to the Engineer for information only, as required by individual Specification sections.
- B. Request for Information
  - 1. Refer to Division 1 Section 01 31 00, "Project Management and Coordination" for additional requirements.
- C. Material Certificates
  - 1. Prepare written statements on manufacturer's letterhead certifying that material complies with requirements.

## D. Welding Certificates

1. Prepare written certification that welding procedures and personnel comply with requirements. Submit record of Welding Procedure Specification (WPS) and Procedure Qualification Record (PQR) on AWS forms. Include names of firms and personnel certified.

## E. Qualification Data

1. Prepare written information that demonstrates capabilities and experience of firm or person. Include lists of completed projects with project names and addresses, names and addresses of project owners, and other information specified.

## F. Installer Certificates

1. Prepare written statements on manufacturer's letterhead certifying that Installer complies with requirements and, where required, is authorized for this specific Project.

## G. Manufacturer Certificates

1. Prepare written statements on manufacturer's letterhead certifying that manufacturer complies with requirements. Include evidence of manufacturing experience where required.

## H. Material Test Reports

1. Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting test results of material for compliance with requirements.

## I. Preconstruction Test Reports

1. Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of tests performed before installation of product, for compliance with performance requirements.

## J. Compatibility Test Reports

1. Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of compatibility tests performed before installation of product. Include written recommendations for primers and substrate preparation needed for adhesion.

## K. Field Test Reports

1. Prepare reports written by a qualified testing agency, on testing agency's standard form, indicating and interpreting results of field tests performed either during installation of product or after product is installed in its final location, for compliance with requirements.

## L. Product Test Reports

1. Prepare written reports indicating current product produced by manufacturer complies with requirements. Base reports on evaluation of tests performed by manufacturer and witnessed by a qualified testing agency, or on comprehensive tests performed by a qualified testing agency.

## M. Manufacturer's Instructions

1. Prepare written or published information that documents manufacturer's recommendations, guidelines, and procedures for installing or operating a product or equipment. Include name of product and name, address, and telephone number of manufacturer. Include the following, as applicable:
  - a. Preparation of substrates
  - b. Required substrate tolerances
  - c. Sequence of installation or erection
  - d. Required installation tolerances
  - e. Required adjustments
  - f. Recommendations for cleaning and protection
  - g. Conflicts between manufacturers' instructions and Contract Documents

## N. Manufacturers Field Reports

1. Prepare written information documenting factory-authorized service representative's tests and inspections. Include the following, as applicable:
  - a. Name, address, and telephone number of factory-authorized service representative making report.
  - b. Statement on condition of substrates and their acceptability for installation of product.
  - c. Statement that products at Project site comply with requirements.
  - d. Summary of installation procedures being followed, whether they comply with requirements and, if not, what corrective action was taken.
  - e. Results of operational and other tests and a statement of whether observed performance complies with requirements.
  - f. Statement whether conditions, products, and installation will affect warranty.
  - g. Other required items indicated in individual Specification Sections.

**1.09 ADDITIONAL SUBMITTALS**

- A. When additional submittals are required, by VRE, they shall be submitted within ten (10) days of receipt of written notification, unless otherwise requested by the Contractor and approved by the CM in writing.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 35 13****Host Railroad Coordination****PART 1 - GENERAL****1.01 SUMMARY**

Section includes requirements for coordinating construction operations on Host Railroad Property including, but not limited to, the following:

- A. Host Railroad safety requirements
- B. Host Railroad train operations
- C. Flagging protection
- D. Daily job briefing
- E. Contractor work hours

**1.02 RELATED SECTIONS**

- A. Section 01 35 23 – Safety and Security Requirements
- B. Section 01 50 00 – Temporary Facilities and Controls

**1.03 DEFINITIONS**

**Employee-In-Charge (EIC):** A designated roadway worker qualified on Operating and On-Track Worker Rules and physical characteristics who is responsible for all movements and on-track safety for a roadway work group within working limits. The employee-in-charge is sometimes referred to as a “flagman.” **Note:** different Host Railroads may refer to this individual by slightly varying names which may include Roadway Worker in Charge (RWIC), “Flagman”, or other.

**1.04 HOST RAILROAD SAFETY REQUIREMENTS**

- A. If the Project or any part of the Project is located on Host Railroad property, the Contractor must adhere to all Host Railroad safety and general conduct requirements. See Section 01 35 23 – Safety and Security Requirements for additional details.
- B. All procedures and requirements of Host Railroad (whether VRE, CSX, Norfolk Southern, or Amtrak or any combination thereof) must be adhered to by the Contractor at all times.

**1.05 HOST RAILROAD TRAIN OPERATIONS**

- A. The safety and continuity of rail operations is of the utmost importance and shall be, in addition to the safety of personnel, the most important consideration at the project site. Contractor shall arrange work so that trains and Host Railroad facilities will be protected and safeguarded at all times.
- B. If the tracks or other facilities of the Host Railroad are endangered during the work, the Contractor shall immediately comply with instructions from the Host Railroad to restore the tracks and facilities to a safe condition. If the Contractor fails to comply, VRE and the Host

- Railroad will take whatever actions are necessary to restore safe conditions. The cost for restoring safe conditions or for repairing damage to the Host Railroad's trains, tracks or other facilities caused by the Contractor's operations shall be paid by the Contractor. This cost may be deducted from payment owed to the Contractor.
- C. The method, sequence, and time schedule of performing work which affects the safety and movement of trains shall be approved by the Host Railroad. The Contractor shall remain responsible for all damage to the Host Railroad, its employees, and any other injured party by these acts or those of its employees.
  - D. The Contractor shall coordinate its daily work with the Host Railroad in order to protect Host Railroad traffic and construction. The Contractor shall give the Host Railroad sufficient advance notice to ensure that the necessary arrangements for protection of Host Railroad operations are made. No claims may be made against the Host Railroad for delays or any other interference that may delay the Contractor's operations.
  - E. The Contractor shall conduct their work so that the scheduled train speeds can be maintained unless permission is received from the Host Railroad for operations that require a reduced speed.
  - F. The responsibility for cooperation between the Host Railroad and the Contractor in the maintenance of Host Railroad traffic will be entirely upon the Contractor, and no claims may be made against the Host Railroad or VRE for delays or any other interference that may have caused the Contractor's operations to be delayed in connection with any work under the contract.

#### **1.06 RAILROAD FLAGGING PROTECTION SERVICES**

- A. The Contractor must conduct its work so as not to interfere with the operation of the Host Railroad.
- B. Contractor shall not be responsible for costs associated with flagging protection.
- C. The purpose of an EIC is to protect the Host Railroad's train operations from the Contractor's activities occurring on the project. It will be left to the sole discretion of the Host Railroad when an EIC is necessary.
- D. Generally, one or more EICs will be required where a track is/or may be adversely affected by the Contractor's equipment and/or personnel. A track is generally considered to be adversely affected when personnel and/or equipment are within twenty-five (25) feet of the centerline of the track. (Please note: As an example: A crane with a one hundred (100) foot boom operating eighty (80) feet from the centerline of the track will adversely affect the track, i.e. - boom failure).
- E. When an EIC is required, VRE will initially arrange for the EIC to provide protection for the project. Once assigned to the project, the Contractor will be responsible for coordinating the daily schedule with the EIC.
- F. The EIC will contact Contractor's designated employee (i.e.: supervision, foreman, gang watchman) at the site regarding their activity. The Contractor's designated employee is



responsible for protecting the Contractor's workers at the site and ensuring the contractor's activities do not interfere with the safe movement of trains.

If the EIC does not show up at the work site, the Contractor will not do any work that will foul the track. The Host Railroad should be contacted to resolve the situation.

- G. When the Host Railroad has designated certain activities to require an EIC, the Contractor must plan their work at least one week in order for the Host Railroad to make arrangements for the EIC and necessary notifications to the Host Railroad's Transportation Department.
- H. If any incident should occur involving a train operating through the project site, the Contractor should immediately notify the EIC and/or the Host Railroad's representative assigned to the Project so that appropriate action can be taken.
- I. The Contractor shall furnish and maintain in working order, at their expense, two-way radios capable of talking from one end of the Project to the other. Provide radios with a minimum of 5 watts transmitting power. Select the frequency utilized for these transmissions and submit to the CM for approval in writing. Frequencies shall not conflict with or overlay any host railroad operations radio frequencies. These radios shall be utilized by the Contractor and the EIC for the purpose of clearing the Contractor's forces from an approaching train.

#### **1.07 DAILY JOB BRIEFING**

- A. A daily job briefing is a short-detailed discussion covering the specifics of the job activities planned for the day.
- B. The Contractor shall conduct a job briefing before the start of work each day. The briefing should include an explanation of all tasks planned for the day, including specific locations on the project and equipment to be utilized if it may foul the tracks.
- C. All Contractor personnel (including subcontractors) expected to perform work on the site that day, shall be in attendance at the job briefing. If a Contractor employee arrives to the site for work after the job briefing is held, another job briefing must be held between said employee, the Contractor's supervisor, and the EIC.
- D. The EIC at the site shall be included in the job briefing. The EIC will explain the type of track protection provided to the Contractor, including limits of protection, available hours for work that day, and other pertinent information relating to the Host Railroad.
- E. All instructions shall be issued clearly and concisely. The Contractor shall ensure instructions are understood by all employees.
- F. The daily job briefing can be performed in conjunction with the Contractor's daily safety meeting. See Section 01 35 23 – Safety and Security Requirements for daily safety meeting requirements.

#### **1.08 CONTRACTOR WORK HOURS**

- A. Scheduled work hours shall be discussed during the pre-construction conference. If, during the time discussed, the Contractor is not prepared, has plausible and logical work-arounds, or does not lose time, compensation shall not be allowed.

- B. Expected rail traffic during scheduled work hours shall be discussed during pre-construction conference.
- C. Railroad operations are not necessarily subject to schedules, trains may operate at any time on any track and historical patterns are no indication of future movements and the Contractor must arrange all work accordingly.
- D. When working on the Host Railroad Right-of-Way, Contractor is working under a Construction Agreement between VRE and the Host Railroad. Right of entry and flagging protection services are provided under the noted construction agreement at the discretion and dependent upon the availability of the Host Railroad.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 35 23****Safety and Security Requirements****PART 1 - GENERAL****1.01 SUMMARY**

Section includes requirements for safety and security including, but not limited to, the following:

- A. VRE safety & security requirements
- B. Railroad safety & security requirements
- C. General construction safety & security requirements

**1.02 RELATED SECTIONS**

- A. Section 01 35 13 – Host Railroad Coordination
- B. General Provisions
- C. VRE Critical Safety Roles for VRE Projects

**1.03 SAFETY AND SECURITY REQUIREMENTS**

- A. The goal of VRE is to provide a safe and healthy worksite with zero accidents and injuries and no property damage or loss. In addition to the safety and security requirements included in this document, the Contractor shall abide by the Critical Safety Roles for VRE Projects included as an Attachment to the Invitation for Bid (IFB). Wherever conflicts or discrepancies exist between requirements, the more stringent requirement shall govern.
- B. The Contractor shall maintain a secure perimeter at all times for the duration of construction. All gates or points of entry shall be opened at the beginning of the workday and closed and locked at the end of the workday by the Contractor. Where openings in the perimeter are required due to construction, temporary fencing or other measures (such as additional guard) shall be employed.
- C. Movement of personnel and materials into the project site shall be monitored by VRE. All Contractor personnel, including delivery drivers, must present approved identification for entry. See Special Provisions for specific information. The Safety and Security Manager (SM) shall provide VRE a list of approved personnel and/or companies on a weekly basis.
- D. The Contractor is responsible for security of all Project materials and equipment stored on the project site. Additional fencing and / or security agent(s) may be required. Any cost for such measures shall be borne by the Contractor.
- E. The Contractor shall provide and maintain a working radio to VRE for communications between VRE security personnel and the SSM.
- F. The SSM shall be responsible for coordinating and controlling:
  - 1. Issuing and maintaining Personal Protective Equipment (PPE).

2. Safety and security compliance of all contracted and subcontracted personnel.

#### **1.04 SUBMITTALS**

##### **A. Contractor's Site Specific Safety Plan**

1. Contractor shall complete and submit one (1) electronic (.pdf) version of the Contractor's Site Specific Safety Plan, to VRE, for review and approval, no later than seven (7) calendar days prior to the scheduled date of the Preconstruction Conference. Once approved by VRE, the Contractor shall submit two (2) hard copies of the plan in a three-ring binder with a proper cover sheet, labels, table of contents, and tabbed dividers as necessary to ensure the document is reader-friendly.
2. Additionally, the Contractor shall provide original signature of Page 2, included in the "Rules to Live By" attachment for each employee who will access VRE property. VRE's Rules to Live By can be found at VRE Webpage- <https://www.vre.org/safety/safety-initiatives/contractors/>
3. The VRE Site Specific Safety Plan Template is included as an Attachment of the IFB.

##### **B. Monthly Safety Reports**

The Contractor shall provide monthly safety reports to VRE, for information only, written by the Contractor's Safety and Security Manager assigned to the project. The report shall be submitted to VRE along with the Contractor's monthly Application for Payment. The monthly safety report can be combined with the monthly Construction Report, if desired. The monthly safety report shall include, but not be limited to, the following information:

1. Project name & location (City/County and State)
2. VRE contract number
3. Contractor's name
4. Reporting period (shall always be the calendar month)
5. List of subcontractors that performed work on the project during the reporting period
6. Brief description of work performed during the reporting period, including specific locations on the project
7. A list of all safety incidents encountered during the reporting period, noting the type of incident, such as:
  - a. Recordable Injuries or Illnesses as defined by OSHA as death, loss of consciousness, days away from work (lost time), restricted work activity or job transfer (light duty), or medical treatment beyond first aid
  - b. First Aid Injuries or Illnesses
  - c. Near Miss Incident, defined by OSHA as an incident in which no property was damaged and no personal injury was sustained, but where, given a slight shift in time or position, damage or injury easily could have occurred

8. The official reports prepared by the Contractor for each safety incident shown on the list
  9. A list of all safety violations noted or suggestions shared with Contractor employees and a description of actions taken to address the issue
  10. An update for any incidents/violations encountered in prior months but not yet closed out
- C. Contractor Safety Briefing Documentation

The Contractor shall submit to VRE, for information only, a record of daily safety briefings held at the site prior to beginning work each day. Written documentation of the daily safety briefings (VRE Jobs & Safety Briefing Guide) shall be submitted to VRE on a monthly basis along with the Contractor's monthly Application for Payment. A separate document shall be provided for each day the Contractor is on the site. The VRE Jobs & Safety Briefing Guide can be found at VRE Webpage- <https://www.vre.org/safety/safety-initiatives/contractors/>.

#### **1.05 SAFETY PERSONNEL**

- A. The Contractor shall provide, or cause to be provided, all technical expertise, qualified personnel, equipment, tools, and material to safely accomplish the Work specified to be performed by the Contractor and subcontractor(s).
- B. At a minimum, the Contractor shall provide the services of at least one full-time on-site Contractor Safety and Security Manager, per construction work shift, for the duration of this Contract, with no other duties assigned, whenever the overall project value exceeds \$5,000,000 or whenever work includes one or more of the following:
1. Bridge work above tracks
  2. Tunnel work below tracks
  3. Cranes and rigging where required crane capacity is greater than 50-tons
  4. Confined space entry
  5. Excavations greater than 4-feet

The Contractor shall identify to VRE, a competent, qualified, and authorized Safety and Security Manager on the worksite and who is, by training or experience, familiar with policies, regulations and standards applicable to the work being performed.

- C. The Safety and Security Manager (SSM) shall be responsible for the safety and security requirements as indicated herein.
1. The competent, qualified and authorized person must be capable of identifying existing and predictable hazards in the surroundings or working conditions which are unsanitary, hazardous or dangerous to employees, shall be capable of ensuring that applicable safety regulations are complied with, and shall have the authority and responsibility to take prompt corrective measures, which may include removal of the Contractor's personnel from the work site or holding or stopping specific work activities to remedy safety or security issues.

- D. The Contractor shall submit the résumés of individual(s) proposed to serve in the role of the Contractor's Safety and Security Manager to the CM for approval in writing. Résumés shall include but not be limited to such items as: work experience, education, safety and health training completed, memberships in professional associations, professional certifications, professional registrations and professional references confirming the qualifications and personal references of contacts for verification shall also be required.
1. The SSM will be interviewed by the VRE PM and the CM. The VRE PM and CM will assign written approval of the Safety Manager. Only qualified personnel will be approved. On-site work may not be performed until the Safety and Security Manager is approved and present on-site.
- E. Qualifications: The SSM must be a full-time on-site position with one of the following qualifications:
1. Minimum of ten years of safety management experience in managing safety programs on large construction projects comparable to this Contract in scope and complexity.
  2. A Certified Safety Professional (CSP) or a Licensed Professional Engineer (PE) with a minimum of five years of experience in railroad construction safety supervision.
- F. For contracts with exposure to the Railroad, the Safety Manager must have at least one-year experience in a railroad environment unless approved by the CM, taking into consideration the proximity of the project to railroad tracks.
- G. Prior to start of construction activities on Railroad Operating Environment/Worksite, the Contractor's Safety Manager shall tour the portions of the worksite affected by this work with VRE's Chief Safety Officer, or designee.

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 42 00****References, Definitions, Abbreviations, and Acronyms****PART 1 - GENERAL****1.01 SUMMARY**

Section includes definitions of many of the general terms, abbreviations, and acronyms utilized in these Specifications and other Contract Documents. Additional definitions, specific to certain subjects, can be found in those subject specification sections.

Abbreviations, where not defined in the Contract Documents, will be interpreted by VRE to mean the normal construction industry terminology.

**1.02 RELATED SECTIONS**

01 25 00 – Substitution Procedures

01 26 00 – Change Order Procedures

01 29 00 – Payment Procedures

01 31 00 – Project Management and Coordination

01 32 00 – Construction Progress Documentation

01 33 00 – Submittal Procedures

01 35 13 – Host Railroad Coordination

01 73 00 – Execution of Work

01 77 00 – Closeout Procedures

All Technical Specifications provided as part of the Contract Documents.

**1.03 DEFINITIONS**

Certain terms used in the Contract Documents are defined generally in this Specification and the Conditions of the Contract. Definitions and explanations contained in this Section are not necessarily either complete or exclusive but are general for the Work to the extent that they may not be stated more explicitly in another element of the Contract Documents.

**Agreement:** The completed and signed Form of Contract Agreement

**Approve:** The term "approved," where used in regard to the CM's action on Contractor's submittals, applications, and requests, is limited to CM's duties and responsibilities as delegated by the Contracting Officer in the Contract and Special Provisions.

**Authority Having Jurisdiction (AHJ):** An organization, office, or individual responsible for enforcing the requirements of a code or standard, or for approving equipment, materials, an

installation, or a procedure. For the majority of VRE projects, the local (County or City) government is the AHJ.

**Change Order:** A written order signed by VRE to incorporate changes, alterations, or other modifications to the Contract. A Change Order may be used to add, modify, or delete: pay items, Contract time, Contract Documents, or other terms of the Contract. Change Orders may be issued on a bilateral or unilateral basis. The term change order shall be understood as Bilateral Change Order, except where specifically noted as a Unilateral Change Order.

**Bilateral Change Order:** A written change order signed by both VRE and the Contractor where VRE and the Contractor agree upon the scope, the cost, and the time adjustment for the proposed change, alteration, or other modification to the Contract. This type of change order is what is typically meant when the term change order is used elsewhere in VRE publications.

**Proposed Change Order (PCO):** A document prepared by the Contractor requesting changes, alterations, or other modifications to the Contract, such as to add, modify, or delete: pay items, Contract time, Contract Documents, or other terms of the Contract. Once a PCO has been accepted by VRE, it becomes a Change Order and will be incorporated into the Contract via a Contract Amendment. Several PCOs may be combined into one Change Order, as determined by the Contract Manager.

**Unilateral Change Order:** A written change order signed only by VRE used to effect a change, alteration, or other modification to the Contract when VRE and the Contractor cannot agree upon the scope, the cost, or the time estimation of the proposed change, alteration, or other modification to the Contract or where due to issues of emergency, safety, environmental damage, or other similar critical factors VRE must act quickly and unilaterally to effect the change. In these cases, VRE must act unilaterally to establish a scope, cost, or time adjustment for, the change, alteration, or other modification to the Contract.

**Claim:** The Contractor's written request or demand for an adjustment to the Contractor's compensation or to the Contract time, for costs, expenses, or other damages, adjustment of the Contract terms, or for any entitlement available under the Contract, made within the time, in the form, and pursuant to the provisions for claims specified in the Contract Documents.

**Construction Manager (CM):** The firm or individual designated by VRE to manage the Contract on behalf of VRE. The Construction Manager is VRE's authorized representative for specific purposes to perform specified duties and responsibilities, and to have the rights and authorities as assigned in connection with completion of the Work in accordance with the Contract Documents, until such time as VRE may notify the Contractor otherwise. The Construction Manager, in conjunction with the Inspector, will monitor the Work for compliance with the Contract Documents.

**Construction Schedule:** See Section 01 32 00, "Construction Progress Documentation," for details and terms specific to the Construction Schedule.

**Contract Amendment:** A change order which has been accepted by VRE, processed, and executed by way of signature by both the Contractor and VRE.



**Contract Documents:** Documents containing the requirements of the Work. They include, the Agreement and all the documents and Exhibits identified therein which shall include the Invitation for Bid (IFB) Documents, Drawings, Specifications, and all modifications including amendments and subsequent Change Orders thereto properly incorporated in the Contract. These include all Contract provisions and attachments made thereto or referenced therein.

**Contractor:** The business that has a direct contract with VRE, which is in writing and signed by VRE, to perform the prescribed Work as an independent contractor. The Contractor may also be referred to as the General Contractor or the Prime Contractor.

**Drawings:** Installation/construction plans, or any other supplementary plans or similar graphic data, illustrating work to be performed that are provided to Contractor as part of the Contract Documents. All drawings pertaining to the Contract, including the Contract Drawings and Construction Notes which show and describe the locations, character, dimensions, and details of the Work to be performed under the contract.

**Engineer of Record:** The firm or individual responsible for preparation of the Drawings, Specifications, and other Contract Documents. May also be referred to as "Engineer."

**Final Completion:** The condition when VRE agrees that all the Work has been fully completed in accordance with the Contract Documents, all punch list items have been addressed and accepted, final cleaning has been accomplished, all closeout submittals have been received in acceptable condition, demonstration and training of systems has taken place, the VRE Closeout Checklist has been completed, and the final Application for Payment from the Contractor has been reviewed and deemed acceptable by VRE. The date of Final Acceptance is the date of execution by the Contracting Officer of a Certificate of Final Acceptance.

**Furnish:** Supply and deliver to Project site, ready for unloading, unpacking, assembly, installation, and similar operations.

**Host Railroad:** A railroad that has effective operating control over the segment of track where the Work is to be performed. See Section 01 35 13, "Host Railroad Coordination," for details and terms specific to the Host Railroad.

**Indicated:** Requirements expressed by graphic representations or in written form on Drawings, in Specifications, and in other Contract Documents. Other terms including "shown," "noted," "scheduled," and "specified" have the same meaning as "indicated."

**Inspector:** The Construction Manager's authorized representative who is assigned to make detailed inspections of the quality and quantity of the work and its conformance to the requirements and provisions of the Contract.

**Install:** Unload, temporarily store, unpack, assemble, erect, place, anchor, apply, work to dimension, finish, cure, protect, clean, and similar operations at Project site.

**Notice of Award:** The Date of Execution of the Agreement by the VRE Manager of Contract Administration.

**Notice to Proceed (NTP):** A written notice issued by VRE to the Contractor stating the Commencement Date, the date on which the Contract time will commence for the Contractor to begin the prosecution of the Work required under the Contract. The Notice to Proceed will specify the Period of Performance of the Contract.

**Owner:** The entity that solicits the work and ultimately possesses the completed work. Unless noted otherwise herein, Virginia Railway Express (VRE) shall be considered the Owner.

**Period of Performance:** The number of consecutive calendar days beginning on the Notice to Proceed date which the Contractor is allotted to complete all the Work required by the Contract. Day number one (1) of the Contract is the date of NTP, unless noted otherwise.

**Plans:** See Drawings.

**Project Manager (PM):** The VRE employee responsible for the management of the Contract. A Construction Manager may be designated by the Project Manager to act on behalf of VRE to perform construction services administration, project oversight, or other services as defined by VRE.

**Project Site:** Space available for performing construction activities. The extent of Project site is indicated in the Drawings.

**Provide:** Furnish and install, complete and ready for the intended use.

**Schedule of Values:** A listing of the Contractor's total contract value by Construction Specifications Institute (CSI) divisions, Contract Pay Items, or other breakdown of items as required by VRE. See Section 01 29 00, "Payment Procedures," for details regarding the Schedule of Values.

**Specifications:** Technical Specifications, Special Provisions, and all written agreements and instructions pertaining to the performance of the Work.

**Technical Specifications:** The part of the Contract Documents that describe the quality of materials, method of installation, standard of workmanship, and the administrative and procedural requirements for the performance of the Work under the contract.

**Special Provisions:** The written statements modifying or supplementing the Technical Specifications or General Terms and Conditions for requirements or conditions peculiar to the Contract.

**Subcontractor:** An individual or business that holds a signed agreement with the Contractor to perform part or all of the Contractor's Work. A second-tier Subcontractor holds a signed agreement with a first-tier Subcontractor to perform part or all of the first-tier Subcontractor's Work.

**Submittal:** A deliverable required by the Contract Documents, specifically the Technical Specifications, to be prepared by the Contractor and approved by VRE, the CM, or the Engineer of Record to verify the Work will be installed utilizing the correct materials and procedures. See Section 01 33 00, "Submittal Procedures," for details and terms specific to Submittals.

**Substantial Completion:** The condition when VRE agrees that the Work, or a specific portion thereof, is sufficiently complete, in accordance with the Contract Documents, so that it can be

utilized by VRE for the full use and function for which it was intended, including the issuance of a Certificate of Occupancy, if applicable, and/or Host Railroad acceptance, if applicable. The date of Substantial Completion of the Work under the Contract is the milestone date on which Substantial Completion condition is accomplished. The only remaining physical work shall be the completion of punch list work prior to Final Acceptance.

**Substitutions:** Changes in products, materials, equipment, and methods of construction from those required by the Contract Documents and proposed by Contractor.

**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.

**Substitutions for Convenience:** Changes proposed by Contractor or VRE that are not required in order to meet other Project requirements but may offer advantage to the Contractor or VRE but are not considered Value Engineering Proposals.

**Superintendent:** The Contractor's Project representative who is authorized to receive and fulfill instructions from the PM or CM and who supervises and directs the Work in the field on the Contractor's behalf.

**Utilities:** Private, county, city, municipal or public facility, structure, or infrastructure, designed, owned and maintained for public use or to provide a public service such as electricity, water, sanitary sewer, storm sewer, drainage culverts, telecommunications, conduits, gas, oil, fiber optics, or cable television.

**Work:** The services performed under this Contract including, but not limited to, furnishing labor, and furnishing and installing materials and equipment required to complete the project specified in the Contract Documents. Where "as shown," "as indicated," "as detailed," or words of similar import are used, it shall be understood that the direction, requirements, permission, or review of the PM or CM is intended unless stated otherwise. As used herein, "provide" shall be understood to mean "provide complete in place," that is, "furnish and install."

#### **1.04 INDUSTRY STANDARDS**

**Applicability of Standards:** Unless the Contract Documents include more stringent requirements, applicable construction industry standards have the same force and effect as if bound or copied directly into the Contract Documents to the extent referenced. Such standards are made a part of the Contract Documents by reference.

**Publication Dates:** Comply with standards in effect as of date of the Contract Documents, unless otherwise indicated.

**Copies of Standards:** Each entity engaged in construction on Project shall be familiar with industry standards applicable to its construction activity. Copies of applicable standards are not bound with the Contract Documents. Where copies of standards are needed to perform a required construction activity, obtain copies directly from publication source and make them available on request.

**1.05 ABBREVIATIONS AND ACRONYMS**

Where abbreviations and acronyms are used in Specifications or other Contract Documents, they shall mean the recognized name of the standards and regulations in the following list. Web site addresses are subject to change and are believed to be accurate and up-to-date as of the date of the Contract Documents.

Abbreviations are also noted on the Contract Plans. If any abbreviation is unknown or unclear the Contractor shall notify the CM or Owner.

**INDUSTRY ORGANIZATIONS**

AAR	Association of American Railroads
AIA	American Institute of Architects
AMTRAK	National Railroad Passenger Corporation
AREMA	American Railway Engineering and Maintenance-of-Way Association
ASTM	American Society for Testing and Materials International
ATSSA	American Traffic Safety Services Association
CSXT	CSX Transportation, Inc.
NECA	National Electric Contractor's Association
NEMA	National Electric Manufacturers Association
NFPA	National Fire Protection Association
NRTL	National Recognized Testing Laboratory
NS	Norfolk Southern Railway Corporation
NVLAP	National Voluntary Laboratory Accreditation Program
UL	Underwriters Laboratories, Inc.

**STANDARDS AND REGULATIONS**

CFR	Code of Federal Regulations Available from Government Printing Office
MUTCD	Manual on Uniform Traffic Control Devices Department of Transportation Federal Highway Administration

**FEDERAL AGENCIES**

FTA	Federal Transit Administration
NIST	National Institute of Standards and Technology U.S. Department of Commerce
OSHA	Occupational Safety & Health Administration

**STATE/LOCAL GOVERNMENT AGENCIES**

DDOT	District Department of Transportation
DRPT	Department of Rail and Public Transportation
VDEQ	Virginia Department of Environmental Quality
VDOT	Virginia Department of Transportation

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 45 00****Quality Assurance and Quality Control****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes general requirements and procedures for:
  - 1. Conflicting Requirements
  - 2. Submittals
  - 3. Quality Control
  - 4. Quality Assurance
  - 5. Test and Inspection Log
  - 6. Contractor's Quality Management Plan
  - 7. Notification of Non-Compliance
- B. Testing and quality control will be separated into two areas of responsibility regulatory and contractor's quality control.
  - 1. Testing by the Owner as required by the most current version of the Fairfax County Special Inspections Manual. This manual is available on-line at: <https://www.fairfaxcounty.gov/landdevelopment/special-inspections-program>. Information provided under this requirement is primarily for use of the Owner and the County's regulatory agencies. Where this information will be provided to the Contractor, the information contained within shall not relieve the Contractor from providing his own testing to ensure compliance with the contract requirements.
  - 2. All other testing as required by the Contract Documents shall be performed by the Contractor. The Contractor shall also provide quality assurance testing as required to ensure full and complete compliance with Contract requirements. Reliance on the Owner's third party testing agency's results will not relieve the Contractor from their contractual obligation to properly perform the Work in accordance with the Contract Documents. The Contractor shall not use the same testing company as employed by the Owner for Special Inspections.
- C. Testing and inspecting services are required to verify compliance with requirements specified or indicated. These services do not relieve Contractor of responsibility for compliance with the Contract Document requirements.
- D. Specific Quality Assurance and Quality Control requirements for individual construction activities are specified in the Sections that specify those activities. Requirements in those Sections may also cover production of standard products.

- E. Specified tests, inspections, and related actions do not limit Contractor's other Quality Assurance and Quality Control procedures that facilitate compliance with the Contract Document requirements.
- F. Requirements for Contractor to provide Quality Assurance and Quality Control services required by the Engineer, Owner, Commissioning Authority (if applicable), or authorities having jurisdiction (as applicable) are not limited by provisions of this Section.
- G. Specific test and inspection requirements are not specified in this Section.

## **1.02 RELATED SECTIONS**

- A. Section 01 33 00 – Submittal Procedures
- B. All Technical Specifications provided as part of the Contract Documents.

## **1.03 DEFINITIONS**

- A. **Quality Assurance (QA):** The application of planned and systematic reviews which demonstrate that Quality Control practices are being effectively implemented.
- B. **Quality Control (QC):** The continuous review, certification, inspection, and testing of project components, including persons, systems, services, materials, documents, techniques, and workmanship to determine whether or not such components conform to the plans, specifications, applicable standards, and project requirements. Services do not include contract enforcement activities performed by the Construction Manager.
- C. **Preconstruction Testing:** Tests and inspections performed specifically for the project before products and materials are incorporated into the Work, to verify performance or compliance with specified criteria.
- D. **Source QC Testing:** Tests and inspections that are performed at the source, e.g., plant, mill, factory, or shop.
- E. **Field QC Testing:** Tests and inspections that are performed on-site for installation of the Work and for completed Work.
- F. **Testing Agency:** An entity engaged to perform specific tests, inspections, or both. Testing laboratory shall mean the same as testing agency.
- G. **Installer:** Contractor or another entity engaged by Contractor as an employee or Subcontractor to perform a particular construction operation, including installation, erection, application, and similar operations.
- H. **Experienced:** Unless otherwise indicated in individual Specification sections, when used with an entity or individual, "experienced" means having successfully completed a minimum of five previous projects similar in nature, size, and extent to this Project; being familiar with special requirements indicated; and having complied with requirements of authorities having jurisdiction.

## **1.04 CONFLICTING REQUIREMENTS**

- A. If compliance with two standards is specified and the standards establish different or conflicting requirements for minimum quantities or quality levels, comply with the most stringent requirement. Refer uncertainties and requirements that are different, but apparently equal, to the CM for a decision before proceeding.

## **1.05 SUBMITTALS**

### **A. Contractor's Quality Management (QM) Plan**

The Contractor shall submit, for review and approval by VRE, a project specific plan detailing Quality Control and Quality Assurance activities and responsibilities for the Project. Submit one (1) electronic (.pdf) version of the plan. The plan shall be submitted no later than seven (7) calendar days prior to the scheduled date of the Preconstruction Conference. Once approved by VRE, the Contractor shall submit two (2) hard copies of the plan in a three-ring binder with a proper cover sheet, labels, table of contents, and tabbed dividers as necessary to ensure the document is reader-friendly.

1. Any approval by the CM of the QM Plan shall be treated as “approved, predicated upon successful implementation.” If the CM finds any portion of the QM plan is not being implemented as approved, CM may issue a stop work order, for any of the portion of work in question.

See detailed requirements for the Quality Management Plan in Article 1.09 of this section.

### **B. Qualification Data**

The Contractor shall submit, for VRE review and approval, qualification data for the Contractor's Quality Control personnel, as specific QC personnel are required by Contract.

### **C. Testing Agency Qualifications**

The Contractor shall submit, for review and approval by VRE, qualifications of the proposed Independent Testing Agency to demonstrate their capabilities and experience. Include proof of qualifications in the form of a recent report on the inspection of the testing agency by a recognized authority. Rejection of an Independent Testing Agency by the CM or VRE does not constitute grounds for additional monetary compensation to the Contractor.

### **D. Test and Inspection Reports**

Submit test and inspection reports as required in individual technical specification sections.

## **1.06 QUALITY CONTROL**

### **A. Contractor Responsibilities**

1. Perform Quality Control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce Work of specified quality.
2. Perform tests and inspections not explicitly assigned to VRE or Others. Perform additional Quality Control activities required to verify that the Work complies with requirements, whether specified or not.



3. Unless otherwise indicated, provide Quality Control services specified and/or those required by the Authority Having Jurisdiction (AHJ.)
4. Cooperate with Independent Testing Agency and provide the following:
  - a. Access to the Work
  - b. Incidental labor, facilities, equipment, and tools necessary to facilitate tests and inspections
  - c. Adequate quantities of representative samples of materials that require testing and inspecting
  - d. Facilities for storage and field curing of test samples
  - e. Security and protection for samples and for testing and inspecting equipment at project site
5. Notify the Independent Testing Agency and the CM at least 24 hours prior to expected time for operations requiring testing and inspection services
6. Schedule jurisdictional inspections, including any special inspections, as required by associated permits or building officials
7. Obtain Certificates of Occupancy, if applicable
- B. Should field conditions conflict with Contract Documents, request clarification from the CM before proceeding.
- C. If manufacturer's instructions conflict with Contract Documents, request clarification from the CM before proceeding.

#### **1.07 QUALITY ASSURANCE**

- A. Independent Testing Agency
  1. Where services are indicated as Contractor's responsibility, engage a qualified testing agency to perform these Quality Control services. Contractor shall employ and pay for the services of an independent firm approved by VRE to perform all inspection and testing.
  2. The Contractor shall not use the same Testing Laboratory as retained by the Owner for Special Inspection Testing. The Contractor shall submit to the CM and Owner the name, address and qualifications of the Testing Laboratory he intends to use on this Project for the acceptance of the Owner and CM.
  3. The Independent Testing Agency shall be a corporately and financially independent testing organization that can function as an unbiased testing authority, professionally independent of manufacturers, suppliers, and installers of equipment, or systems evaluated by the testing organization shall be contracted by the Contractor to perform the contractually required tests.
  4. The Independent Testing Agency shall be a Nationally Recognized Testing Laboratories (NRTL), a National Voluntary Laboratory Accreditation Program (NVLAP), or an

independent agency with the experience and capability to conduct testing and inspecting indicated, as documented according to ASTM E329; and with additional qualifications specified in individual Sections; and, where required by authorities having jurisdiction, that is acceptable to authorities.

- a. NRTL: A nationally recognized testing laboratory according to 29 CFR 1910.7
  - b. NVLAP: A testing agency accredited according to NIST's National Voluntary Laboratory Accreditation Program
5. VRE reserves the right to employ a separate Independent Testing Agency (ITA) at its own cost under separate contract. Contractor shall not employ same entity engaged by VRE, if applicable, unless agreed to in writing by VRE.
6. Testing Agency Responsibilities
- a. Cooperate with VRE, the CM, and the Contractor in performance of duties. Provide qualified personnel to perform required tests and inspections.
  - b. Perform inspections, tests, and other services specified in individual technical specification sections.
  - c. Determine the location from which test samples will be taken and in which in-situ tests are conducted.
  - d. Submit a certified written report of each test, inspection, and similar Quality Control service. Reports shall be submitted by the Independent Testing Agency directly to the CM indicating observations and results of tests and indicating compliance or non-compliance with Contract Documents.
    - i. Report shall cite applicable Contract requirements, tests or analytical procedures used. Provide actual results and include a statement that the item tested or analyzed conforms or fails to conform to specified requirements. If the item fails to conform, notify CM immediately. Conspicuously stamp the cover sheet for each report in large red letters "CONFORMS" or "DOES NOT CONFORM" to the specification requirements, whichever is applicable.
    - ii. A testing laboratory representative authorized to sign certified test reports shall sign test results. Furnish the signed reports, certifications, and other documentation directly to the CM.
  - e. Retesting and reinspection required because of non-conformance to specified requirements shall be performed by the same Independent Testing Agency. The cost for retesting will be borne by the Contractor.
  - f. Notify the CM and Contractor promptly of irregularities or deficiencies observed in the Work during performance of its services.
- B. The Construction Manager has the authority to reject work due to non-compliance with Contract Documents.

**1.08    TEST AND INSPECTION LOG**

- A. Contractor shall prepare and maintain a record of tests and inspections. Report shall include, but not be limited, to the following:
  - 1. Date test or inspection was conducted
  - 2. Description of the Work tested or inspected
  - 3. Date test or inspection results were transmitted to the CM
  - 4. Identification of testing agency or special inspector conducting test or inspection
- B. Contractor shall maintain a log for inspection by the CM, when requested.

**1.09    CONTRACTOR'S QUALITY MANAGEMENT PLAN**

- A. The Contractor shall prepare a Quality Management Plan for the project which will spell out the policies, processes, and procedures to be used in order to assure the quality of all work and products produced for the project. The Quality Management Plan shall include planned and systematic actions necessary to provide adequate confidence to VRE that construction will satisfy the given requirement for quality. The Federal Transit Administration (FTA) Quality Assurance and Quality Control Guidelines shall be referenced in the preparation of this plan, if the project is fully or partially funded by the FTA.
  - 1. The only work that is authorized to proceed prior to the approval of the QM Plan is mobilization of storage and office trailers, temporary utilities, and surveying.
  - 2. Approval of the QM Plan is required prior to the start of any construction. The CM reserves the right to require changes in the QM Plan and operations as necessary, including but not limited to removal of personnel, to ensure the specified quality of work. The CM reserves the right to interview any member of the QC organization at any time in order to verify the submitted qualifications. All QC organization personnel shall be subject to acceptance by the CM. The CM may require the removal of any individual for non-compliance with quality requirements specified in the contract.
- B. Notify the CM, in writing, of any proposed change, including changes in the QC organization personnel, a minimum of seven calendar days prior to a proposed change. Proposed changes shall be subject to acceptance by the CM.
- C. The Quality Management Plan shall include a written quality policy, written plan, written procedures, and a management team that supports and takes responsibility for quality and personnel who undertake Quality Control activities. The procedures shall include, at a minimum, the following elements:
  - 1. Management Responsibility
    - a. Personnel Matrix
    - b. Names and Qualifications
    - c. Duties, Responsibilities and Authority of QC Personnel

2. Document Control Procedures (using PMIS prescribed by VRE)
  3. Subcontracting and Purchasing Procedures
  4. Inspection and Testing
    - a. Testing Laboratory Information and Certifications
    - b. Special Inspections
  5. Procedures for Verification of Materials at Delivery
  6. Procedures for Control of Inspection, Measuring and Test Equipment
  7. Procedures for Reporting, Review and Disposition of Nonconforming Product
  8. Corrective Actions
  9. Procedures for Control of Quality Records
  10. Training
- D. Quality Control Personnel Qualifications
1. Provide sufficient qualified full-time quality control personnel trained and experienced in managing and executing Quality Assurance and Quality Control procedures similar in nature and extent to those required for Project. Personnel shall monitor work activity at all times. Scheduling and coordinating of all inspections shall match the type and pace of the work activity.
    - a. In cases where multiple trades, disciplines, or subcontractors are on site at same time, each activity shall be tested and inspected by personnel skilled in that portion of the work.
    - b. In cases where multiple shifts are employed, the quality-control staff shall be increased as required to monitor the work on each shift.
  2. The following position is key personnel as defined by VRE in this and other Division 01 Specification Sections:
    - a. Quality Control Manager (QCM)
      - i. Duties

Provide a QCM at the work site to implement and manage the Contractor's QC Program. The duties and responsibilities of the QCM is to ensure compliance with the QM Plan. The QCM shall not be designated as the safety competent person as defined by Division 01 Section 01 35 23 "Safety and Security Requirements."

The QCM is required to attend QC planning meetings, conduct the QC meetings, perform submittal review and approval, ensure testing is performed and provide QC certifications and documentation required in this contract. The QCM is responsible for documentation performed by Testing Laboratory personnel and any other inspection and testing personnel required by this Contract.

1. On Projects above \$5,000,000 the only duties and responsibilities of the QCM are to manage and implement the Contractors approved QC Plan on the Contract.
2. On Projects below \$5,000,000 the QCM may have other shared duties and responsibilities in addition to managing and implementing the Contractors approved QC Plan on the Contract.

ii. Qualifications

A graduate of a four year ABET accredited college program in one of the following disciplines: Engineering, Architecture, Construction Management, Engineering Technology, Building Construction, Building Science, or approved equivalent experience/certification. Experience shall include a minimum of 5 years' experience as a superintendent, QCM, project manager, project engineer or construction manager on similar size and type construction contracts which included the major trades that are part of this Contract.

The individual shall be familiar with VRE's Safety and Security Guidelines, Host Railroad Safety and Quality Control Requirements and have experience in the areas of hazard identification and safety compliance.

Certifications may include Construction Quality Management courses offered by agencies including but not limited to: Construction Management Association of America (CMAA), Associated General Contractors (ACG), Associated Builders and Contractors (ABC) and the Army Corps of Engineers.

Submit the résumés of individuals proposed to serve in the role of Quality Control Manager to the CM. The QCM shall be interviewed by the CM. The VRE PM and CM will assign written approval to the QC Manager and their designee.

iii. Alternate QCM Duties and Qualifications

Designate an alternate for the QCM at the work site to serve in the event of the designated QCM's absence. The period of absence may not exceed two weeks at one time, and not more than 30 workdays during a calendar year. The qualification requirements for the Alternate QCM shall be the same as for the QCM.

E. Quality Control of Submittal Process

Describe procedures for ensuring compliance with requirements through review and management of submittal process. Indicate qualifications of personnel responsible for submittal review.

F. Testing and Inspection

In the Quality Management Plan, include a comprehensive schedule of Work requiring testing or inspection, including the following:

1. Tests and inspections performed by the Independent Testing Agency

2. Special inspections as required by authorities having jurisdiction
3. Tests and inspections indicated in the Contract Documents as to be performed by VRE or Others

G. Continuous Inspection of Workmanship

Describe the process for continuous inspection during construction to identify and correct deficiencies in workmanship in addition to testing and inspection specified. Indicate types of corrective actions to be required to bring work into compliance with standards of workmanship established by Contract requirements.

H. Monitoring and Documentation

1. Maintain current and complete records of testing and inspection reports including log of approved and rejected results. Include work the Construction Manager has indicated as nonconforming or defective. Indicate corrective actions taken to bring nonconforming work into compliance with requirements. Comply with requirements of authorities having jurisdiction.
  - a. Testing log shall be current and up-to-date and include supporting field test reports, arranged by specification section. Log shall be kept in a 3-ring binder readily available to the CM during normal business hours.
2. Contractor shall maintain current quality control records, on forms acceptable to VRE , of all control activities, production, tests and inspections performed. These records shall include factual evidence that required tests or inspections have been performed, including type and number of tests or inspections involved; results of tests or inspections; nature of defects, causes for rejection, etc.; proposed remedial action; and corrective actions taken. These records shall cover both conforming and defective or deficient features (non-conforming) and shall include a statement that all supplies and materials incorporated into the Work are in full compliance with terms of the Contract.
  - a. Legible copies of these records shall be furnished to CM monthly. The records shall cover all work placed subsequent to the previously furnished records and shall be verified by Contractor's QC Personnel. Contractor shall document tests and inspections as specified in the technical provisions of the Specifications, and these records shall be available for review by the CM throughout the life of the Contract.
3. At a minimum, the QC Personnel shall furnish the signed reports, certifications, and a summary report of field tests at the end of each month to the CM.

**1.10 NOTIFICATION OF NON-COMPLIANCE**

- A. The CM will notify the Contractor of any detected non-compliance with the foregoing requirements. The Contractor shall take immediate corrective action after receipt of such notice. Such notice, when delivered to the Contractor at the work site, shall be deemed sufficient for the purpose of notification. If the Contractor fails or refuses to comply promptly, VRE may:

1. Issue an order stopping all or part of the work until satisfactory corrective action has been taken. The Contractor shall make no part of the time lost due to such stop orders the subject of a claim for extension of time for excess costs or damages.
  2. Repair, replace or otherwise remedy the defective work at the Contractor's expense. Cost incurred by VRE to correct defective work shall be deducted from the total amount due to the Contractor.
  3. Withhold an amount from the payment due the Contractor as may be deemed necessary at the discretion of the CM.
  4. Terminate the Contractor's right to proceed for Default after providing required notice in accordance with the Termination for Default procedures described in the General Provisions.
- B. In cases where the Contractor fails to properly operate, maintain and comply with their Quality Management Plan or the Contract Provisions, VRE may:
1. Order the Contractor to replace ineffective or unqualified Quality Control Personnel or subcontractors.
  2. Issue an order stopping all or part of the work until acceptable personnel are on site and a new Quality Management Plan is approved by the CM. The Contractor shall make no part of the time lost due to such stop orders the subject of claim for extension of time for excess costs or damages.
  3. Take a credit from the contract for Quality Control Activities not performed.
  4. Terminate the Contractor's right to proceed for Default after providing required notice in accordance with the Termination for Default procedures described in the General Provisions.
- C. The Contractor shall maintain a detailed record of every non-compliance and corrective action taken.

## **PART 2 - PRODUCTS**

Not Used

## **PART 3 - EXECUTION**

### **3.01 SPECIAL INSPECTIONS/TESTING**

- A. This project is classified as a Critical Structure and as such is subject to the provisions and requirements of the Fairfax County Critical Structures Program. These provisions and requirements are detailed in the *Fairfax County Special Inspection Manual*. The Contractor is advised that the provisions and requirements of the most current editions of this Manual are hereby

made a part of these Contract Documents by reference. This manual is available on-line at: <https://www.fairfaxcounty.gov/landdevelopment/special-inspections-program>. This Manual requires certain inspection, testing and certification by both the Contractor and the Owner.

- B. The Owner shall employ one or more Independent Testing Laboratories to perform those tests specifically required by Fairfax County Special Inspections Program and Manual for elements of the project that are declared critical.
- C. The Contractor is responsible for all other testing not covered by the Critical Structures Program as required by the contract documents.
- D. The Contractor shall furnish required notice and/or data to the Owner's Independent Testing Agency to perform its work in a proper and orderly manner. The Contractor shall notify the Owner's Testing Agency not less than 24 hours in advance of such required inspections or tests, and the Contractor will ensure that the work element is ready for inspections or testing. The Owner's Independent Testing Laboratory will only perform such inspections or tests as are required to ensure compliance with the provisions of the Special Inspections Program. The Contractor shall not proceed with subsequent work unless the required inspections or tests are performed and the results certified as compliant with contract requirements.
- E. The Owner's Independent Testing Laboratory is not responsible for securing or performing code required building inspections and is strictly limited by the scope of services above. The Independent Testing Laboratory has no authority and no authority should be assumed to control the means or methods of construction or to in any way intervene in the Contractor's prosecution of the work.
- F. In the event the work for which a test is scheduled is not reasonably ready for testing at the time indicated, the Contractor shall bear the Independent Testing Agency's cost for rescheduling the test. The Independent Testing Agency will advise the Contractor of the cost and provide a copy of such notice to the CM and Owner.
- G. In the event the work fails the test of the Independent Testing Agency, the Contractor shall bear the full cost of such retest, including CM's time spent in processing such retest information prior to Acceptance by Fairfax County Special Inspections Program.
- H. Any costs for retesting due to non-complying construction methods or failure of the initial test (regardless of results of retesting), any overtime costs of inspectors due to the Contractor's failure to have work ready for inspection, or any costs incurred for failure to give required notice of cancellation for inspections will be charged to the Contractor.
- I. In the event that work is determined by the CM to be nonconforming, the Contractor may request special or additional tests to determine the acceptability of the in-place product. Such tests are for the Contractor's convenience, and the Owner's decision either to accept the subject work or to require removal and replacement does not relieve the Contractor of paying for all such testing and review time of the CM.
- J. The Contractor shall take reasonable precautions to schedule work in a manner to minimize the number of concrete placements. Where large mass concrete placement is scheduled, sufficient notice should be given to the CM and the Independent Testing Agency to ensure that sufficient



Independent Testing Agency personnel are available to test the work and that deficiencies can be corrected and retested, without delay to the work.

**3.02 CONTRACTOR'S COORDINATION FOR TESTING FIRMS**

- A. Cooperate with laboratory personnel and provide access to work.
- B. Provide to laboratory representative samples of materials to be tested in required quantities.
- C. Furnish copies of mill test reports.
- D. Furnish casual labor and facilities:
  - 1. To provide access to work to be tested
  - 2. To obtain and handle samples at the site
  - 3. To facilitate inspections and tests
  - 4. For laboratory's exclusive use for storage and curing of test samples
- E. Arrange with laboratory and pay for additional samples and tests required for Contractor's convenience.
- F. The Contractor shall notify the Owner's Independent Testing Agency a minimum of 24 hours in advance of such required tests, and the Contractor will ensure that the work element is ready for testing at the time requested. The Contractor shall not proceed with subsequent work unless the required test is performed and the results certified as compliant with contract requirements.

**END OF SECTION**

**SECTION 01 50 00****Temporary Facilities and Controls****PART 1 - GENERAL****1.01 SUMMARY**

A. This section specifies the general requirements for furnishing, installing, and operating temporary facilities and controls. This Section includes:

1. Submittals
2. Compliance
3. Materials
4. Equipment
5. Installation
6. Construction Manager's Temporary Field Office
7. Contractor's Temporary Field Office
8. Contractor Personnel Parking
9. Temporary Utility Service
10. Temporary Sanitary Facilities
11. Project Identification Signage
12. U.S. Department of Labor Signage
13. Maintenance of Traffic (Roadway)
14. Construction Operations Under Railroad Traffic
15. Work, Staging and Storage Areas
16. Termination and Removal

**1.02 RELATED SECTIONS**

- A. Section 01 29 00 – Payment Procedures  
B. Section 01 33 00 – Submittal Procedures

**1.03 MEASUREMENT AND PAYMENT**

- A. No separate payment will be made for any temporary facilities and controls required under this section. Include cost of such work in contract price listed for general conditions.

**1.04 SUBMITTALS**

- A. Shop Drawings: Submit to CM, for VRE's review and approval, site plans indicating all temporary facilities, including support and security; utility connections and traffic flows.

Provide detailed drawings of utility connections and special facilities. Submittals shall include detailed list of materials for use and related specification.

- B. Implementation and Termination Schedule: Within 15 calendar days of date established for submittal of Contractor's first Construction Schedule, submit a schedule indicating implementation and termination of each temporary facility.

#### **1.05 COMPLIANCE**

- A. Regulations: Comply with industry standards and applicable laws and regulations of authorities having jurisdiction, including but are not limited to, the following:
1. Building Code requirements.
  2. Host Railroad.
  3. Health and safety regulations.
  4. Police and Fire Department regulations.
  5. Environmental protection regulations.
  6. All temporary facilities shall be ADA compliant.
- B. Standards: Comply with ANSI A10.6, NECA's "Temporary Electrical Facilities,"
1. Trade Jurisdictions: Assigned responsibilities for installation and operation of temporary utilities are not intended to interfere with trade regulations and union jurisdictions.
  2. Electrical Service: Comply with NECA, NEMA, and Underwriters' Laboratory (UL) standards and regulations for temporary electrical service. Install service to comply with NFPA 70.
- C. Tests and Inspections: Arrange for applicable utility service provider to test and inspect each temporary utility before use. Coordinate with applicable utility service provider for requirements for certifications, permits, and inspections. Obtain permits from applicable utility service for temporary construction and temporary utilities.

#### **1.06 MATERIALS**

- A. General: Provide new materials. Undamaged, previously used materials in serviceable condition may be used if approved by CM. Provide materials suitable for use intended.

#### **1.07 EQUIPMENT**

- A. General: Provide new equipment suitable for use intended. If acceptable to CM, undamaged, previously used equipment in serviceable condition may be used.
- B. Temporary Facilities/Field Offices: Prefabricated or mobile units with lockable entrances, operable windows, and serviceable finishes; heated and air conditioned; on foundations adequate for normal loading and provided with proper tie-downs.
- C. Drinking-Water Fixtures: Containerized, tap-dispenser, bottled-water drinking-water units, including paper cup supply.

1. Where power is accessible, provide electric water coolers to maintain dispensed water temperature at 45 to 55 deg F.
- D. Electrical Outlets/Receptacles: Properly configured, NEMA-polarized outlets that will prevent insertion of 110v or 120v receptacles into higher-voltage outlets and equipped with ground-fault circuit interrupters with reset button.
- E. Self-Contained Toilet Units: Single-occupant units of chemical, aerated re-circulation, or combustion type; vented; fully enclosed with a glass-fiber-reinforced polyester shell or similar nonabsorbent material.
- F. Fire Extinguishers: Hand carried, portable, UL rated with class and extinguishing agent as required by locations and classes of fire exposures.
- G. Heating and Cooling Equipment: Unless CM authorizes use of permanent heating system, provide temporary heating units with individual space thermostatic control.
  1. Use of gasoline-burning space heaters, open-flame heaters, or salamander-type heating units is prohibited.
  2. Heating and Cooling Units: Listed and labeled, by a testing agency acceptable to authorities having jurisdiction, and marked for intended use for type of fuel being consumed. If liquid fuel is used, provide under-unit containment in the event of leakage. Provide adequate ventilation or direct vent the units top the outside.

#### **1.08 INSTALLATION, GENERAL**

- A. Prior to installation of temporary facilities and utilities, submit to the CM a site layout providing locations and details of the facilities and utilities.
- B. Use qualified personnel for installation of temporary facilities.
- C. Provide each facility ready for use when needed to avoid delay. Maintain and modify as required. Do not remove until facilities are no longer needed or are replaced by authorized use of completed permanent facilities.

#### **1.09 CONSTRUCTION MANAGER'S (AND CONTRACTOR'S) TEMPORARY FIELD OFFICE**

- A. The Contractor shall provide one mobile unit (FOR USE BY THE CM) on the Project site complete with parking facilities, hereinafter called field office, for the use of VRE and its Construction Manager in administering the Contract. Additionally, the Contractor shall provide one mobile unit for use by the Contractor.
- B. The field offices shall be situated in the work area at an approved location. The field offices shall be complete as specified and ready for occupancy by the Construction Manager and Contractor within fourteen (14) calendar days after receipt of Notice to Proceed. It shall be maintained and serviced by the Contractor as hereinafter specified until 60 days following completion of the work. A mobile unit shall have the features specified below.
- C. The Contractor shall obtain and pay all costs for hauling, building, and connection permits. The field offices shall be substantially constructed satisfactory to VRE.

- D. All materials shall be good commercial quality. The field offices shall provide a minimum of 600 square feet of usable area, with the following additional requirements:
1. Exterior surfaces of buildings and all interior surfaces, other than factory-finished surfaces, shall be painted with two coats of an approved paint of approved color(s). No painting will be required on aluminum or stainless-steel surfaces.
  2. Exterior walls, ceilings and floors, shall be insulated; interior walls and ceiling surfaces shall be paneled with finished plywood or gypsum wallboard of not less than one-half inch thickness, or other suitable materials.
  3. Floors shall be covered with flooring material such as resilient tile or sheet linoleum. Floors shall be constructed to withstand a live load of 125 psf.
  4. One (1) rest room shall be provided, with lavatory, self-contained toilet unit, mirror, soap holder, toilet paper holder, paper towel dispenser, and hot and cold water supply.
  5. Lighting shall be provided to furnish a minimum of 100 foot-candles at desk height uniformly in all areas except rest rooms. Rest rooms shall be provided with adequate lighting.
  6. Duplex electrical receptacles shall be provided around interior walls at approximately ten-foot spacing.
  7. An electric water cooler shall be installed to supply cool drinking water.
  8. At Contractor's cost and expense, install, operate, protect and maintain a temporary Heating and air conditioning system. The system shall have thermostatic control. Systems shall be capable of maintaining office at ambient temperature of 72F.
  9. Water, sewer, and electrical utility connections shall be provided as necessary.
  10. Adequate access from public streets shall be provided to the field offices together with adjacent space for parking two (2) cars, for use by the CM and VRE. The access roadway and parking area shall be graded for drainage and surfaced with crushed stone, concrete or bituminous pavement in an approved manner.
  11. The interior of the field offices shall provide the following nominal dimensions for partitioned office rooms with doors and locks:
    - a. One (1) at minimum one hundred ninety-two (192) square feet
    - b. One (1) Conference Room (general area) minimum three hundred sixty (360) square feet
  12. The field offices shall also include two (2) exterior doors, 100 square feet of counter space and 200 square feet of shelving arranged as directed by the Construction Manager. Each exterior door shall be equipped with a cylinder lock, mastered keyed alike, and two (2) keys.
- E. The field offices shall be provided with the following new furniture and equipment:
1. Two (2) Desks, 60 inches by 30 inches; with one file drawer and four drawers, all with locks; with swivel armchair

2. Four (4) Folding Tables, 72 inches by 30 inches
  3. Sixteen (16) Folding Side Chairs
  4. One (1) Plan Table, 30 inches by 72 inches, inclined and at height suitable for standing
  5. Two (2) Bookcases, 36 inches by 42 inches, with four shelves
  6. Two (2) Fireproof File Cabinets, legal size, four drawers, with lock
  7. One (1) Rolling Plan Storage Rack, twelve-stick
  8. One (1) Utility Cabinet, 18 inches by 46 inches by 30 inches, with lock
  9. One (1) Dry Erase Board, 60 inches by 36 inches
  10. One (1) Refrigerator, minimum 10 cubic feet, frost free
  11. One (1) Microwave, minimum 1000 watts
  12. Three (3) Wastebaskets, small size
  13. One (1) First Aid Kit containing eye and skin protection for emergencies. List telephone number for hospitals and ambulance service in each first aid kit.
  14. Two (2) Fire Extinguishers
  15. One (1) digital multifunction commercial document printer/copier system which shall include color copy, print, and scan functions. The copier shall accommodate, at a minimum, 2 reams of paper sizes 8 ½ x 11 and 11 x 17. The Contractor shall maintain the equipment, provide replacement materials, and any associated software for the duration of this Contract.
- F. Quantities and specifics of the furniture and equipment can be negotiated at the discretion of the Construction Manager, if so requested by the Contractor.
- G. All windows shall be provided with shades, blinds, or curtains and security grills
- H. Maintenance and service shall be provided by the Contractor as follows:
1. Repair and weekly cleaning of the field offices, parking area and access road, including complete janitorial services and supplies
  2. The furnishing of all utilities which shall include sewer, water, electric, telephone, and high speed (DSL, cable, or fiber optic) internet connection.
  3. During other than normal working hours, provide security measures and area protection for the Construction Manager's facility equivalent to that used by the Contractor for his job site shop and office facilities, or as approved by VRE.
  4. Provide sufficient area lighting for the Construction Manager's facility, equivalent to that provided by the Contractor for his job site shop and office facilities.
- I. Pest Control: Contractor shall retain a local exterminator or pest-control company to recommend practices to minimize attraction and harboring of rodents, roaches, and other pests. Engage this pest-control service to perform extermination and control procedures at regular

intervals so Temporary facilities will be free of pests and their residues at Substantial Completion. Perform control operations lawfully, using environmentally safe materials.

- J. At the completion of this Contract, the complete facility will become the property of the Contractor, who shall remove it and restore the site.

**1.10 CONTRACTOR PERSONNEL PARKING**

- A. VRE is not responsible for on or offsite parking. Parking facilities for Contractor's personnel shall be the Contractor's responsibility.
- B. Contractor is limited to the construction area as defined in the contract documents. If available, the on-site parking and staging of both company-owned and personal vehicles will be limited to the construction area as defined in the Contract documents. Do not under any circumstances, leave any vehicle unattended with motor running, or with ignition key in-place.
- C. Parking of company-owned and construction personnel's private vehicles at VRE parking lots is prohibited.
- D. If off-site parking is required, Contractor will be responsible for the maintenance, security, safety, and operation of its vehicles/equipment. This cost will be considered part of the Contractor's general conditions. Transportation of personnel to the Work site is the responsibility of the Contractor. Contractor is responsible for the payment of any parking charges or fines resulting from illegal parking at any work site(s). The Contractor shall monitor parking of construction personnel's private vehicles and ensure that the public has unobstructed access to and through parking areas.

**1.11 TEMPORARY UTILITY SERVICE**

- A. Determine the need for such temporary utility service as may be required to perform the work and make arrangements with utility companies for such service.
- B. The Contractor shall provide temporary electrical service of sufficient capacity to serve its requirements during the life of the Contract. Temporary services shall be furnished, installed, connected, and maintained by the Contractor in an approved manner.
- C. The source of temporary power for testing may be the temporary service, portable generator or other approved system which will deliver power at the voltage and other characteristics required to accomplish testing as specified. Circuits and construction for temporary systems shall suit the needs of the work and comply with NEC (National Electric Code) and the codes and regulations of the jurisdictional authorities and the requirements of VRE.
- D. Remove all materials and equipment involved with temporary utility service as part of final cleanup.
- E. All costs incurred in obtaining permits; utility service, including connection and disconnection; and furnishing, installing, maintaining, and removing such materials as may be required shall be borne by the Contractor.

**1.12 TEMPORARY SANITARY FACILITIES**

- A. The Contractor shall furnish for use of his work force the necessary temporary toilet conveniences, secluded from public observation, wash facilities and drinking-water fixtures. Keep in a clean, sanitary condition.
  - 1. Disposable Supplies: Provide toilet tissue, paper towels, paper cups, and similar disposable materials for each facility. Maintain adequate supply. Provide covered waste containers for disposal of used material.
  - 2. Toilets: Install self-contained toilet units, located as approved by CM. Shield toilets to ensure privacy. Provide separate facilities for male and female personnel.
  - 3. Wash Facilities: Install wash facilities supplied with potable water at convenient locations for personnel who handle materials that require wash up. Dispose of drainage properly. Supply cleaning compounds appropriate for each type of material handled.
    - a. Provide safety showers, eyewash fountains, and similar facilities for convenience, safety, and sanitation of personnel.
  - 4. Drinking-Water Facilities: Provide bottled-water, drinking-water units.
- B. Comply with the requirements and regulations of the local, state, and other agencies having jurisdiction.

#### **1.13 PROJECT IDENTIFICATION SIGNAGE**

- A. Provide one sign for the Field Office to indicate the location of the office. Use 1/2 or 3/4-inch-thick exterior, A-B grade plywood, cut two (2) feet by four (4) feet long. Paint the sign with one coat of primer sealer and two coats of white semi-gloss enamel. Letter each sign with black enamel paint, using block letters at least four (4) inches high, with the Contract Name, Contract Number and the words VRE/CONSTRUCTION MANAGER'S FIELD OFFICE painted each on a separate line. Where the field office to be so identified is not readily visible from the project entrance, paint a directional arrow on the sign and locate the sign near the project entrance. The exact location of the field office signs and the proposed method of mounting shall be subject to the approval of the Construction Manager.
- B. Contractor's Identification Signs: The Contractor may erect his own signs to identify himself and, if he wishes, his subcontractors. The overall size of the Contractor's identification signs shall not exceed four (4) feet by eight (8) feet wide. The exact location, method of mounting and mounting height of the Contractor's identification signs will be subject to the approval of the Construction Manager.
- C. Provide other signs as indicated and as required to inform public and individuals seeking entrance to Project.
- D. Provide temporary, directional signs for construction personnel and visitors.
- E. Maintain all signs throughout the course of construction until final acceptance, keeping them clean, in good repair, and free of obstructions.
- F. Upon final acceptance of the work, remove and dispose of all signs, unless otherwise directed by VRE.



**1.14 U.S. DEPARTMENT OF LABOR SIGNAGE**

The following posters required by the U.S. Department of Labor shall be posted at the construction site, in English and Spanish, in a location visible to all workers:

- A. The Davis-Bacon Act, Poster WH-1321
- B. Equal Employment Opportunity Act, Poster EEOC-P/E-1
- C. Minimum Wage / Fair Labor Standards Act, Poster WH-1088
- D. OSHA Job Safety and Health Protection, Poster OSHA-3165

The required posters can be downloaded and/or purchased from the U.S. Department of Labor website.

**1.15 MAINTENANCE OF TRAFFIC (ROADWAY)**

- A. If the project is located adjacent to a public street or highway, the Contractor shall have at least one person on the project site during all work operations who is currently verified either by VDOT's Intermediate Work Zone Traffic Control training or by the American Traffic Safety Services Association (ATSSA) Intermediate Traffic Control Supervisor (TCS) training. This person shall be responsible for the oversight of work zone traffic control within the project limits in compliance with the Contract requirements, the VWAPM if the Project is located in Virginia, and the MUTCD. This person's duties shall include the supervision of the installation, adjustment (if necessary), inspection, maintenance, and removal when no longer required, of all work zone traffic control devices on the project.
- B. Certified flaggers shall be provided, by the Contractor, in sufficient number and locations as necessary for control and protection of vehicular and pedestrian traffic in accordance with the VWAPM (Virginia Work Area Protection Manual) and the MUTCD (Manual on Uniform Traffic Control Devices). Flaggers shall be able to communicate to the traveling public in English while performing the job duty as a flagger at the flagger station. Flaggers shall use sign paddles to regulate traffic in accordance with the VWAPM or MUTCD, as applicable.
- C. Employees performing flagging duties shall be certified for such activity by a certification course accepted by VDOT (or local jurisdiction as necessary). Certification cards shall be carried by flaggers while performing flagging duties and presented to the CM or VRE upon request.
- D. The Contractor shall conduct its operations in a manner that will ensure that traffic will be uninterrupted except as approved by VRE. At the close of each work day, the area of work shall be confined to the smallest area possible so that the maximum use of surrounding streets, parking lots, and passenger facilities will be restored and the hazard to pedestrian and vehicular traffic reduced to a minimum. No excavation shall remain open within the roadway, parking lot, or passenger facility without the approval of VRE except when the excavation can be safely bridged with the use of steel plates or other materials acceptable to VRE. When areas of excavation outside of the roadway do remain open, the area shall be barricaded to the satisfaction of VRE and warning signs shall be posted.

- E. At all times the Contractor shall use the personnel and traffic control signs and devices necessary to comply with Part VI of the MUTCD. During the progress of the work when the street may be obstructed to any extent by construction equipment or construction operations, in addition to the signs and barricades, special workers, equipped with "STOP\SLOW" double sided traffic control paddles, shall be designated by the Contractor to direct traffic. These workers so designated shall not be assigned to any other duties while engaged in directing traffic. The Contractor has sole responsibility for ensuring that its operations are conducted in a safe manner.
- F. All costs associated with contractor's personnel, signs, barricades, and any other items necessary for protection of the site and Work, as well as access in and out of the site, either temporary or permanent, shall be the responsibility of the Contractor and included in the base bid for the project.
- G. The MOT plan as implemented in the field during construction of this project shall be as directed, reviewed, and approved by VRE, the Construction Manager, and the AHJ (Authority Having Jurisdiction).
- H. The Contractor shall furnish, install, maintain, and remove when no longer required, all traffic control and protective devices required.
- I. Controls within Railroad right of way are subject to Railroad approval.

#### **1.16 CONSTRUCTION OPERATIONS UNDER RAILROAD TRAFFIC**

- A. General: Construction equipment is defined for the purpose of this article as all types of equipment, vehicles, and tools used in connection with construction work. The term workmen include every person or firm performing work in or adjacent to public streets.
- B. Construction Operations:
  - 1. No construction work involving occupancy or impact of tracks shall take place without prior approval of the VRE and the Host Railroad.
  - 2. Contractor shall comply with instructions provided by the Railroad flagman, VRE, the CM and/or the Inspector regarding safety rules and regulations near active tracks.
- C. Crossing Tracks / Traffic Lanes: When crossing open traffic lanes by construction equipment is necessary, such crossing shall be safeguarded with flagmen.
- D. Removal of Traffic Control Devices: All temporary signs, barricades, barrier curbs, drums, and cones used for safeguard traffic in connection with construction work shall be removed at the close of the work day, unless the state of the work is such that warning devices are still needed and are adapted for night closing. In such cases notify VRE reasonably in advance of the normal quitting time that he may review the status of the work and request additional safety measures as he deems necessary.
- E. Storage: Material storage shall be limited to designated staging areas.

#### **1.17 WORK, STAGING AND STORAGE AREAS**

- A. The Contract Drawings will show the work areas available to Contractor for storage of project materials and for parking of project construction equipment. These areas will be provided to the Contractor for the duration of construction without charge. CM and Contractor will make a joint site visit to document condition of staging area prior to occupancy. Take photos for the record.
- B. The Contractor at their own expense, if necessary, shall provide additional work and storage space as approved by VRE.
- C. If off-site storage of materials and equipment is required, Contractor will be responsible for the maintenance, security, safety, and operation of these facilities. This cost will be considered part of the Contractor's general conditions. Transportation of materials and equipment to the Work site is the responsibility of the Contractor.
- D. Erect and maintain a 6-foot high chain link fence topped with 3-strands of barbed wire around perimeter of staging area. Protect all stored equipment from the weather. VRE accepts no responsibility for items stored in this area.
- E. Upon completion of Construction, remove all temporary staging area facilities and return the areas to their original condition.
- F. Do not stockpile construction materials, spoils, debris or refuse in any area other than that specifically approved for such purpose by the CM.
- G. Constrain stockpiled material in a manner to prevent its movement by wind or train slip stream or draft.

#### **1.18 TERMINATION AND REMOVAL**

- A. Remove each temporary facility when need for its service has ended, when it has been replaced by authorized use of a permanent facility, or no later than Substantial Completion. Complete or, if necessary, restore permanent construction that may have been delayed because of interference with temporary facility. Repair damaged Work, clean exposed surfaces, and replace construction that cannot be satisfactorily repaired.
  - 1. Properly recondition and restore those portions of the site occupied by temporary facilities and controls to condition acceptable to CM, at least equal to condition at time of start of Work, unless otherwise authorized in writing by CM.
  - 2. Materials and facilities that constitute temporary facilities are the property of Contractor. VRE reserves right to take possession of Project identification signs.
  - 3. Remove temporary paving not intended for or acceptable for integration into permanent paving. Where area is intended for landscape development, remove soil and aggregate fill that do not comply with requirements for fill or subsoil. Remove materials contaminated with road oil, asphalt and other petrochemical compounds, and other substances that might impair growth of plant materials or lawns. Repair or replace roadway paving, curbs, and sidewalks at temporary entrances, as required by authorities having jurisdiction.

4. At Substantial Completion, clean and renovate permanent facilities used during construction period. Comply with final cleaning requirements in Division 01 Section 01 77 00 "Closeout. Procedures"

**PART 2 - PRODUCTS**

Not Used

**PART 3 - EXECUTION**

Not Used

**END OF SECTION**

**SECTION 01 73 00****Execution of Work****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes general administrative and procedural requirements governing execution of the Work including, but not limited to, the following:
  - 1. Subcontracting
  - 2. Cooperation of Contractor
  - 3. Cooperation with Utility Companies
  - 4. Cooperation Among Contractors
  - 5. Cutting and Patching
  - 6. Existing Conditions
  - 7. Preparation
  - 8. Installation
  - 9. Construction Survey/Layout
  - 10. Historical and Scientific Specimens
  - 11. Correction of the Work
  - 12. Products Installed by VRE
  - 13. Salvage Materials and Owner Provided Materials
  - 14. Progress Cleaning
  - 15. Dust Control
  - 16. Starting and Testing
  - 17. Protection of installed construction
  - 18. Maintenance of Work
  - 19. Removal of Unacceptable and Unauthorized Work

**1.02 RELATED SECTIONS**

- A. General Conditions for Construction
- B. Section 01 26 00 – Change Order Procedures
- C. Section 01 31 00 – Project Management and Coordination
- D. Section 01 32 00 – Construction Progress Documentation

- E. Section 01 45 00 – Quality Assurance and Quality Control
- F. Section 01 50 00 – Temporary Facilities and Controls

**1.03 SUBMITTALS**

- A. Qualification Data: For licensed land surveyor
- B. Certificates: Submit certificate signed by licensed land surveyor or certifying that location and elevation of improvements comply with requirements.
- C. Certified Surveys: Submit two copies signed by licensed land surveyor.

**1.04 QUALITY ASSURANCE**

- A. Land Surveyor Qualifications: A professional land surveyor who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing land-surveying services of the kind indicated.
- B. Manufacturer's Installation Instructions: Obtain and maintain on-site manufacturer's written recommendations and instructions for installation of products and equipment.

**1.05 SUBCONTRACTING**

- A. All subcontractors are subject to approval by the CM and VRE prior to such subcontractors performing any Work on the project. A subcontractor list shall be submitted to the CM for approval per Section 01 31 00, "Project Management and Coordination."

**1.06 COOPERATION OF CONTRACTOR**

- A. The Contractor shall give the Work the constant attention necessary to facilitate quality and progress, and shall fully cooperate with the CM, the Inspector, and other contractors involved in the prosecution of the Work. If any portion of a project is located within the limits of a municipality, military installation, or other federally owned property, the Contractor shall cooperate with the appropriate officials and their agents in the prosecution of the Work to the same extent as with VRE.
- B. The Contractor shall have on the project at all times during prosecution of the Work a competent Superintendent who is capable of reading and understanding the plans and Specifications, experienced in the type of work being performed, and who shall receive instructions from VRE, the CM, or their authorized representatives. The Superintendent shall have full authority to execute the orders and directions of the CM without delay and supply promptly such materials, equipment, tools, labor, and incidentals as may be required.

**1.07 COOPERATION WITH UTILITY COMPANIES**

- A. The adjustment of utilities consists of the relocation, removal, replacement, rearrangement, reconstruction, improvement, protection, disconnection, connection, shifting, or altering of an existing utility in any manner.
- B. Existing utilities within VRE's knowledge at the design stage of the project will be indicated on the plans. Where possible, VRE will make arrangements for adjusting these utilities prior to project construction. The utility owner will adjust existing private and public utilities that require adjustment, unless the Contract requires the Contractor to perform such adjustment as

- a pay item. The new location of such utilities may not be shown on the plans. Some utilities may remain or be adjusted within the construction limits simultaneously with project construction operations.
- C. The Contractor shall coordinate project construction with planned utility adjustments and take all necessary precautions to prevent disturbance of the utilities. The Contractor shall report to the CM any failure on the part of the utility owner to cooperate or proceed with the planned utility adjustments.
  - D. The Contractor shall perform Contract utility work in a manner that will cause the least inconvenience to the utility owner and those being served by the utility owner.
  - E. The Contractor shall protect existing, adjusted, or new utilities that are shown on the plans, marked by Miss Utility, or otherwise known to the Contractor that are to remain within the right of way so as to prevent disturbance or damage resulting from construction operations. If during prosecution of the work the Contractor encounters an existing utility that requires adjustment, they shall not interfere with the utility but shall take the proper precautions to protect the utility and shall promptly notify the CM of the need for adjustment.
  - F. If the Contractor desires the temporary or permanent adjustment of utilities for their own benefit, they shall conduct all negotiations with the utility owners and pay all costs in connection with the adjustment.
  - G. The Contractor shall promptly notify the CM in writing if the Contractor encounters utilities that are not shown on the plans, marked by Miss Utility, or otherwise known to the Contractor before the site is disturbed further and before the affected work is performed. Upon receipt of the Contractor's written notification, the CM will acknowledge receipt and investigate the conditions. The CM will notify the Contractor whether or not an adjustment to the Contract is warranted. Adjustments will be made according to Sections 01 26 00, "Change Order Procedures," as applicable.
  - H. No adjustment that results in a benefit to the Contractor will be allowed unless the Contractor has provided the required written notice.

#### **1.08 COOPERATION AMONG CONTRACTORS**

- A. VRE may at any time contract or approve concurrent Contracts for performance of other work on, near, or within the same geographical area of the work specified in an existing Contract. Contractors shall not impede or limit access to such work by others.
- B. When separate Contracts are awarded within the limits of one project, contractors shall not hinder the work being performed by other Contractors. Contractors working on the same project shall cooperate with each other. In the case of dispute, all Contractors shall proceed as directed by the CM.
- C. When Contracts are awarded to separate Contractors for known concurrent construction in a common area, the Contractors, in conference with the CM, shall establish a written joint schedule of operations. The schedule shall be based on the limitations of the individual Contracts and the joining of the work of one Contract with the others. The schedule shall set forth the approximate dates and sequences for the several items of work to be performed and

- shall ensure completion within the respective Contract time limit. The schedule shall be submitted to the CM for review and approval no later than 30 days after the award date of the later Contract and prior to the first monthly application for payment. The schedule shall be agreeable to, signed by, and binding on each Contractor. The CM may allow modifications of the schedule when benefit to the Contractors and VRE will result.
- D. Any modification of the schedule shall be in writing, mutually agreed to and signed by the contractors, and shall be binding on the contractors in the same manner as the original agreement.
  - E. If the contractors fail to agree on a joint schedule of operations, they shall submit their individual schedules to the CM, who will prepare a schedule that will be binding on each Contractor.
  - F. The joint schedule and any modification thereof shall become a part of each Contract involved. The failure of any Contractor to abide by the terms of the joint schedule will be justification for declaring the Contractor in default of their Contract.
  - G. Each Contractor shall assume all liability, financial or otherwise, in connection with their Contract and shall protect and save harmless the Owner from any and all damages and claims that may arise because of any inconvenience, delay, or loss he experiences as a result of the presence and operations of other contractors working in or near the work covered by their Contract. They shall also assume all responsibility for any of their work not completed because of the presence or operation of other Contractors.
  - H. VRE will not assume any responsibility for acts, failures, or omissions of one Contractor that delay the work of another except as provided herein.

## **PART 2 - PRODUCTS**

Not Used

## **PART 3 - EXECUTION**

### **3.01 CUTTING AND PATCHING**

- A. Cutting: Removal of in-place construction necessary to permit installation of other work.
- B. Patching: Fitting and repair work required to restore construction to original conditions after installation of other work.
- C. The Contractor is responsible for cutting, fitting, or patching as required. The Contractor shall not unnecessarily damage any portion of the project work by cutting, fitting, or patching. Any damages resulting from cutting, fitting, or patching in the project shall be borne by the Contractor.
- D. Cutting and Patching Plan: Submit plan describing procedures at least 10 days prior to the time cutting and patching will be performed. Include the following information:
  - 1. Extent: Describe reason for and extent of each occurrence of cutting and patching.



2. Changes to In-Place Construction: Describe anticipated results. Include changes to structural elements and operating components as well as changes in building appearance and other significant visual elements.
3. Products: List products to be used for patching and firms or entities that will perform patching work.
4. Dates: Indicate when cutting and patching will be performed.
5. Utilities and Mechanical and Electrical Systems: List services and systems that cutting and patching procedures will disturb or affect. List services and systems that will be relocated and those that will be temporarily out of service. Indicate length of time permanent services and systems will be disrupted.
  - a. Include description of provisions for temporary services and systems during interruption of permanent services and systems.

### **3.02 EXISTING CONDITIONS**

- A. The existence and location of underground and other utilities and construction indicated as existing are not guaranteed. Before beginning sitework, investigate and verify the existence and location of underground utilities, mechanical and electrical systems, and other construction affecting the Work.
  1. Before construction, verify the location and invert elevation at points of connection of sanitary sewer, storm sewer, and water-service piping; underground electrical services, and other utilities.
  2. Furnish location data for work related to Project that must be performed by public utilities serving Project site.
- B. Before proceeding with each component of the Work, examine substrates, areas, and conditions, with Subcontractor, Installer, or Applicator present where indicated, for compliance with requirements for installation tolerances and other conditions affecting performance. Record observations.
  1. Examine roughing-in for mechanical and electrical systems to verify actual locations of connections before equipment and fixture installation.
  2. Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.
  3. Verify compatibility with and suitability of substrates, including compatibility with existing finishes or primers.
- C. Written Report: Where a written report listing conditions detrimental to performance of the Work is required by other Sections, include the following:
  1. Description of the Work.
  2. List of detrimental conditions, including substrates.
  3. List of unacceptable installation tolerances.

4. Recommended corrections.
- D. Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions and the cost of any and all remedial work required due to installation on unacceptable surfaces and substrates or under improper conditions shall be borne by the Contractor.

### **3.03 PREPARATION**

- A. Furnish information to local utility and/or Owner that is necessary to adjust, move, or relocate existing utility structures, utility poles, lines, services, or other utility appurtenances located in or affected by construction. Coordinate with authorities having jurisdiction.
  1. Refer to Section 01 11 00, "Summary of Work," for utility information.
- B. Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
- C. Verify space requirements and dimensions of items shown diagrammatically on Drawings.
- D. Immediately upon discovery of the need for clarification of the Contract Documents caused by differing field conditions outside the control of Contractor, submit a request for information to the CM according to requirements in Section 01 31 00, "Project Management and Coordination."

### **3.04 INSTALLATION**

- A. Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.
  1. Make vertical work plumb and make horizontal work level.
  2. Where space is limited, install components to maximize space available for maintenance and ease of removal for replacement.
  3. Conceal pipes, ducts, and wiring in finished areas unless otherwise indicated.
- B. Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.
- C. Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.
- D. Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.
- E. Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.
- F. Do not use tools or equipment that produce harmful noise levels. Noise ordinances issued by the Authority Having Jurisdiction must be followed.

- G. Obtain and distribute to the parties involved templates for work specified to be factory prepared and field installed. Check Shop Drawings of other work to confirm that adequate provisions are made for locating and installing products to comply with indicated requirements.
- H. Provide blocking and attachment plates and anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.
  - 1. Mounting Heights: Where mounting heights are not indicated, mount components at heights directed by VRE or the CM.
  - 2. Allow for building movement, including thermal expansion and contraction.
  - 3. Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.
- I. Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

### **3.05 CONSTRUCTION SURVEY/LAYOUT**

- A. Unless otherwise specified, the Contractor shall establish all baselines for the location of the principal component parts of the Work, establish a suitable number of benchmarks adjacent to the Work, and develop all detailed surveys necessary for construction. The Contractor shall carefully preserve benchmarks, reference points and stakes, and in the case of destruction thereof by the Contractor or due to the Contractor's negligence or the negligence of any subcontractor, the Contractor shall be responsible for expense and damage resulting therefrom and shall be responsible for any mistakes that may be caused by the loss or disturbance of such benchmarks, reference points and stakes.
- B. Before proceeding to lay out the Work, the Contractor shall verify layout information shown on Drawings, in relation to the property survey and existing benchmarks. If discrepancies are discovered, promptly notify the CM.
- C. The Contractor shall engage a land surveyor licensed in the jurisdiction where the project is physically located to lay out the Work using accepted surveying practices. The licensed land surveyor shall:
  - 1. Establish benchmarks and control points to set lines and levels at each story of construction and elsewhere as needed to locate each element of the project
  - 2. Establish limits on use of project site
  - 3. Establish dimensions within tolerances indicated. Do not scale Drawings to obtain required dimensions.
  - 4. Inform installers of lines and levels to which they must comply
  - 5. Check the location, level, and plumb, of every major element as the Work progresses

6. Notify the CM when deviations from required lines and levels exceed allowable tolerances
  7. Close site surveys with an error of closure equal to or less than the standard established by the AHJ
  8. Locate and lay out site improvements, including grading, fill and topsoil placement, ramps and walkways, utility slopes, and rim and invert elevations.
  9. Locate and lay out control lines and levels for structures, station platforms, building foundations, column grids, and floor levels, including those required for mechanical and electrical work
  10. Transfer survey markings and elevations for use with control lines and levels
  11. Level foundations and piers from two or more locations
- D. Maintain a record log of layout control work. Record deviations from required lines and levels. Include beginning and ending dates and times of surveys, weather conditions, name and duty of each survey party member, and types of instruments and tapes used. Make the log available for reference by the CM upon request.
- E. Benchmarks
1. Refer to drawings for existing benchmarks, control points, and property corners
  2. Locate existing permanent benchmarks, control points, and similar reference points before beginning the Work. Preserve and protect permanent benchmarks and control points during construction operations.
    - a. Do not change or relocate existing benchmarks or control points without prior written approval of the CM. Report lost or destroyed permanent benchmarks or control points promptly. Report the need to relocate permanent benchmarks or control points to CM before proceeding.
    - b. Replace lost or destroyed permanent benchmarks and control points promptly. Base replacements on the original survey control points.
  3. Establish and maintain a minimum of two permanent benchmarks on Project site, referenced to data established by survey control points. Comply with authorities having jurisdiction for type and size of benchmark.
  4. Record benchmark locations, with horizontal and vertical data, on Project Record Documents.
  5. Where the actual location or elevation of layout points cannot be marked, provide temporary reference points sufficient to locate the Work.
  6. Remove temporary reference points when no longer needed. Restore marked construction to its original condition.

### **3.06 HISTORICAL AND SCIENTIFIC SPECIMENS**

- A. All articles of historical/scientific value or archeological significance, including coins, fossils, and articles of antiquity, which may be uncovered by Contractor during progress of the work,

shall become the property of VRE. Such findings shall be reported immediately to the Construction Manager who will determine method of removal, where necessary, and final disposition thereof.

### **3.07 CORRECTION OF THE WORK**

- A. Repair or remove and replace defective construction. Restore damaged substrates and finishes. Comply with requirements in this Specification Section.
  - 1. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly adjusting operating equipment.
- B. Restore permanent facilities used during construction to their specified condition.
- C. Remove and replace damaged surfaces that are exposed to view if surfaces cannot be repaired without visible evidence of repair.
- D. Repair components that do not operate properly. Remove and replace operating components that cannot be repaired.
- E. Remove and replace chipped, scratched, and broken glass or reflective surfaces in kind.

### **3.08 PRODUCTS INSTALLED BY VRE**

- A. Provide access to Project site for VRE's construction personnel.
- B. Coordinate construction and operations of the Work with work performed by VRE construction personnel.
  - 1. Inform VRE of Contractor's preferred construction schedule for VRE's portion of the Work. Adjust construction schedule based on a mutually agreeable timetable. Notify VRE if changes to schedule are required due to differences in actual construction progress.
  - 2. Include VRE's construction personnel at pre-activity meetings covering portions of the Work that are to receive VRE's work. Attend pre-activity meetings conducted by VRE's construction personnel if portions of the Work depend on VRE's construction.
- C. Contractor shall be responsible for maintaining all products installed by VRE. The Contractor shall take all necessary precautions for safety of and shall provide reasonable protection to prevent damage, injury or loss to persons, properties, equipment and vehicles.
  - 1. Damage to products installed by VRE, caused by the Contractor, shall be repaired or replaced to the satisfaction of VRE at the expense of the Contractor.
  - 2. VRE, at its sole discretion, shall have the right to repair and/or replace damaged products. Such costs shall be deducted from Contractor invoices upon completion of the repair or replacement of the damage.

### **3.09 SALVAGE MATERIALS AND OWNER PROVIDED MATERIALS**

- A. The Contractor shall maintain adequate property control records for materials and equipment specified to be salvaged. Contractor shall be responsible for the adequate storage and protection of salvaged materials and equipment. The Contractor shall replace, at no cost to VRE salvage materials and equipment that are broken or damaged during the salvage operations as the result

of the Contractor's negligence. Salvage material not specified for reuse shall be the property of the Contractor and shall be removed from the site.

- B. Owner provided materials shall become the responsibility of the contractor upon mobilization to the site and shall be treated and secured typical to other material to be used on the project.

### **3.10 PROGRESS CLEANING**

- A. Maintain and clean project site and work areas daily, including common areas. Coordinate progress cleaning for joint-use areas where more than one installer has worked. Enforce requirements strictly. Dispose of materials lawfully.
  - 1. Comply with requirements in NFPA 241 for removal of combustible waste materials and debris.
  - 2. Do not hold waste materials more than seven calendar days during normal weather or three calendar days if the temperature is expected to rise above 80 deg F.
  - 3. Contain hazardous and unsanitary waste materials separately from other waste. Mark containers appropriately and dispose of legally, according to regulations.
    - a. Use containers intended for holding waste materials of type to be stored.
  - 4. Coordinate progress cleaning for joint-use areas where Contractor and other contractors are working concurrently.
  - 5. Do not transport construction debris through occupied areas of existing facilities.
- B. Maintain project site free of waste materials and debris.
- C. Maintain and clean areas where work is in progress to the level of cleanliness necessary for proper execution of the Work.
  - 1. Remove liquid spills promptly.
  - 2. Where dust would impair proper execution of the Work, broom-clean or vacuum the entire work area, as appropriate.
- D. Keep railroad tracks and adjacent spaces clear of mud, dirt, debris, and any other substances or construction materials at all times.
- E. Public roads, driveways, and pedestrian areas shall be cleared of all mud, dust, debris, etc. on a daily basis or as directed by the CM.
- F. Keep installed work clean. Clean installed surfaces according to written instructions of manufacturer or fabricator of product installed, using only cleaning materials specifically recommended. If specific cleaning materials are not recommended, use cleaning materials that are not hazardous to health or property and that will not damage exposed surfaces.
- G. Remove debris from concealed spaces before enclosing the space.
- H. Clean exposed surfaces and protect as necessary to ensure freedom from damage and deterioration at time of Substantial Completion.

- I. Do not bury or burn waste materials on site. Do not wash waste materials down sewers or into waterways. Comply with waste disposal requirements in Section 01 50 00, "Temporary Facilities and Controls."
- J. During handling and installation, clean and protect construction in progress and adjoining materials already in place. Apply protective covering where required to ensure protection from damage or deterioration at Substantial Completion.
- K. Clean and provide maintenance on completed construction as frequently as necessary through the remainder of the construction period. Adjust and lubricate operable components to ensure operability without damaging effects.
- L. Supervise construction operations to assure that no part of the construction, completed or in progress, is subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- M. Responsibilities of the Contractor:
  - 1. Dumpsters shall be located at each site, accessible to building and roads. Each Contractor may legally load acceptable construction debris into the dumpsters from this project only. Cost of all disposal fees shall be by the Contractor and dumpsters shall remain on the project until project completion, or as directed by the CM. The Contractor shall secure dumpsters during off-hours. This excludes asbestos items.
  - 2. The Contractor is responsible for clean-up and disposal of waste materials, debris and rubbish on a daily basis.
  - 3. The Owner may issue written notification of insufficient cleaning relative to the requirements of this Section. Upon issuance of the cleaning notice:
    - a. All waste and accumulation of trash containing the Contractor's debris shall be removed from the Owner's premises within 24 hours of notification.
    - b. All designated project areas containing the Contractor's debris or requiring general housekeeping shall be left fine broom clean (interior) or raked clean (exterior or rough surface). Sweeping compound shall be used for all interior broom cleaning to control dust.
    - c. Failure by the Contractor to comply with the 24-hour requirement of the notice to the satisfaction of the Owner will result in a cleaning program directed by the Owner at the expense of the Contractor. Cost of clean-up performed by the Owner will be deducted from the Contractor's Request for Payment.
  - 4. Maintain areas under Contractor's control free of waste materials, debris, and rubbish. Maintain site in a clean and orderly condition.
  - 5. Daily clean interior areas to provide suitable conditions for work.
  - 6. Broom clean interior areas prior to start of surface finishing and continue cleaning on an as-needed basis.

7. Control cleaning operations so that dust and other particles will not adhere to wet or newly coated surfaces.
8. Remove waste materials, debris, and rubbish from site or to a dumpster provided by the Contractor daily.
9. The Contractor shall provide end-of-day cleanup of all work on a daily basis, conforming to requirements above.

### **3.11 DUST CONTROL**

- A. The Contractor shall, at all times, control the spread of dust and dirt during the execution of the work. Use water mist, temporary closures, and other suitable methods. Use wet saws for cutting. Provide walk-off mats at entrances and exits to construction areas.
  1. Do not use water when it may damage existing construction or create hazardous or objectionable conditions.
  2. Wet mop floors to eliminate trackable dust and dirt and wipe down walls and doors of dust and dirt.
- B. Do not direct dust and dirt onto railroad tracks during cleaning.

### **3.12 STARTUP AND TESTING**

- A. Start equipment and operating components to confirm proper operation. Remove malfunctioning units, replace with new units, and retest.
- B. Adjust equipment for proper operation. Adjust operating components for proper operation without binding.
- C. Test each piece of equipment to verify proper operation. Test and adjust controls and safeties. Replace damaged and malfunctioning controls and equipment.
- D. Comply with manufacturer field service requirements as noted in Section 01 45 00, "Quality Assurance and Quality Control."

### **3.13 PROTECTION OF INSTALLED CONSTRUCTION**

- A. Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.
- B. Comply with manufacturer's written instructions for temperature and relative humidity.
- C. Supervise construction operations to ensure that in progress work is not stored on and/or effects completed construction such as floors and walls, which are subject to harmful, dangerous, damaging, or otherwise deleterious exposure during the construction period.
- D. Roof Areas:
  1. Construction traffic and storage of materials on completed roof surfaces is not allowed. Where work is required, the contractor shall submit a protection plan, 14 calendar days prior to scheduled commencement of the work. Protection plan to include the following:
    - a. Type of work to be performed.



- b. Location of work areas.
  - c. Route of materials and workers to work area.
  - d. Materials and methods to be used.
2. Proceed with work after owner's authorization. Damage to roof surfaces shall be repaired and the cost of any and all remedial work shall be borne by the Contractor.

**3.14 MAINTENANCE OF WORK**

- A. The Contractor shall maintain the Work, the project site, construction area, railway, roadway, and passenger areas affected by construction from the beginning of construction operations until final acceptance with adequate equipment and forces to keep the roadway and structures in a safe and satisfactory condition at all times and to ensure the continuous and effective day by day prosecution of the Work.
- B. The Contractor shall bear all costs of performing maintenance work before final completion.

**3.15 REMOVAL OF UNACCEPTABLE AND UNAUTHORIZED WORK**

- A. Work that does not conform to the Contract requirements, whether the result of unacceptable workmanship, use of unacceptable materials, damage through carelessness, or any other cause within the Contractor's control, will be considered unacceptable work.
- B. Unacceptable work shall be remedied or removed as determined by the CM and replaced in an acceptable manner at the Contractor's expense. The CM may accept the unacceptable work at a reduced price when acceptance is considered to be in the best interest of the public.
- C. Work that is done contrary to the instructions of the CM, contrary to the requirements of the Contract, beyond the lines shown on the plans or as designated by the CM except as specified herein, or without authority will be considered unauthorized and will not be paid for. The CM may order the Contractor to remove or replace unauthorized work at the Contractor's expense.
- D. The Contractor shall not perform destructive sampling or testing of the work without written authorization of the CM. Unauthorized destructive sampling or testing will cause the work to be considered unacceptable.
- E. In the event the Contractor is granted authorization to perform destructive sampling or testing, the Contractor shall obtain the approval of the CM for the method and location of each test prior to beginning such sampling or testing. In addition, destructive sampling and testing shall be performed in the presence of the CM.

**END OF SECTION**

**SECTION 01 77 00****Closeout Procedures****PART 1 - GENERAL****1.01 SUMMARY**

- A. Section includes administrative and procedural requirements for contract closeout, including, but not limited to, the following:
  - 1. Closeout Submittals
  - 2. Substantial Completion Procedures
  - 3. Project Punchlist
  - 4. Final Completion Procedures
  - 5. Operation and Maintenance Manuals
  - 6. Warranties and Guarantees
  - 7. Project Record Documents
  - 8. Final Cleaning
  - 9. Repair of the Work

**1.02 RELATED SECTIONS**

- A. Section 01 29 00 – Payment Procedures
- B. Section 01 32 00 – Construction Progress Documentation
- C. Section 01 45 00 – Quality Assurance and Quality Control
- D. Section 01 73 00 – Execution of Work

**1.03 SUBMITTALS**

- A. Closeout submittals shall include, but not be limited to, the following:
  - 1. Certificate or Letter of Substantial Completion (provided to Contractor by CM)
  - 2. Certificate of Occupancy (or Certificate of Final Inspection) from the AHJ
  - 3. Project Record Documents
    - a. As-Built / Red Line Contract Drawings
    - b. As-Built / Red Line Shop Drawings
    - c. As-Built / Red Line Specifications
    - d. As-Built Construction Schedule
  - 4. Operation and Maintenance Manual(s)
  - 5. Warranties

6. Maintenance Bond (if applicable)
7. Final Certified Payroll Records
8. Spare Parts / Stock Materials (as required per Technical Specifications)
9. Post-Construction Photos
10. Affidavit of Payment of Debts and Claims (Contractor and Subcontractors)
11. Releases of Liens (Contractor and Subcontractors)
12. Consent of Surety to Final Payment
13. Final DBE Utilization Statement (if applicable)
14. Final Application for Payment
15. Contractor Closeout Checklist, signed

#### **1.04 SUBSTANTIAL COMPLETION PROCEDURES**

##### **A. Definition**

1. "Substantial Completion" is the condition when VRE agrees that the Work, or a specific portion thereof, is sufficiently complete, in accordance with the Contract Documents, so that it can be utilized by VRE for the full use and function for which it was intended, including the issuance of a Certificate of Occupancy, if applicable, and/or Host Railroad acceptance, if applicable. The date of Substantial Completion of the Work under the Contract is the milestone date on which Substantial Completion condition is accomplished. The only remaining physical work shall be the completion of punch list work prior to Final Acceptance.

##### **B. Substantial Completion Inspection**

1. No less than fourteen (14) calendar days prior to the date the Contractor plans to have the Work, or designated portions of the Work, Substantially Complete, the Contractor shall provide a written notice to VRE, requesting VRE review/inspect the Project for Substantial Completion. Attached to this request should be a list of items the Contractor has not yet completed.
2. Before requesting inspection for determining date of Substantial Completion, complete the following. List items below that are incomplete in request.
  - a. Prepare list of items to be completed and corrected, indicating the value of each item on the list, the reasons why the Work is incomplete and a schedule for completing the work.
  - b. Ensure previously outstanding technical submittals and Shop Drawings have been submitted and approved.
  - c. Advise CM of pending insurance changeover requirements.

- d. Obtain and submit releases permitting VRE unrestricted use of the Work and access to services and utilities. Include occupancy permits, operating certificates, and similar releases.
- e. Prepare and submit Project Record Documents except Record Contract CPM Schedule; also prepare and submit Operation and Maintenance manuals, Substantial Completion construction photographs and damage or settlement surveys.
- f. Prepare and submit proof that specified testing and code inspections have been completed, accepted and certified, including, but not limited to, structural work, sprinkler piping systems, fire alarm and FPS systems, electrical system testing, and hydrostatic pressure testing of sanitary lines. Submit all regulatory and Host Rail Agency approvals as applicable.
- g. Deliver tools, spare parts, extra materials, and similar items to location designated by CM. Label with manufacturer's name and model number where applicable.
- h. Complete startup testing of systems.
- i. Submit test/adjust/balance records.
- j. Terminate and remove temporary facilities from Project site, along with mockups, construction tools, and similar elements.
- k. Advise VRE of changeover in utilities.
- l. Submit changeover information related to VRE's occupancy, use, operation, and maintenance.
- m. Instruct VRE's personnel in operation, adjustment, and maintenance of products, equipment, and systems, as required by Contract Documents. Submit demonstration and training videos.
  - i. Assemble educational materials necessary for instruction, including documentation and training.
  - ii. Provide instruction at mutually agreed on times.
    - 1. Schedule training with CM with at least 15 calendar days' advance notice.
    - 2. Submit training agenda to CM for review and approval for each system/equipment no later than 15 calendar days prior to the scheduled system/equipment startup. After approving the agenda, CM shall provide a listing of dates, times and places of the training programs for Contractor coordination.
  - iii. VRE shall provide space with tables and chairs, if applicable, for conducting the classroom portion of all training.
  - iv. Provide instructional equipment at instruction location.
- n. Complete final cleaning requirements.

- o. Touch up and otherwise repair and restore marred exposed finishes to eliminate visual defects.
- 3. Inspection: Upon receipt of the notice, VRE or designee shall schedule an inspection of the Project in the form of a complete walkthrough with the Contractor's Project Manager, Superintendent or designated representative, to inspect the work and notify the Contractor of any deficiencies. When it has been determined the work is substantially complete, VRE will prepare a certificate of substantial completion listing minor deficiencies, if any, to be corrected.
  - a. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.
  - b. Punch list work must be completed before final completion. Failure to complete the punch list work within 60 calendar days of issuance, may result in VRE ordering the work to be completed by others at the cost to Contractor and deducting the value of such from retainage withheld.
  - c. Results of completed inspection will form the basis of requirements for Final Acceptance.

C. Certificate of Substantial Completion

When it has been determined by VRE that Substantial Completion has been attained, VRE will prepare a Certificate of Substantial Completion and formally transmit it to the Contractor.

**1.05 PROJECT PUNCH LIST (INCOMPLETE ITEMS)**

- 1. Following the Substantial Completion inspection, the Construction Manager will prepare and distribute a Project Punch List to the Contractor, VRE, and other parties as necessary.
- 2. The Project Punch List will be in tabular format and include the following information:
  - a. Sequential punch list item number
  - b. Description of the item requiring correction
  - c. Specific location on the Project of each item
  - d. Name of contractor, subcontractor, or other party responsible for the correction
  - e. Date item was originally recorded on the punch list
  - f. Blank columns for date and person's initials to be used for acceptance of each item
  - g. Name and identification of each space and area affected by construction operations for incomplete items and items needing correction including, if necessary, areas disturbed by Contractor that are outside the limits of construction.
- 3. Include the following information at the top of each page:
  - a. Contract name and number
  - b. Date

- c. Name of CM
  - d. Name of Contractor
  - e. Page number
- 4. Only the VRE Project Manager, the Construction Manager, or the Inspector can provide acceptance of punch list items.
  - 5. Final demobilization from the worksite is prohibited until punch list work is completed and accepted. Payment for demobilization will not be processed until punch list work is completed and accepted by VRE.

## **1.06 FINAL COMPLETION PROCEDURES**

### **A. Definition**

"Final Completion" is the condition when VRE agrees that all the Work has been fully completed in accordance with the Contract Documents, all punch list items have been addressed and accepted, final cleaning has been accomplished, all closeout submittals have been received in acceptable condition, demonstration and training of systems has taken place, the VRE Closeout Checklist has been completed, and the final Application for Payment from the Contractor has been reviewed and deemed acceptable by VRE. The date of Final Acceptance is the date of execution by the Contracting Officer of a Certificate of Final Acceptance.

### **B. When the Contractor believes the Project has reached Final Completion, as defined above, the Contractor shall provide a written notice to VRE, requesting VRE review the Project for Final Completion and release of retainage. The written notice shall indicate the following:**

- 1. Contract documents have been reviewed and work has been inspected and found to be in compliance;
- 2. Deficiencies listed in the certificate of substantial completion have been corrected;
- 3. Equipment and systems have been tested, adjusted and balanced and are fully operational;
- 4. Operations of systems have been demonstrated to VRE and Host Rail Road;
- 5. Work is complete and is ready for final inspection and acceptance by VRE.

### **C. Before requesting VRE review the Project for Final Completion, all closeout submittals as described in this Specification section and requirements detailed in other individual Specification Sections, shall be submitted and accepted by VRE.**

- 1. The Contractor's final Application for Payment shall be attached to the request for Final Completion.
  - a. Submit the final Application for Payment according to Section 01 29 00, "Payment Procedures."

2. Submit certified copy of CM's Substantial Completion inspection list of items to be completed or corrected (punch list), endorsed and dated by CM. The certified copy of the list shall state that each item has been completed or otherwise resolved for acceptance.
3. Submit a Contractor/CM joint statement evidencing that all Record Documents such as stamped shop drawings (working drawings) red-line drawings, Operation and Maintenance Manuals, warranties, product data, survey records and similar required submittals have been approved.
  - a. Submit warranties required by Contract Documents, maintenance service agreements, final certifications, and similar documents.
    - i. Submit Contractor Warranty Letter, for review and approval, a minimum of 30 days before requesting inspection for Final Completion. The initiation date for all warranties and guarantees shall be the date of Final Completion.
4. Complete demobilization and removal of temporary facilities from the site including construction equipment and facilities, mockups, and other similar elements. Restore areas to previously existing condition, if applicable.
5. Execute final Contract Modification and submit final Subcontractor Payment Form
6. Evidence of compliance with requirements of governing agencies, if applicable, to include but not limited to:
  - a. Certificates of inspection
  - b. Certificate of occupancy
7. Evidence that claims have been settled.
8. Evidence of payment and release of liens such as but not limited to:
  - a. Contractor's affidavit of payment of debts and claims
  - b. Contractor's Affidavit of Release of Liens
  - c. Subcontractor's Affidavit of Release of Liens
  - d. Consent of Surety to Final Payment
9. Final adjustment of accounts
10. Final, liquidated damages settlement statement, if applicable.
11. Submit Record Contract CPM Schedule.
12. Return of all VRE issued property.
13. Spare Parts.
14. Labor certification.
15. Commissioning of new systems, as required
16. Training and demonstration of new systems, as required

17. Complete final cleaning requirements
  18. Submit pest-control final inspection report and warranty, if applicable.
  19. Turn over all salvaged materials to VRE as indicated on the plans and specifications.
- D. Release of Liens: VRE, before making any payment including Final Payment, shall require the Contractor to furnish a complete release of all liens arising out of this Contract, or receipts in full in lieu thereof, and if required in either case, an affidavit that so far as the Contractor has knowledge or information, the releases and receipts include all the labor and material for which a lien could be filed.
- E. Inspection: On receipt of request, CM will either proceed with inspection or notify Contractor of unfulfilled requirements. CM will prepare a final Certificate for Payment after inspection or will notify Contractor of construction that must be completed or corrected before certificate will be issued.
1. Re-inspection: Request re-inspection when the Work identified in previous inspections as incomplete is completed or corrected.

**1.07 OPERATION AND MAINTENANCE MANUALS, GENERAL**

- A. Organization: Unless otherwise indicated, organize information by Division and then into a separate section for each system and subsystem, and a separate section for each piece of equipment not part of a system. Each manual shall contain the following in the order listed:
1. Title Page
  2. Table of Contents
  3. Manual Contents
- B. Title Page: Enclose title page in transparent plastic sleeve. Include the following information on the title page:
1. Specific subject matter included in manual such as Division number and title, Specification Section number and title, equipment, systems and subsystems.
  2. Name and number of the Contract.
  3. Date of submittal.
  4. Name, address, telephone number, and contact person of Contractor, Subcontractor, and supplier.
  5. Cross-reference to related systems in other portions of the Operation and Maintenance Manuals.
- C. Table of Contents: Include a printed, printed by a laser printer, table of contents for each volume, arranged according to the specification format. List each product included in manual, identified by product name, indexed to the content of the volume, and cross-referenced to Specification Section number in the Contract Documents.



1. If operation or maintenance documentation requires more than one volume to accommodate data, include comprehensive table of contents for all volumes in each volume of the set.
- D. Manual Contents: Organize into sets of manageable size. Arrange contents by Division then by system, subsystem, and equipment. If possible, assemble instructions for subsystems, equipment, and components of one system into a single binder.
  1. In addition to requirements in the sections below, include operation data required in individual Specification Sections.
  2. Include copies of Warranties or Guarantees for specific products or equipment in the applicable section of the O&M Manual.
  3. Binders: Heavy-duty, 3-ring vinyl covered loose-leaf binders, in thickness necessary to accommodate contents, sized to hold 8-1/2-by-11-inch paper; with clear plastic sleeve on spine to hold label describing contents. Binders shall not be filled beyond 75 percent of their rated capacity.
    - a. Provide maximum 3-inch binder thickness. Smaller binders are acceptable as long as 75 percent rated binder capacity is not exceeded.
    - b. If two or more binders are necessary to accommodate data for a system, organize data in each binder into groupings by subsystem and related components. Cross-reference other binders if necessary to provide essential information for proper operation or maintenance of equipment or system.
    - c. Identify each binder on front (If Identification cannot be placed on the front provide as the first page) and spine, with printed title "OPERATION AND MAINTENANCE MANUAL," Contract number and name, and specific subject matter of contents, such as "Division 06," to include Specification Section. Indicate volume number for multiple-volume sets. The use of business labels is prohibited.
  4. Dividers: Provide three-hole, heavyweight, and plastic tabbed dividers, for each separate Specification section number and title. Provide laser printed description for each tab section (front and back of tabs), to indicate the appropriate Specification Section. Provide a description of the product or heading for sub tabs using the same laser printed format on the dividers.
  5. Protective Plastic Sleeves: Provide protective transparent plastic sheet protectors to enclose the Title Page, all Table of Content pages, and photographs (if applicable).
    - a. For CD-ROMs, provide transparent plastic three-ring sleeves designed to accommodate CD-ROMs.
  6. Drawings: Attach reinforced, punched binder tabs on drawings and bind with text.
    - a. If oversize drawings are necessary, fold drawings to same size as text pages and use as foldouts.

- b. If drawings are too large to be used as foldouts, fold and place drawings in transparent envelopes and bind envelopes with text. Insert typewritten pages indicating drawing titles, descriptions of contents, in the transparent envelopes along with drawings. Drawings shall cross-reference the appropriate manual volume and Specification Section. Drawing holding envelopes are not acceptable.
- c. Provide operations and maintenance material on electronic version (CD-ROM or USB Drive).

#### **1.08 OPERATION AND MAINTENANCE MANUALS**

- A. Operation and Maintenance Manuals Initial Submittal: Submit one draft copies of each Manual in the approved format at least 30 calendar days before requesting inspection for Final Completion or any required training. Include a complete Operations and Maintenance Directory. CM will return a copy of draft within 30 calendar days of receipt, and mark whether general scope and content of Manuals are acceptable.
- B. Operation and Maintenance Manuals Revised Submittals: Submit one revised copies of each manual in final form, including one CD containing electronic O & M documentation, at least 10 calendar days before final completion or training, whichever occurs first. CM will return a copy with comments within 15 calendar days after receipt.
- C. At least 30 calendar days before Final or required training Completion, prepare and deliver to VRE one (1) electronic (.pdf) version (CD-ROM or USB) and three (3) hard copies of a manual containing all information pertaining to the operation and maintenance (O&M) of all products and equipment provided under the Contract.
  - 1. For purposes of payment, O & M and Material and Finishes Manuals will be submitted and accepted by VRE prior to final payment.
- D. Where operation and maintenance documentation includes information on installations by more than one factory-authorized service representative, the Contractor shall assemble and coordinate information furnished by representatives and prepare manuals.
- E. Operations and Maintenance Manual (Electronic Version)
  - 1. The O&M Manual shall consist of high-quality electronic files (or color prints of such files), legible, and not scanned from a hard copy. Include a table of contents and a cover sheet noting the project name, location, VRE contract number, and Substantial Completion date. Each document in the O&M Manual shall be preceded by an intermediate cover sheet containing the Specification section number and title, the name of the product or equipment, and the location at the Project where the product or equipment can be found.
  - 2. The electronic version of the O&M Manual shall contain "bookmarks" labeled with Specification section number and title, as well as sub-bookmarks within each Specification section noting the name of the product or equipment so that the document can be easily navigated by the user.
  - 3. Information in the electronic version shall be identical to information included in the Operations and Maintenance Manual (Hard Copy).

F. Operations and Maintenance Manual (Hard Copy)

1. Operations Content: Include requirements in this Section and other operation data and requirements detailed in individual Specification Sections. In addition, information will include, but not be limited to, the following information, if applicable. Organize manuals into separate and distinct volumes by Division.
  - a. System, subsystem and equipment descriptions
  - b. Safety instruction and related issues.
  - c. Performance and design criteria if Contractor is delegated design responsibility.
  - d. Operating standards.
  - e. Operating procedures.
  - f. Operating logs.
  - g. Wiring diagrams, including color-coding and terminal designations. Include all factory preset or field-set dip switch and jumper settings for all electronic equipment.
  - h. Control diagrams.
  - i. Piped system diagrams.
  - j. Precautions against improper use.
  - k. License requirements including inspection and renewal dates.
  - l. Material Safety Data Sheets.
2. Operating Procedures shall include but not be limited, to the following, as applicable.
  - a. Startup procedures
  - b. Equipment or system break-in procedures.
  - c. Routine and normal operating instructions.
  - d. Regulation and control procedures.
  - e. Instructions on stopping.
  - f. Normal shutdown instructions.
  - g. Seasonal and weekend operating instructions.
  - h. Required sequences for electric or electronic systems.
  - i. Special operating instructions and procedures.
  - j. Procedures or operations that may void warranty.
3. Systems and Equipment Controls: Describe the sequence of operation, and diagram controls as installed.

4. Piped Systems: Diagram piping as installed and color-coding shall be used where required for identification.
5. Maintenance Content: Organize information into a separate section for each product, material, and finish. Include requirements in this Section and other maintenance data and requirements detailed in individual Specification Sections. Provide one section for architectural products, including applied materials and finishes, and a second for products designed for moisture protection and products exposed to the weather.

Include source information, product information, maintenance procedures, repair materials and sources, schedule of products, location of products and warranties, as described below.

List each product included in manual identified by product name and arranged to match manual's table of contents. For each product, list name, address, and telephone number of Installer or supplier and maintenance service agent, and cross-reference Specification Section number and title in Project Manual.

- a. Product Information shall include but not be limited, to the following, as applicable:
  - i. Product name and model number.
  - ii. Manufacturer's name.
  - iii. Color, pattern, and texture.
  - iv. Material and chemical composition.
  - v. Reordering information for specially manufactured products.
  - vi. Fire/flame-spread test certificates.
  - vii. Material Safety Data Sheets.
- b. Maintenance Procedures shall include but not be limited to, manufacturer's written recommendations and the following, as applicable:
  - i. Inspection procedures.
  - ii. Types of cleaning agents to be used and methods of cleaning.
  - iii. List of cleaning agents and methods of cleaning detrimental to product.
  - iv. Schedule for routine cleaning and maintenance.
  - v. Repair instructions.
  - vi. Preventative/predictive maintenance tasks and frequencies.
- c. Repair Materials and Sources: Include lists of materials and local sources of materials and related services.
- d. Schedule of Products and Locations: Provide complete information, including reference drawings, in the materials and finishes manual on all products specified in all applicable Divisions.

- e. Warranties: Reference all applicable warranties listed in Warranty Manual. Include lists of circumstances and conditions that would affect validity of warranties or bonds.
  - i. Include procedures to follow and required notifications for warranty claims.
  - ii. Clearly indicate commencement and expiration dates.

#### **1.09 WARRANTIES AND GUARANTEES**

- A. Within 30 calendar days before requesting Final Completion or any required training, prepare and deliver to VRE one (1) electronic (.pdf) version and one (1) hard copy of all warranties and guarantees, made out to VRE, required by the Special Terms and Conditions, individual Specification sections, and other Contract Documents. Both versions shall be provided in color. Products and Equipment shall not be considered delivered (for payment purposes) until the approved warranties have been received,
- B. The initiation date for all warranties and guarantees shall be the date of Final Completion.
- C. Warranty Book/Manual: Organize warranty documents into an orderly sequence based on the table of the Contract Specifications. Warranty documents include Contractor and major subcontractors warranty letters, special warranty documents, and manufacturer's warranties.
  - 1. Include a table of contents and a cover sheet noting the project name, location, VRE contract number, and Substantial Completion date.
  - 2. The General Contractor's workmanship warranty shall be included as the first document in the warranty book.
  - 3. Include copies of warranties or guarantees for specific products or equipment in the applicable section of the O&M Manual.
  - 4. The hard copy of the warranty book shall be a heavy-duty 3-ring vinyl-covered binder containing tabbed dividers labeled with Specification section number and title.
    - i. Identify each binder on front and spine, with printed title "PROJECT WARRANTIES," Contract number and name and subject matter of contents. If identification cannot be attached to the front include it as the first page in the manual. Indicate volume number for multiple-volume sets.
    - ii. Dividers: Provide three-hole, heavyweight, plastic tabbed dividers, (or as approved by VRE) for each separate section. Provide laser printed description for each tabbed section on the front and back of tabs. Tabs shall indicate the appropriate Specification Section number and title. Provide a description of the warranty or heading for sub tabs using the same laser printed format on the dividers. Provide an index of the contents in each section on the first page behind each section divider.
- D. Electronic Version of Warranty Book/Manual: The electronic file containing warranties and guarantees shall contain "bookmarks" labeled with Specification section number and title, as well as sub-bookmarks within each Specification section noting the name of the product or

equipment so that the document can be easily navigated by the user. Information in the electronic version shall be identical to information included in the Warranty Book/Manual.

#### **1.10 PROJECT RECORD DOCUMENTS**

- A. Project Record Documents shall be the responsibility of the Contractor and shall consist of the following items:
  - 1. As-Built Contract Drawings
  - 2. As-Built Shop Drawings
  - 3. As-Built Specifications
  - 4. As-Built Construction Schedule
- B. Within 30 calendar days before requesting Final Completion or any required training, the Contractor shall submit one (1) electronic (.pdf) version and one (1) hard copy version of the Project Record Documents, to VRE for review and approval. It is acceptable to provide an annotated electronic (.pdf) document or scan the hard copy version in order to create the electronic file, provided all notes and sketches are legible. Both the electronic and hard copy versions must be provided in color. Hard copies of drawings shall be provided in 22" x 34" size.
- C. Maintain one copy of each submittal during the construction period for Project Record Document purposes. Post changes and modifications to Project Record Documents as they occur.
- D. Store Project Record Documents in the field office apart from the Contract Documents. Do not use project record documents for construction purposes. Maintain record documents in good order and in a clean, dry, legible condition protected from deterioration and loss. Repair or reproduce torn or dirty sheets. Provide access to Project Record Documents for CM 's reference during normal working hours.
- E. As-Built Contract Drawings
  - 1. The Contractor shall mark up one set of prints of the applicable Contract Drawings to portray as-built construction. The prints shall be neatly and clearly marked in red ink or red pencil to show all variations between the Work actually provided and that indicated on the Contract Drawings. All drafting shall conform to good drafting practice and shall include such supplementary notes, legends, and details as may be necessary for legibility and clear portrayal of the as-built construction.
  - 2. As-built drawings shall be maintained throughout the Project, incorporating new and revised drawings as modifications are issued, and finalized promptly at the completion of the Project. Routinely mark drawings to show the actual installation where installation varies from that shown originally. Record information in an understandable drawing technique. Ensure mark-ups are legible and reproducible. Record data as soon as possible after obtaining it. Record and check markups before enclosing concealed installations.

3. As-built drawings shall be kept current and available for inspection by the CM in a location accessible to the CM on a daily basis during working hours. The CM will review updates to the as-built drawings periodically to ensure they are maintained.
4. Information shown on the as-built drawings should include, but not be limited to:
  - a. Dimensional changes to Drawings
  - b. Revisions to details shown on Drawings
  - c. Depths of foundations below first floor
  - d. Locations and depths of underground utilities
  - e. Revisions to routing of piping and conduits
  - f. Revisions to electrical circuitry
  - g. Actual equipment locations
  - h. Duct size and routing
  - i. Locations of concealed internal utilities
  - j. Changes made by Change Order or Change Directive
  - k. Changes made following VRE's written orders
  - l. Details not on the original Contract Drawings
  - m. Field records for variable and concealed conditions
  - n. Actual installed information about Work that is otherwise shown only schematically
  - o. Other information about concealed elements that would be difficult to identify, measure or record later
  - p. Note Change Order numbers, RFI numbers, and similar identification, where applicable.
5. Format
  - a. Identify and date each record Drawing. Include the designation "PROJECT RECORD DRAWING" in a prominent location.
  - b. Cover Sheet shall have the designation "PROJECT RECORD DRAWINGS", Date, Name of Contractor, and signature.
6. Additional Requirements
  - a. When there are multiple copies of the same sheet with different mark-ups on each copy, the General Contractor is responsible for consolidating all mark-ups onto a single copy of each individual sheet.
  - b. The information from all RFI's, Change Notices, Design Clarifications, field adjustments, or any other changes, must be noted on the appropriate drawing. These mark-ups must include enough information to clearly show the actual constructed

conditions resulting from the change. The information may be drawn onto the drawing, copied onto the drawing or copied onto a new full-size sheet. Every change in construction must have RFI's, Change Orders or similar supplementary documents; therefore, they must be copied in original size and attached to the back of the preceding drawing or at the end of the drawing set, as an appendix, as a full-size sheet, same in size as the drawing set. Multiple RFI's, CN's and other supplemental documents may be copied in each single sheet.

- c. All changes made on the drawings shall reference the appropriate RFI, Change Notices, Design Clarification, or details from the contractor prepared shop drawings. If the mark-up is due to a field adjustment, it shall be indicated as such.
- d. Notes and sketches printed by hand are acceptable but shall be neat, legible, and reproducible.

#### F. As-Built Shop Drawings

As-built shop drawings shall be prepared in the same manner as the as-built contract drawings. A set of as-built shop drawings shall be provided for every set of shop drawings submitted and approved for use on the Project. Include electrical, mechanical, plumbing, structural steel, and other shop drawings as applicable to the Project.

- 1. Initial Submittal: Submit one set of complete, full-sized, As-Built Shop Drawings. Additional sets of drawings are not to be copied and submitted until after substantial completion to insure all changes are shown on the drawings. The CM will facilitate review of drawings and indicate whether the As-Built Shop Drawings are acceptable. The CM will return review comments indicating any corrections that need to be made to the drawings. The corrected As-Built Shop Drawings may then be reproduced, and organized into sets, printed, bound, and submitted as final submittal.
- 2. Final Submittal: After construction is complete and changes are recorded, submit three complete, full-sized, printed sets of As-Built Shop Drawings. Include each sheet, whether or not changes and additional information were recorded. Submit four copies of the As-Built Shop Drawings in the approved electronic format. In addition, submit the original set of marked-up record drawings onto which the mark-ups were made.

#### G. As-Built Specifications

The Contractor shall mark up one set of Specifications to show all variations between the Work actually provided and that indicated on the Contract Drawings. Include the following items on the as-built specifications.

- 1. Give particular attention to information on concealed products and installations that cannot be readily identified and recorded later.
- 2. Mark copy with the proprietary name and model number of products, materials, and equipment furnished, including substitutions and product options selected.
- 3. Record the name of manufacturer, supplier, installer, and other information necessary to provide a record of selections made.



4. Note related Change Orders, Record Drawings, and Product Data where applicable.
- H. As-Built Construction Schedule  
See Section 01 32 00, "Construction Progress Documentation," for details regarding the As-Built Construction Schedule.
- I. If Project Record Documents are not submitted in accordance with this Specification section, and other Contract requirements, as applicable, the submittal will not be reviewed and will be returned to the Contractor for revision and resubmittal.

## **PART 2 - PRODUCTS**

- A. Cleaning Agents: For final cleaning, use cleaning materials and agents recommended by manufacturer or fabricator of the surface to be cleaned. Do not use cleaning agents that are potentially hazardous to health or property or that might damage finished surfaces.
- B. Products - The Contractor shall turn over all salvaged materials to VRE, as necessary.

## **PART 3 - EXECUTION**

### **3.01 FINAL CLEANING**

- A. Conduct cleaning and waste-removal operations to comply with local laws and ordinances and Federal and local environmental and antipollution regulations. Final cleaning shall include removal of all waste and surplus materials and equipment caused by the work prior to final inspection. Progress cleaning during construction is included in Division 01 Section "Execution of Work."
- B. Employ experienced workers or professional cleaners for final cleaning. Clean each surface or unit to condition expected in an average commercial building cleaning and maintenance program. Comply with manufacturer's written instructions.
- C. The following cleaning operations shall be completed before requesting VRE review the Project for Substantial Completion:
  1. Clean Project site, yard, and grounds, in areas disturbed by construction activities, including landscape development areas, of rubbish, waste material, litter, and other foreign substances.
  2. Sweep paved areas broom clean. Remove petrochemical spills, stains, and other foreign deposits.
  3. Rake grounds that are neither planted nor paved to a smooth, even-textured surface.
  4. Remove tools, construction equipment, machinery, and surplus material from Project site.
  5. Remove snow and ice to provide safe access to public areas.

6. Clean exposed exterior and interior hard-surfaced finishes to a dirt-free condition, free of stains, films, and similar foreign substances. Avoid disturbing natural weathering of exterior surfaces. Restore reflective surfaces to their original condition.
  7. Remove debris and surface dust from limited access spaces, including roofs, plenums, shafts, trenches, equipment vaults, manholes, attics, and similar spaces.
  8. Sweep concrete floors broom clean in unoccupied spaces.
  9. Clean transparent materials, including mirrors and glass in doors and windows. Remove glazing compounds and other noticeable, vision-obscuring materials. Polish mirrors and glass, taking care not to scratch surfaces.
  10. Remove labels that are not permanent.
  11. Wipe surfaces of mechanical and electrical equipment, elevator equipment, and similar equipment. Remove excess lubrication, paint and mortar droppings, and other foreign substances.
  12. Clean plumbing fixtures to a sanitary condition, free of stains, including stains resulting from water exposure.
  13. Replace disposable air filters and clean permanent air filters. Clean exposed surfaces of diffusers, registers, and grills.
  14. Clean ducts, blowers, and coils if units were operated without filters during construction or that display contamination with particulate matter on inspection.
  15. Clean HVAC system in compliance with NADCA Standard 1992-01. Provide written report on completion of cleaning.
  16. Clean light fixtures, lamps, globes, and reflectors to function with full efficiency.
  17. Leave Project clean and ready for occupancy.
- D. Construction Waste Disposal: Comply with waste disposal requirements in Section 01 73 00, "Execution of Work."
- E. Pest Control: Engage an experienced, licensed exterminator to make a final inspection and rid Project of rodents, insects, and other pests. Prepare and submit a report to CM.
- F. Comply with safety standards for cleaning. Do not burn waste materials. Do not bury debris or excess materials on VRE or Railroad property. Do not discharge volatile, harmful, or dangerous materials into drainage systems. Remove waste materials from Project site and dispose of lawfully.

### **3.02 REPAIR OF THE WORK**

- A. Complete repair and restoration operations before requesting VRE review the Project for Substantial Completion.
- B. Repair or remove and replace defective construction. Repairing includes replacing defective parts, refinishing damaged surfaces, touching up with matching materials, and properly

- adjusting operating equipment. Where damaged or worn items cannot be repaired or restored, provide replacements. Remove and replace operating components that cannot be repaired. Restore damaged construction and permanent facilities used during construction to specified condition.
- C. Remove and replace chipped, scratched, and broken glass, reflective surfaces, and other damaged transparent materials.
  - D. Touch up and otherwise repair and restore marred or exposed finishes and surfaces. Replace finishes and surfaces that already show evidence of repair or restoration.
  - E. Do not paint over "UL" and other required labels and identification, including mechanical and electrical nameplates. Remove paint applied to required labels and identification.
  - F. Replace parts subject to operating conditions during construction that may impede operation or reduce longevity.
  - G. Replace burned-out bulbs, bulbs noticeably dimmed by hours of use, and defective and noisy starters in fluorescent and mercury vapor fixtures to comply with requirements for new fixtures.

**END OF SECTION**

## SECTION 024119 - SELECTIVE DEMOLITION

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Demolition and removal of selected portions of platform and canopy roof.

## 1.2 MATERIALS OWNERSHIP

- A. Unless otherwise indicated, demolition waste becomes property of Contractor.

## 1.3 INFORMATIONAL SUBMITTALS

- A. Proposed Protection Measures: Submit report, including Drawings, that indicates the measures proposed for protecting individuals and property. Indicate proposed locations and construction of barriers.
- B. Schedule of selective demolition activities with starting and ending dates for each activity.
- C. Predemolition photographs or video.

## 1.4 FIELD CONDITIONS

- A. Owner will occupy portions of platform immediately adjacent to selective demolition area. Conduct selective demolition so Owner's operations will not be disrupted.
- B. Conditions existing at time of inspection for bidding purpose will be maintained by Owner as far as practical.
- C. Notify Engineer of discrepancies between existing conditions and Drawings before proceeding with selective demolition.
- D. Hazardous Materials: It is not expected that hazardous materials will be encountered in the Work.
  1. If suspected hazardous materials are encountered, do not disturb; immediately notify Engineer and Owner. Hazardous materials will be removed by Owner under a separate contract.
- E. Storage or sale of removed items or materials on-site is not permitted.
- F. Utility Service: Maintain existing utilities indicated to remain in service and protect them against damage during selective demolition operations.

1. Maintain fire-protection facilities in service during selective demolition operations.
- G. Arrange selective demolition schedule so as not to interfere with Owner's operations.

## 1.5 WARRANTY

- A. Existing Warranties: Remove, replace, patch, and repair materials and surfaces cut or damaged during selective demolition, by methods and with materials and using approved contractors so as not to void existing warranties.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Regulatory Requirements: Comply with governing EPA notification regulations before beginning selective demolition. Comply with hauling and disposal regulations of authorities having jurisdiction.
- B. Standards: Comply with ASSE A10.6 and NFPA 241.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify that utilities have been disconnected and capped before starting selective demolition operations.

### 3.2 UTILITY SERVICES AND MECHANICAL/ELECTRICAL SYSTEMS

- A. Existing Services/Systems to Remain: Maintain services/systems indicated to remain and protect them against damage.
- B. Existing Services/Systems to Be Removed, Relocated, or Abandoned: Locate, identify, disconnect, and seal or cap off utility services and mechanical/electrical systems serving areas to be selectively demolished.
  1. Owner will arrange to shut off indicated services/systems when requested by Contractor.
  2. Arrange to shut off utilities with utility companies.
  3. If services/systems are required to be removed, relocated, or abandoned, provide temporary services/systems that bypass area of selective demolition and that maintain continuity of services/systems to other parts of structure.

### 3.3 PROTECTION

- A. Temporary Protection: Provide temporary barricades and other protection required to prevent injury to people and damage to adjacent buildings and facilities to remain.
- B. Temporary Shoring: Design, provide, and maintain shoring, bracing, and structural supports as required to preserve stability and prevent movement, settlement, or collapse of construction and finishes to remain, and to prevent unexpected or uncontrolled movement or collapse of construction being demolished.
- C. Remove temporary barricades and protections where hazards no longer exist.

### 3.4 SELECTIVE DEMOLITION

- A. General: Demolish and remove existing construction only to the extent required by new construction and as indicated. Use methods required to complete the Work within limitations of governing regulations and as follows:
  - 1. Neatly cut openings and holes plumb, square, and true to dimensions required. Use cutting methods least likely to damage construction to remain or adjoining construction. Use hand tools or small power tools designed for sawing or grinding, not hammering and chopping. Temporarily cover openings to remain.
  - 2. Cut or drill from the exposed or finished side into concealed surfaces to avoid marring existing finished surfaces.
  - 3. Do not use cutting torches until work area is cleared of flammable materials. At concealed spaces, such as duct and pipe interiors, verify condition and contents of hidden space before starting flame-cutting operations. Maintain portable fire-suppression devices during flame-cutting operations.
  - 4. Maintain fire watch during and for at least two hours after flame-cutting operations.
  - 5. Locate selective demolition equipment and remove debris and materials so as not to impose excessive loads on supporting walls, floors, or framing.
  - 6. Dispose of demolished items and materials promptly.
- B. Site Access and Temporary Controls: Conduct selective demolition and debris-removal operations to ensure minimum interference with roads, streets, walks, walkways, and other adjacent occupied and used facilities.
- C. Removed and Reinstalled Items:
  - 1. Clean and repair items to functional condition adequate for intended reuse.
  - 2. Pack or crate items after cleaning and repairing. Identify contents of containers.
  - 3. Protect items from damage during transport and storage.
  - 4. Reinstall items in locations indicated. Comply with installation requirements for new materials and equipment. Provide connections, supports, and miscellaneous materials necessary to make item functional for use indicated.
- D. Existing Items to Remain: Protect construction indicated to remain against damage and soiling during selective demolition. When permitted by Architect, items may be removed to a suitable, protected storage location during selective demolition and cleaned and reinstalled in their original locations after selective demolition operations are complete.

## 3.5 CLEANING

- A. Remove demolition waste materials from Project site and dispose of them in an EPA-approved construction and demolition waste landfill acceptable to authorities having jurisdiction.
  - 1. Do not allow demolished materials to accumulate on-site.
  - 2. Remove and transport debris in a manner that will prevent spillage on adjacent surfaces and areas.
  - 3. Remove debris from elevated portions of structure by a chute, hoist or other device that will convey debris to grade level in a controlled descent.
- B. Burning: Do not burn demolished materials.
- C. Clean adjacent structures and improvements of dust, dirt, and debris caused by selective demolition operations. Return adjacent areas to condition existing before selective demolition operations began.

END OF SECTION 02 41 19

## SECTION 03 30 00 - CAST-IN-PLACE CONCRETE

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes non-shrink grout and cast-in-place concrete, including formwork, reinforcement, concrete materials, mixture design, placement procedures, and finishes.
- B. Related Requirements:
  - 1. Section 31 50 00 "Excavation Support and Protection".

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture.
- C. Steel Reinforcement Shop Drawings: Placing Drawings that detail fabrication, bending, and placement.

## 1.3 INFORMATIONAL SUBMITTALS

- A. Material certificates.
- B. Material test reports.
- C. Formwork Shop Drawings: Prepared by or under the supervision of a qualified professional engineer, detailing fabrication, assembly, and support of formwork.

## 1.4 QUALITY ASSURANCE

- A. 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.
  - 1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities."
- B. Testing Agency Qualifications: An independent agency, qualified according to ASTM C 1077 and ASTM E 329 for testing indicated.
- C. VDOT Road and Bridge Specification: The contractor's testing firm shall perform the testing in accordance with requirements of the VDOT Road and Bridge Specifications, 2016. Submit certified results of all tests performed, in accordance with the General Requirements.



## 1.5 PRECONSTRUCTION TESTING

- A. Preconstruction Testing Service: Engage a qualified testing agency to perform preconstruction testing on concrete mixtures.

## 1.6 FIELD CONDITIONS

- A. Cold-Weather Placement: Comply with VDOT Road and Bridge Specifications, 2016.
- B. Hot-Weather Placement: Comply with VDOT Road and Bridge Specifications, 2016.

## PART 2 - PRODUCTS

## 2.1 CONCRETE, GENERAL

- A. ACI Publications: Comply with the following unless modified by requirements in the Contract Documents:
  - 1. ACI 301.
  - 2. ACI 117.

## 2.2 FORM-FACING MATERIALS

- A. Smooth-Formed Finished Concrete Exposed to View: Form-facing panels that provide continuous, true, and smooth concrete surfaces. Furnish in largest practicable sizes to minimize number of joints.
- B. Rough-Formed Finished Concrete Not Exposed to View: Plywood, lumber, metal, or another approved material. Provide lumber dressed on at least two edges and one side for tight fit.

## 2.3 STEEL REINFORCEMENT

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Bar Supports: Bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded-wire reinforcement in place. Manufacture bar supports from steel wire, plastic, or precast concrete according to CRSI's "Manual of Standard Practice."

## 2.4 CONCRETE MATERIALS

- A. Comply with Virginia Department of Transportation (VDOT) Road and Bridge Specifications, 2016, for the concrete materials. Concrete shall have a 28 day compressive strength of 4000 psi and shall comply with VDOT Class A4 concrete, General.

## 2.5 CURING MATERIALS

- A. Provide curing materials per VDOT Road and Bridge Specifications, 2016, Section 220.

## 2.6 CONCRETE MIXTURES, GENERAL

- A. Prepare design mixtures for each type and strength of concrete as specified in VDOT Road and Bridge Specifications, 2016.

## 2.7 CONCRETE MIX

- A. Design mixes as specified in VDOT Road and Bridge Specifications, 2016, Section 217, Table II-17. Cast-in-place concrete shall be Mix No. A4 General.

## 2.8 FABRICATING REINFORCEMENT

- A. Fabricate steel reinforcement according to CRSI's "Manual of Standard Practice."

## 2.9 NON-SHRINK GROUT

- A. Factory packaged, non-staining, noncorrosive, nongaseous, non-metallic grout conforming to ASTM C1107, and shall be a commercial formulation suitable for the proposed application.
- B. Non-gas-forming and free of oxidizing catalysts and inorganic accelerators.
- C. Place non-shrink grout in accordance with the recommendations of ACI and the manufacturer's published specifications for mixing and placing. Place non-shrink grout only where indicated on the Contract Drawings.
- D. Products: Subject to compliance with requirements, provide one of the following, or approved equal.
  - 1. Masterflow 928, BASF Building Systems.
  - 2. Hi-Flow Grout, Euclid Chemical Company.
  - 3. SikaGrout 212 High Performance Anchoring Grout, Sika Corporation
- E. Mix non-shrink grout material with water per manufacturer's recommendations.
- F. Surfaces to receive the non-shrink grout shall be roughened and cleaned thoroughly, and shall be moistened thoroughly immediately before placing the mortar. All loose particles shall be removed and the surface flushed thoroughly with neat cement grout immediately before the grouting mortar is placed. Place fluid grout from one side only. Puddle, chain or pump to ensure all voids are completely filled. The dams and forms shall not be removed until grout attains initial set. Finish exposed surfaces to match surrounding concrete, and cure as recommended by grout manufacturer.

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PART 3 - EXECUTION

## 3.1 FORMWORK INSTALLATION

- A. Design, erect, shore, brace, and maintain formwork, according to ACI 301, to support vertical, lateral, static, and dynamic loads, and construction loads that might be applied, until structure can support such loads.
- B. Construct formwork so concrete members and structures are of size, shape, alignment, elevation, and position indicated, within tolerance limits of ACI 117.
- C. Chamfer exterior corners and edges of permanently exposed concrete.

## 3.2 EMBEDDED ITEM INSTALLATION

- A. Place and secure anchorage devices and other embedded items required for adjoining work that is attached to or supported by cast-in-place concrete. Use setting drawings, templates, diagrams, instructions, and directions furnished with items to be embedded.

## 3.3 STEEL REINFORCEMENT INSTALLATION

- A. General: Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
  - 1. Do not cut or puncture vapor retarder. Repair damage and reseal vapor retarder before placing concrete.

## 3.4 JOINTS

- A. General: Construct joints true to line with faces perpendicular to surface plane of concrete.
- B. Construction Joints: Install so strength and appearance of concrete are not impaired, at locations indicated or as approved by Engineer.

## 3.5 CONCRETE PLACEMENT

- A. Before placing concrete, verify that installation of formwork, reinforcement, and embedded items is complete and that required inspections are completed.
- B. Deposit concrete continuously in one layer or in horizontal layers of such thickness that no new concrete is placed on concrete that has hardened enough to cause seams or planes of weakness. If a section cannot be placed continuously, provide construction joints as indicated. Deposit concrete to avoid segregation.
  - 1. Consolidate placed concrete with mechanical vibrating equipment according to ACI 301.

### 3.6 FINISHING FORMED SURFACES

- A. Rough-Formed Finish: As-cast concrete texture imparted by form-facing material with tie holes and defects repaired and patched. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces not exposed to public view.
- B. Smooth-Formed Finish: As-cast concrete texture imparted by form-facing material, arranged in an orderly and symmetrical manner with a minimum of seams. Repair and patch tie holes and defects. Remove fins and other projections that exceed specified limits on formed-surface irregularities.
  - 1. Apply to concrete surfaces exposed to public view.

### 3.7 CONCRETE PROTECTING AND CURING

- A. Protect and cure concrete in accordance with VDOT Road and Bridge Specifications, 2016.

### 3.8 CONCRETE SURFACE REPAIRS

- A. Defective Concrete: Repair and patch defective areas when approved by Engineer. Remove and replace concrete that cannot be repaired and patched to Engineer's approval.
- B. Patching Mortar: Mix dry-pack patching mortar, consisting of 1 part portland cement to 2-1/2 parts fine aggregate passing a No. 16 sieve, using only enough water for handling and placing.
- C. Repairing Formed Surfaces: Surface defects include color and texture irregularities, cracks, spalls, air bubbles, honeycombs, rock pockets, fins and other projections on the surface, and stains and other discolorations that cannot be removed by cleaning.
  - 1. Immediately after form removal, cut out honeycombs, rock pockets, and voids more than 1/2 inch in any dimension to solid concrete. Limit cut depth to 3/4 inch. Make edges of cuts perpendicular to concrete surface. Clean, dampen with water, and brush-coat holes and voids with bonding agent. Fill and compact with patching mortar before bonding agent has dried. Fill form-tie voids with patching mortar or cone plugs secured in place with bonding agent.
  - 2. Repair defects on surfaces exposed to view by blending white portland cement and standard portland cement so that, when dry, patching mortar matches surrounding color. Patch a test area at inconspicuous locations to verify mixture and color match before proceeding with patching. Compact mortar in place and strike off slightly higher than surrounding surface.
  - 3. Repair defects on concealed formed surfaces that affect concrete's durability and structural performance as determined by Engineer.
- D. Repairing Unformed Surfaces: Test unformed surfaces, such as floors and slabs, for finish and verify surface tolerances specified for each surface. Correct low and high areas. Test surfaces sloped to drain for trueness of slope and smoothness; use a sloped template.

1. Repair finished surfaces containing defects. Surface defects include spalls, popouts, honeycombs, rock pockets, crazing and cracks in excess of 0.01 inch wide or that penetrate to reinforcement or completely through unreinforced sections regardless of width, and other objectionable conditions.
  2. After concrete has cured at least 14 days, correct high areas by grinding.
  3. Correct localized low areas during or immediately after completing surface finishing operations by cutting out low areas and replacing with patching mortar. Finish repaired areas to blend into adjacent concrete.
  4. Correct other low areas scheduled to receive floor coverings with a repair underlayment. Prepare, mix, and apply repair underlayment and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface. Feather edges to match adjacent floor elevations.
  5. Correct other low areas scheduled to remain exposed with a repair topping. Cut out low areas to ensure a minimum repair topping depth of 1/4 inch to match adjacent floor elevations. Prepare, mix, and apply repair topping and primer according to manufacturer's written instructions to produce a smooth, uniform, plane, and level surface.
  6. Repair defective areas, except random cracks and single holes 1 inch or less in diameter, by cutting out and replacing with fresh concrete. Remove defective areas with clean, square cuts and expose steel reinforcement with at least a 3/4-inch clearance all around. Dampen concrete surfaces in contact with patching concrete and apply bonding agent. Mix patching concrete of same materials and mixture as original concrete, except without coarse aggregate. Place, compact, and finish to blend with adjacent finished concrete. Cure in same manner as adjacent concrete.
  7. Repair random cracks and single holes 1 inch or less in diameter with patching mortar. Groove top of cracks and cut out holes to sound concrete and clean off dust, dirt, and loose particles. Dampen cleaned concrete surfaces and apply bonding agent. Place patching mortar before bonding agent has dried. Compact patching mortar and finish to match adjacent concrete. Keep patched area continuously moist for at least 72 hours.
- E. Perform structural repairs of concrete, subject to Engineer's approval, using epoxy adhesive and patching mortar.
- F. Repair materials and installation not specified above may be used, subject to Engineer's approval.

### 3.9 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified testing and inspecting agency to perform field tests and inspections and prepare test reports.

END OF SECTION 03 30 00

## SECTION 034100 - PRECAST STRUCTURAL CONCRETE

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes precast structural concrete.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each precast concrete mixture.
- C. Shop Drawings:
  - 1. Include member locations, plans, elevations, dimensions, shapes and sections, openings, support conditions, and types of reinforcement, including special reinforcement.
  - 2. Detail fabrication and installation of precast structural concrete units, including connections at member ends and to adjoining construction.
- D. Delegated-Design Submittal: For precast structural concrete indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.3 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator and testing agency.
- B. Welding certificates.
- C. Material certificates.
- D. Material Test Reports: For aggregates.
- E. Source quality-control reports.
- F. Field quality-control and special inspection reports.

## 1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A firm that assumes responsibility for engineering precast structural concrete units to comply with performance requirements. Responsibility includes preparation of Shop Drawings and comprehensive engineering analysis by a qualified professional engineer.
  - 1. Designated as a PCI-certified plant, Group C, as follows:

- a. Category C1 for Precast Concrete Products (no prestressed reinforcement)
  - b. Category C2 for Prestressed Hollowcore and Repetitively Produced Products
  - c. Category C3 for Prestressed Straight Strand Structural Members
- B. Quality-Control Standard: For manufacturing procedures, testing requirements, and quality-control recommendations for types of units required, comply with PCI MNL 116, "Manual for Quality Control for Plants and Production of Structural Precast Concrete Products."
- C. Welding Qualifications: Qualify procedures and personnel according to the following:
- 1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
  - 2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

## 1.5 COORDINATION

- A. Furnish loose connection hardware and anchorage items to be embedded in or attached to other construction before starting that Work. Provide locations, setting diagrams, templates, instructions, and directions, as required, for installation.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Delegated Design: Engage a qualified professional engineer, as defined in Section 014000 "Quality Requirements," to design precast structural concrete units.
- B. Design Standards: Comply with ACI 318 and with design recommendations in PCI MNL 120, "PCI Design Handbook - Precast and Prestressed Concrete," applicable to types of precast structural concrete units indicated.
- C. Structural Performance: Precast structural concrete units and connections shall withstand design loads indicated within limits and under conditions indicated.

### 2.2 REINFORCING MATERIALS

- A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.
- B. Low-Alloy-Steel Reinforcing Bars: ASTM A 706/A 706M, deformed.
- C. Steel Bar Mats: ASTM A 184/A 184M, fabricated from ASTM A 615/A 615M, Grade 60 or ASTM A 706/A 706M, deformed bars, assembled with clips.
- D. Plain-Steel Welded Wire Reinforcement: ASTM A 185/A 185M, fabricated from as-drawn steel or galvanized-steel wire into flat sheets.
- E. Deformed-Steel Welded Wire Reinforcement: ASTM A 497/A 497 or ASTM A 1064/A 1064, flat sheet.

- F. Supports: Suspend reinforcement from back of mold or use bolsters, chairs, spacers, and other devices for spacing, supporting, and fastening reinforcing bars and welded wire reinforcement in place according to PCI MNL 116.

## 2.3 PRESTRESSING TENDONS

- A. Strand: ASTM A 416/A 416M, Grade 270, uncoated, seven-wire, low-relaxation strand.
  - 1. Coat unbonded post-tensioning strand with post-tensioning coating complying with ACI 423.7 and sheath with polypropylene tendon sheathing complying with ACI 423.7. Include anchorage devices and coupler assemblies.

## 2.4 CONCRETE MATERIALS

- A. Portland Cement: ASTM C 150/C 150M, Type I or Type III, gray, unless otherwise indicated.
- B. Supplementary Cementitious Materials:
  - 1. Fly Ash: ASTM C 618, Class C or F, with maximum loss on ignition of 3 percent.
  - 2. Silica Fume: ASTM C 1240, with optional chemical and physical requirement.
  - 3. Ground Granulated Blast-Furnace Slag: ASTM C 989, Grade 100 or 120.
  - 4. Blended Hydraulic Cement: ASTM C 595/C 595M, excluding Type IS.
- C. Normal-Weight Aggregates: Except as modified by PCI MNL 116, ASTM C 33/C 33M, with coarse aggregates complying with Class 5S, Class 5M, Class 4S or Class 4M. Stockpile fine and coarse aggregates for each type of exposed finish from a single source (pit or quarry) for Project.
- D. Water: Potable; free from deleterious material that may affect color stability, setting, or strength of concrete and complying with chemical limits of PCI MNL 116.
- E. Air-Entraining Admixture: ASTM C 260, certified by manufacturer to be compatible with other required admixtures.
- F. Chemical Admixtures: Certified by manufacturer to be compatible with other admixtures and to not contain calcium chloride, or more than 0.15 percent chloride ions or other salts by weight of admixture.

## 2.5 STEEL CONNECTION MATERIALS

- A. Carbon-Steel Plates and Angles: ASTM A 36/A 36M.
- B. Carbon-Steel-Headed Studs: ASTM A 108, Grade 1010 through 1020, cold finished, AWS D1.1/D1.1M, Type A or B, with arc shields and with minimum mechanical properties of PCI MNL 116.
- C. W-shapes, channels: ASTM A992 Grade 50.



- D. Carbon-Steel Structural Tubing: ASTM A 500/A 500M, Grade B.
- E. Wrought Carbon-Steel Bars: ASTM A 675/A 675M, Grade 65.
- F. Deformed-Steel Wire or Bar Anchors: ASTM A 496/A 496M or ASTM A 706/A 706M.
- G. Carbon-Steel Bolts and Studs: ASTM A 307, Grade A; carbon-steel, hex-head bolts and studs; carbon-steel nuts, ASTM A 563; and flat, unhardened steel washers, ASTM F 844.
- H. High-Strength Bolts and Nuts: ASTM A 325 or ASTM A 490, Type 1, heavy hex steel structural bolts; heavy hex carbon-steel nuts, ASTM A 563; and hardened carbon-steel washers, ASTM F 436. Use  $\frac{3}{4}$ " minimum diameter.
  - 1. Do not zinc coat ASTM A 490 bolts.
- I. Zinc-Coated Finish: For exterior steel items and items indicated for galvanizing, apply zinc coating by hot-dip process according to ASTM A 123/A 123M or ASTM A 153/A 153M.
  - 1. Galvanizing Repair Paint: High-zinc-dust-content paint with dry film containing not less than 94 percent zinc dust by weight, and complying with DOD-P-21035B or SSPC-Paint 20.
- J. Shop-Primed Finish: Prepare surfaces of nongalvanized-steel items, except those surfaces to be embedded in concrete, according to requirements in SSPC-SP 3, and shop apply lead- and chromate-free, rust-inhibitive primer, complying with performance requirements in MPI 79 according to SSPC-PA 1.

## 2.6 BEARING PADS

- A. Provide bearing pads for precast structural concrete units as recommended by precast fabricator for application.

## 2.7 GROUT MATERIALS

- A. Sand-Cement Grout: Portland cement, ASTM C 150/C 150M, Type I, and clean, natural sand, ASTM C 144 or ASTM C 404. Mix at ratio of 1 part cement to 2-1/2 to 3 parts sand, by volume, with minimum water required for placement and hydration. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.
- B. Nonmetallic, Nonshrink Grout: Packaged, nonmetallic, noncorrosive, nonstaining grout containing selected silica sands, portland cement, shrinkage-compensating agents, plasticizing and water-reducing agents, complying with ASTM C 1107/C 1107M, Grade A for drypack and Grades B and C for flowable grout and of consistency suitable for application within a 30-minute working time. Water-soluble chloride ion content less than 0.06 percent by weight of cement when tested according to ASTM C 1218/C 1218M.
- C. Epoxy-Resin Grout: Two-component, mineral-filled epoxy resin; ASTM C 881/C 881M, of type, grade, and class to suit requirements.

## 2.8 CONCRETE MIXTURES

- A. Prepare design mixtures for each type of precast concrete required.
  - 1. Limit use of fly ash to 25 percent replacement of portland cement by weight and ground granulated blast-furnace slag to 50 percent of portland cement by weight; silica fume to 10 percent of portland cement by weight.
  - 2. Limit the total of fly ash, pozzolans, ground granulated blast-furnace slag and silica fume to a maximum percent of total cementitious materials by weight of 50%.
  - 3. Limit the total of fly ash, pozzolans and silica fume to a maximum percent of total cementitious materials by weight of 35%.
- B. Design mixtures may be prepared by a qualified independent testing agency or by qualified precast plant personnel at precast structural concrete fabricator's option.
- C. Limit water-soluble chloride ions to maximum percentage by weight of cement permitted by ACI 318 when tested according to ASTM C 1218/C 1218M.
- D. Normal-Weight Concrete Mixtures: Proportion face and backup mixtures or full-depth mixtures, at fabricator's option by either laboratory trial batch or field test data methods according to ACI 211.1, with materials to be used on Project, to provide normal-weight concrete with the following properties:
  - 1. Compressive Strength (28 Days): 5000 psi.
  - 2. Maximum Water-Cementitious Materials Ratio: 0.40.
- E. Water Absorption: Limit water absorption to 6 percent by weight or 14 percent by volume, tested according to ASTM C 642, except for boiling requirement.
- F. Add air-entraining admixture at manufacturer's prescribed rate to result in concrete at point of placement having an air content complying with ACI 318 and PCI MNL 116.
- G. When included in design mixtures, add other admixtures to concrete mixtures according to manufacturer's written instructions.
- H. Concrete Mix Adjustments: Concrete mix design adjustments may be proposed if characteristics of materials, Project conditions, weather, test results, or other circumstances warrant.

## 2.9 FABRICATION

- A. Cast-in Anchors, Inserts, Plates, Angles, and Other Anchorage Hardware: Fabricate anchorage hardware with sufficient anchorage and embedment to comply with design requirements. Accurately position for attachment of loose hardware, and secure in place during precasting operations. Locate anchorage hardware where it does not affect position of main reinforcement or concrete placement.
  - 1. Weld-headed studs and deformed bar anchors used for anchorage according to AWS D1.1/D1.1M and AWS C5.4, "Recommended Practices for Stud Welding."

- B. Furnish loose hardware items including steel plates, clip angles, seat angles, anchors, dowels, cramps, hangers, and other hardware shapes for securing precast structural concrete units to supporting and adjacent construction.
- C. Cast-in reglets, slots, holes, and other accessories in precast structural concrete units as indicated on the Contract Drawings.
- D. Cast-in openings larger than 2 inches in any dimension. Do not drill or cut openings or prestressing strand without Engineer's approval.
- E. Reinforcement: Comply with recommendations in PCI MNL 116 for fabricating, placing, and supporting reinforcement.
- F. Reinforce precast structural concrete units to resist handling, transportation, and erection stresses and specified in-place loads.
- G. Prestress tendons for precast structural concrete units by either pretensioning or post-tensioning methods. Comply with PCI MNL 116.
- H. Comply with requirements in PCI MNL 116 and in this Section for measuring, mixing, transporting, and placing concrete. After concrete batching, no additional water may be added.
- I. Place concrete in a continuous operation to prevent cold joints or planes of weakness from forming in precast concrete units.
- J. Thoroughly consolidate placed concrete by vibration without dislocating or damaging reinforcement and built-in items, and minimize pour lines, honeycombing, or entrapped air voids on surfaces. Use equipment and procedures complying with PCI MNL 116.
- K. Comply with PCI MNL 116 procedures for hot- and cold-weather concrete placement.
- L. Identify pickup points of precast structural concrete units and orientation in structure with permanent markings, complying with markings indicated on Shop Drawings. Imprint or permanently mark casting date on each precast structural concrete unit on a surface that does not show in finished structure.
- M. Cure concrete, according to requirements in PCI MNL 116, by moisture retention without heat or by accelerated heat curing using live steam or radiant heat and moisture. Cure units until compressive strength is high enough to ensure that stripping does not have an effect on performance or appearance of final product.
- N. Discard and replace precast structural concrete units that do not comply with requirements, including structural, manufacturing tolerance, and appearance, unless repairs meet requirements in PCI MNL 116 and meet Engineer's approval.

## 2.10 FABRICATION TOLERANCES

- A. Fabricate precast structural concrete units to shapes, lines, and dimensions indicated so each finished unit complies with PCI MNL 116 product dimension tolerances as well as position tolerances for cast-in items.

## 2.11 COMMERCIAL FINISHES

- A. Commercial Grade: Remove fins and protrusions larger than 1/8 inch and fill holes larger than 1/2 inch. Rub or grind ragged edges. Faces must have true, well-defined surfaces. Air holes, water marks, and color variations are permitted. Limit form joint offsets to 3/16 inch.
- B. Standard Grade: Normal plant-run finish produced in molds that impart a smooth finish to concrete. Surface holes smaller than 1/2 inch caused by air bubbles, normal color variations, form joint marks, and minor chips and spalls are permitted. Fill air holes greater than 1/4 inch in width that occur more than once per 2 sq. in. Major or unsightly imperfections, honeycombs, or structural defects are not permitted. Limit joint offsets to 1/8 inch.
- C. Grade B Finish: Fill air pockets and holes larger than 1/4 inch in diameter with sand-cement paste matching color of adjacent surfaces. Fill air holes greater than 1/8 inch in width that occur more than once per 2 sq. in. Grind smooth form offsets or fins larger than 1/8 inch. Repair surface blemishes due to holes or dents in molds. Discoloration at form joints is permitted.
- D. Grade A Finish: Repair surface blemishes and fill air holes with the exception of air holes 1/16 inch in width or smaller, and form marks where the surface deviation is less than 1/16 inch. Float apply a neat cement-paste coating to exposed surfaces. Rub dried paste coat with burlap to remove loose particles. Discoloration at form joints is permitted. Grind smooth all form joints.
- E. Screed or float finish unformed surfaces. Strike off and consolidate concrete with vibrating screeds to a uniform finish. Hand screed at projections. Normal color variations, minor indentations, minor chips, and spalls are permitted. Major imperfections, honeycombing, or defects are not permitted.
- F. Smooth, steel trowel finish unformed surfaces. Consolidate concrete, bring to proper level with straightedge, float, and trowel to a smooth, uniform finish.
- G. Apply roughened surface finish according to ACI 318 to precast concrete units that receive concrete topping after installation.
- H. Broom Finish: Apply a broom finish to exterior concrete platforms, steps, ramps and elsewhere where used for public traffic use. Broom finish immediately after float finishing. Slightly roughen trafficked surfaces by brooming with fiber-bristle broom perpendicular to main traffic route.

## 2.12 SOURCE QUALITY CONTROL

- A. Testing: Test and inspect precast structural concrete according to PCI MNL 116 requirements and ASTM C 1610/C 1610M, ASTM C 1611/C 1611M, ASTM C 1621/C 1621M, and ASTM C 1712/C 1712M.
- B. Defective Units: Discard and replace precast structural concrete units that do not comply with requirements, including strength, manufacturing tolerances, and color and texture range. Chipped, spalled, or cracked units may be repaired, subject to Architect's approval.

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Install clips, hangers, bearing pads, and other accessories required for connecting precast structural concrete units to supporting members and backup materials.
- B. Erect precast structural concrete level, plumb, and square within specified allowable tolerances. Provide temporary structural framing, shoring, and bracing as required to maintain position, stability, and alignment of units until permanent connections are complete.
  - 1. Maintain horizontal and vertical joint alignment and uniform joint width as erection progresses.
  - 2. Remove projecting lifting devices and use plastic patch caps or sand-cement grout to fill voids within recessed lifting devices flush with surface of adjacent precast surfaces when recess is exposed.
  - 3. For hollow-core slab voids used as electrical raceways or mechanical ducts, align voids between units and tape butt joint at end of slabs.
- C. Connect precast structural concrete units in position by bolting, welding, grouting, or as otherwise indicated on Shop Drawings. Remove temporary shims, wedges, and spacers as soon as practical after connecting and grouting are completed.
- D. Field cutting of precast units is not permitted without approval of Engineer.
- E. Fasteners: Do not use drilled or powder-actuated fasteners for attaching accessory items to precast, prestressed concrete units.
- F. Welding: Comply with applicable requirements in AWS D1.1/D1.1M and AWS D1.4/D1.4M for welding, welding electrodes, appearance, quality of welds, and methods used in correcting welding work.
- G. At bolted connections, use lock washers, tack welding, or other approved means to prevent loosening of nuts after final adjustment.
- H. Grouting or Dry-Packing Connections and Joints: Grout connections and joints and open spaces at keyways, connections, and joints where required or indicated on Shop Drawings. Retain flowable grout in place until hard enough to support itself. Alternatively, pack spaces with stiff dry-pack grout material, tamping until voids are completely filled.

## 3.2 ERECTION TOLERANCES

- A. Erect precast structural concrete units level, plumb, square, and in alignment without exceeding the noncumulative erection tolerances of PCI MNL 135.
- B. Minimize variations between adjacent slab members by jacking, loading, or other method recommended by fabricator and approved by Engineer.

### 3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Engage a qualified special inspector to perform the following special inspections:
  - 1. Erection of precast structural concrete members.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Visually inspect field welds and test according to ASTM E 165 or to ASTM E 709 and ASTM E 1444. High-strength bolted connections are subject to inspections.
- D. Testing agency will report test results promptly and in writing to Contractor and Engineer.
- E. Repair or remove and replace work where tests and inspections indicate that it does not comply with specified requirements.
- F. Additional testing and inspecting, at Contractor's expense, shall be performed to determine compliance of replaced or additional work with specified requirements.
- G. Prepare test and inspection reports.

### 3.4 REPAIRS

- A. Repair precast structural concrete units if permitted by Engineer.
  - 1. Repairs may be permitted if structural adequacy, serviceability, durability, and appearance of units have not been impaired.
- B. Mix patching materials and repair units so cured patches blend with color, texture, and uniformity of adjacent exposed surfaces and show no apparent line of demarcation between original and repaired work, when viewed in typical daylight illumination from a distance of 20 feet (6 m).
- C. Prepare and repair damaged galvanized coatings with galvanizing repair paint according to ASTM A 780/A 780M.
- D. Wire brush, clean, and paint damaged prime-painted components with same type of shop primer.
- E. Remove and replace damaged precast structural concrete units that cannot be repaired or when repairs do not comply with requirements as determined by Engineer.

### 3.5 CLEANING

- A. Clean mortar, plaster, fireproofing, weld slag, and other deleterious material from concrete surfaces and adjacent materials immediately.

- B. Clean exposed surfaces of precast concrete units after erection and completion of joint treatment to remove weld marks, other markings, dirt, and stains.
  - 1. Perform cleaning procedures, if necessary, according to precast concrete fabricator's written recommendations. Protect other work from staining or damage due to cleaning operations.
  - 2. Do not use cleaning materials or processes that could change the appearance of exposed concrete finishes or damage adjacent materials.

END OF SECTION 034100

## SECTION 05 12 00 - STRUCTURAL STEEL FRAMING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Structural steel.
2. Grout.

## B. Related Requirements:

1. Section 05 12 13 "Architecturally Exposed Structural Steel Framing" for additional requirements for architecturally exposed structural steel.

## 1.2 DEFINITIONS

- A. Structural Steel: Elements of the structural frame indicated on Drawings and as described in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: Show fabrication of structural-steel components.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Qualification Data: For Installer, fabricator and testing agency.
- B. Welding certificates.
- C. Mill test reports for structural steel, including chemical and physical properties.
- D. Source quality-control reports.
- E. Field quality-control and special inspection reports.

## 1.5 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD.



- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category CSE.
- C. Welding Qualifications: Qualify procedures and personnel according to AWS D1.1/D1.1M, "Structural Welding Code - Steel."
- D. Comply with applicable provisions of the following specifications and documents:
  - 1. AISC 303, "Code of Standard Practice for Steel buildings and Bridges".
  - 2. AISC 360, "Specification for Structural Steel Buildings".
  - 3. RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
  - 4. ASTM Specifications.
  - 5. AWS D1.1/D1.1M, "Structural Welding Code."

## PART 2 - PRODUCTS

### 2.1 STRUCTURAL-STEEL MATERIALS

- A. W-Shapes, WT-shapes and channels: ASTM A 992/A 992M Grade 50.
- B. Angles, Plates and Bars: ASTM A 36/A 36M.
- C. Cold-Formed Hollow Structural Sections: ASTM A 500/A 500M, Grade B, structural tubing.
- D. Steel Pipe: ASTM A 53/A 53M, Type E, Grade B.
- E. Welding Electrodes: Comply with AWS requirements.

### 2.2 BOLTS, CONNECTORS, AND ANCHORS

- A. Zinc-Coated High-Strength Bolts, Nuts, and Washers: ASTM A 325, Type 1, heavy-hex steel structural bolts; ASTM A 563, Grade DH heavy-hex carbon-steel nuts; and ASTM F 436, Type 1, hardened carbon-steel washers.
  - 1. Finish: Mechanically deposited zinc coating.
  - 2. Direct-Tension Indicators: ASTM F 959, Type 325, compressible-washer type with mechanically deposited zinc coating finish.
- B. Unheaded Anchor Rods: ASTM F 1554, Grade 55, weldable.
  - 1. Configuration: Straight.
  - 2. Finish: Hot-dip zinc coating, ASTM F 2329/F 2329M.

### 2.3 PRIMER

- A. Primer: Comply with Section 099000 "Painting".

## 2.4 GROUT

- A. Nonmetallic, Shrinkage-Resistant Grout: ASTM C 1107/C 1107M, factory-packaged, nonmetallic aggregate grout, noncorrosive and nonstaining, mixed with water to consistency suitable for application and a 30-minute working time.

## 2.5 FABRICATION

- A. Structural Steel: Fabricate and assemble in shop to greatest extent possible. Fabricate according to AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," and to AISC 360.

## 2.6 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Slip Critical with Class A surface preparation.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.

## 2.7 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  - 1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  - 2. Surfaces to be field welded.
  - 3. Surfaces of high-strength bolted, slip-critical connections.
  - 4. Surfaces to receive sprayed fire-resistive materials (applied fireproofing).
  - 5. Galvanized surfaces.
- B. Surface Preparation: Clean surfaces to be painted. Remove loose rust and mill scale and spatter, slag, or flux deposits. Prepare surfaces according to Section 099000 "Painting".
- C. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

## 2.8 SOURCE QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified testing agency to perform shop tests and inspections.

1. Provide testing agency with access to places where structural-steel work is being fabricated or produced to perform tests and inspections.
- B. Bolted Connections: Inspect and test shop-bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- C. Welded Connections: Visually inspect shop-welded connections according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
  1. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
  2. Ultrasonic Inspection: ASTM E 164.
  3. Radiographic Inspection: ASTM E 94.
- D. Prepare test and inspection reports.

### PART 3 - EXECUTION

#### 3.1 EXAMINATION

- A. Verify, with certified steel erector present, elevations of concrete-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

#### 3.2 ERECTION

- A. Set structural steel accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
- B. Baseplates and Leveling Plates: Clean concrete-bearing surfaces of bond-reducing materials, and roughen surfaces prior to setting plates. Clean bottom surface of plates.
  1. Set plates for structural members on wedges, shims, or setting nuts as required.
  2. Weld plate washers to top of baseplate.
  3. Snug-tighten anchor rods after supported members have been positioned and plumbed. Do not remove wedges or shims but, if protruding, cut off flush with edge of plate before packing with grout.
  4. Promptly pack grout solidly between bearing surfaces and plates so no voids remain. Neatly finish exposed surfaces; protect grout and allow to cure. Comply with manufacturer's written installation instructions for shrinkage-resistant grouts.
- C. Maintain erection tolerances of structural steel within AISC 303, "Code of Standard Practice for Steel Buildings and Bridges."

### 3.3 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  - 1. Joint Type: Slip Critical with Class A surface preparation.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work.
  - 1. Comply with AISC 303 and AISC 360 for bearing, alignment, adequacy of temporary connections, and removal of paint on surfaces adjacent to field welds.
  - 2. Remove backing bars or runoff tabs, back gouge, and grind steel smooth.
  - 3. Assemble and weld built-up sections by methods that maintain true alignment of axes without exceeding tolerances in AISC 303, "Code of Standard Practice for Steel Buildings and Bridges," for mill material.

### 3.4 FIELD QUALITY CONTROL

- A. Special Inspections: Contractor will engage an independent qualified special inspector to perform the following special inspections:
  - 1. Verify structural-steel materials and inspect steel frame joint details.
  - 2. Verify weld materials and inspect welds.
  - 3. Verify connection materials and inspect high-strength bolted connections.
- B. Testing Agency: Contractor will engage an independent qualified testing agency to perform tests and inspections.
- C. Bolted Connections: Inspect and test bolted connections according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts."
- D. Welded Connections: Visually inspect field welds according to AWS D1.1/D1.1M.
  - 1. In addition to visual inspection, test and inspect field welds according to AWS D1.1/D1.1M and the following inspection procedures, at testing agency's option:
    - a. Magnetic Particle Inspection: ASTM E 709; performed on root pass and on finished weld. Cracks or zones of incomplete fusion or penetration are not accepted.
    - b. Ultrasonic Inspection: ASTM E 164.
    - c. Radiographic Inspection: ASTM E 94.

END OF SECTION 05 12 00

## SECTION 051213 - ARCHITECTURALLY EXPOSED STRUCTURAL STEEL FRAMING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes architecturally exposed structural-steel (AESS).
  - 1. Requirements in Section 05 12 00 "Structural Steel Framing" also apply to AESS.

## 1.2 DEFINITIONS

- A. AESS: Structural steel designated as "architecturally exposed structural steel" or "AESS" in the Contract Documents.

## 1.3 ACTION SUBMITTALS

- A. Shop Drawings: Show fabrication of AESS components. Shop Drawings for structural steel may be used for AESS provided items of AESS are specifically identified and requirements below are met for AESS.
  - 1. Indicate welds by standard AWS symbols, distinguishing between shop and field welds, and show size, length, and type of each weld. Show backing bars that are to be removed and supplemental fillet welds where backing bars are to remain. Indicate grinding, finish, and profile of welds.
  - 2. Indicate type, size, and length of bolts, distinguishing between shop and field bolts. Identify pretensioned and slip-critical, high-strength bolted connections. Indicate orientation of bolt heads.
- B. Samples: Submit Samples of AESS to set quality standards for exposed welds.
  - 1. Two steel plates, 3/8 by 8 by 4 inches, with long edges joined by a groove weld and with weld ground smooth.
  - 2. Steel plate, 3/8 by 8 by 8 inches, with one end of a short length of rectangular steel tube, 4 by 6 by 3/8 inches, welded to plate with a continuous fillet weld and with weld ground smooth and blended.
  - 3. Round steel tube or pipe, minimum 8 inches in diameter, with end of another round steel tube or pipe, approximately 4 inches in diameter, welded to its side at a 45-degree angle with a continuous fillet weld and with weld ground smooth and blended.

## 1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: A qualified fabricator that participates in the AISC Quality Certification Program and is designated an AISC-Certified Plant, Category STD, or is accredited by the IAS Fabricator Inspection Program for Structural Steel (AC 172).

- B. Installer Qualifications: A qualified installer who participates in the AISC Quality Certification Program and is designated an AISC-Certified Erector, Category ACSE.
- C. Shop-Painting Applicators: Qualified according to AISC's Sophisticated Paint Endorsement P3 or SSPC-QP 3, "Standard Procedure for Evaluating Qualifications of Shop Painting Applicators."

## 1.5 DELIVERY, STORAGE, AND HANDLING

- A. Use special care in handling to prevent twisting, warping, nicking, and other damage. Store materials to permit easy access for inspection and identification. Keep steel members off ground and spaced by using pallets, dunnage, or other supports and spacers. Protect steel members and packaged materials from corrosion and deterioration.
  - 1. Do not store materials on structure in a manner that might cause distortion, damage, or overload to members or supporting structures. Repair or replace damaged materials or structures as directed.

## 1.6 FIELD CONDITIONS

- A. Field Measurements: Where AECS is indicated to fit against other construction, verify actual dimensions by field measurements before fabrication.

## PART 2 - PRODUCTS

### 2.1 FILLER

- A. Filler: Polyester filler intended for use in repairing dents in automobile bodies.

### 2.2 PRIMER

- A. Primer: Comply with Section 099000 "Painting".

### 2.3 FABRICATION

- A. In addition to special care used to handle and fabricate AECS, comply with the following:
  - 1. Fabricate with exposed surfaces smooth, square, and free of surface blemishes including pitting, rust, scale, and roughness.
  - 2. Grind sheared, punched, and flame-cut edges of AECS to remove burrs and to provide smooth surfaces and edges.
  - 3. Fabricate AECS with exposed surfaces free of mill marks, including rolled trade names and stamped or raised identification.
  - 4. Fabricate AECS with exposed surfaces free of seams to maximum extent possible.

5. Remove blemishes by filling or grinding or by welding and grinding, before cleaning, treating, and shop priming.
  6. Fabricate with piece marks fully hidden in the completed structure or made with media that permits full removal after erection.
  7. Fabricate AESS to the tolerances specified in AISC 303 for steel that is designated AESS.
  8. Seal-weld open ends of hollow structural sections with 3/8-inch closure plates.
- B. Coping, Blocking, and Joint Gaps: Maintain uniform gaps of 1/8 inch with a tolerance of 1/32 inch.
- C. Bolt Holes: Cut, drill, mechanically thermal cut, or punch standard bolt holes perpendicular to metal surfaces.
- D. Cleaning Corrosion-Resisting Structural Steel: Clean and prepare steel surfaces that are to remain unpainted according to SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning."
- E. Holes: Provide holes required for securing other work to structural steel and for other work to pass through steel members.
1. Cut, drill, or punch holes perpendicular to steel surfaces. Do not thermally cut bolt holes or enlarge holes by burning.
  2. Baseplate Holes: Cut, drill, mechanically thermal cut, or punch holes perpendicular to steel surfaces.
  3. Weld threaded nuts to framing and other specialty items indicated to receive other work.

## 2.4 SHOP CONNECTIONS

- A. High-Strength Bolts: Shop install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
1. Joint Type: Slip Critical with Class A Surface Preparation.
- B. Weld Connections: Comply with AWS D1.1/D1.1M and AWS D1.8/D1.8M for tolerances, appearances, welding procedure specifications, weld quality, and methods used in correcting welding work, and comply with the following:
1. Assemble and weld built-up sections by methods that will maintain true alignment of axes without exceeding specified tolerances.
  2. Use weld sizes, fabrication sequence, and equipment for AESS that limit distortions to allowable tolerances.
  3. Provide continuous, sealed welds at angle to gusset-plate connections and similar locations where AESS is exposed to weather.
  4. Provide continuous welds of uniform size and profile where AESS is welded.
  5. Grind butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus zero inch.
  6. Make butt and groove welds flush to adjacent surfaces within tolerance of plus 1/16 inch, minus zero inch. Do not grind unless required for clearances or for fitting other components, or unless directed to correct unacceptable work.

7. Remove backing bars or runoff tabs; back-gouge and grind steel smooth.
8. At locations where welding on the far side of an exposed connection of AESS occurs, grind distortions and marking of the steel to a smooth profile aligned with adjacent material.
9. Make fillet welds oversize and grind to uniform profile with smooth face and transition.
10. Make fillet welds of uniform size and profile with exposed face smooth and slightly concave. Do not grind unless directed to correct unacceptable work.

## 2.5 GALVANIZING

- A. Hot-Dip Galvanized Finish: Apply zinc coating by the hot-dip process to structural steel according to ASTM A 123/A 123M.
  1. Do not quench or apply post-galvanizing treatments that might interfere with paint adhesion.
  2. Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

## 2.6 SHOP PRIMING

- A. Shop prime steel surfaces except the following:
  1. Surfaces embedded in concrete or mortar. Extend priming of partially embedded members to a depth of 2 inches.
  2. Surfaces to be field welded.
  3. Surfaces to be high-strength bolted with slip-critical connections.
  4. Surfaces to receive sprayed fire-resistive materials.
- B. Surface Preparation:
  1. Surface preparation shall comply with Section 099000 "Painting."
- C. Preparing Galvanized Steel for Shop Priming: After galvanizing, thoroughly clean steel of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.
- D. Priming: Immediately after surface preparation, apply primer according to manufacturer's written instructions and at rate recommended by SSPC to provide a minimum dry film thickness of 1.5 mils. Use priming methods that result in full coverage of joints, corners, edges, and exposed surfaces.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Verify, with steel erector present, elevations of concrete-bearing surfaces and locations of anchor rods, bearing plates, and other embedments for compliance with requirements.



1. Prepare a certified survey of bearing surfaces, anchor rods, bearing plates, and other embedments showing dimensions, locations, angles, and elevations.
- B. Proceed with installation only after unsatisfactory conditions have been corrected.

### 3.2 PREPARATION

- A. Provide temporary shores, guys, braces, and other supports during erection to keep AEES secure, plumb, and in alignment.
  1. If possible, locate welded tabs for attaching temporary bracing and safety cabling where they will be concealed from view in the completed Work.

### 3.3 ERECTION

- A. Set AEES accurately in locations and to elevations indicated and according to AISC 303 and AISC 360.
  1. Erect AEES to the tolerances specified in AISC 303 for steel that is designated AEES.
- B. Do not use thermal cutting during erection unless approved by Architect and Engineer. Finish thermally cut sections within smoothness limits in AWS D1.1/D1.1M.

### 3.4 FIELD CONNECTIONS

- A. High-Strength Bolts: Install high-strength bolts according to RCSC's "Specification for Structural Joints Using ASTM A 325 or A 490 Bolts" for type of bolt and type of joint specified.
  1. Joint Type: Slip Critical with Class A Surface Preparation.
  2. Orient bolt heads in same direction for each connection and to maximum extent possible in same direction for similar connections.
- B. Weld Connections: Comply with requirements in "Weld Connections" Paragraph in "Shop Connections" Article.
  1. Remove backing bars or runoff tabs; back-gouge and grind steel smooth.
  2. Remove erection bolts, fill holes, and grind smooth.
  3. Fill weld access holes and grind smooth.

### 3.5 FIELD QUALITY CONTROL

- A. Testing Agency: Contractor shall engage a qualified independent testing and inspecting agency to inspect AEES as specified in Section 051200 "Structural Steel Framing." The testing agency is not responsible for enforcing requirements relating to aesthetic effect.
- B. Architect will observe AEES in place to determine acceptability relating to aesthetic effect.

## 3.6 REPAIRS AND PROTECTION

- A. Remove welded tabs that were used for attaching temporary bracing and safety cabling and that are exposed to view in the completed Work. Grind steel smooth.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 051213

## SECTION 05 50 00 - METAL FABRICATIONS

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Miscellaneous steel framing and supports.
2. Miscellaneous steel trim.

## B. Products furnished, but not installed, under this Section include the following:

1. Steel pipe sleeves, slotted-channel inserts, and wedge-type inserts indicated to be cast into concrete.
2. Steel weld plates and angles for casting into concrete for applications where they are not specified in other Sections.

## 1.2 ACTION SUBMITTALS

## A. Product Data: For Grout.

## B. Shop Drawings: Show fabrication and installation details.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

## A. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes acting on exterior metal fabrications by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects.

1. Temperature Change: 120 deg F, ambient; 180 deg F, material surfaces.

## 2.2 METALS

## A. Metal Surfaces, General: Provide materials with smooth, flat surfaces unless otherwise indicated. For metal fabrications exposed to view in the completed Work, provide materials without seam marks, roller marks, rolled trade names, or blemishes.

## B. Steel Plates, Angles, and Bars: ASTM A 36/A 36M.

## C. Steel Tubing: ASTM A 500/A 500M, Grade B, cold-formed steel tubing.

## D. Steel Pipe: ASTM A 53/A 53M, Type E, Grade B, unless otherwise indicated.

## 2.3 MISCELLANEOUS MATERIALS

- A. Shop Primers: Provide primers that comply with Section 099000 "Painting."
- B. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- C. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.
- D. Concrete: Comply with requirements in Section 033000 "Cast-in-Place Concrete" for normal-weight, air-entrained, concrete with a minimum 28-day compressive strength of 4000 psi.

## 2.4 FABRICATION, GENERAL

- A. Shop Assembly: Preassemble items in the shop to greatest extent possible. Use connections that maintain structural value of joined pieces.
- B. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges. Remove sharp or rough areas on exposed surfaces.
- C. Weld corners and seams continuously to comply with the following:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended.
- D. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Locate joints where least conspicuous.
- E. Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.
- F. Where units are indicated to be cast into concrete, equip with integrally welded steel strap anchors not less than 8 inches from ends and corners of units and 24 inches o.c.

## 2.5 MISCELLANEOUS FRAMING AND SUPPORTS

- A. General: Provide steel framing and supports not specified in other Sections as needed to complete the Work.
- B. Fabricate units from steel shapes, plates, and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

## 2.6 MISCELLANEOUS STEEL TRIM

- A. Unless otherwise indicated, fabricate units from steel shapes, plates, and bars of profiles shown with continuously welded joints and smooth exposed edges. Miter corners and use concealed field splices where possible.
- B. Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.
- C. Galvanize miscellaneous steel trim where specified.
- D. Prime miscellaneous steel trim with primer specified in Section 099000 "Painting."

## 2.7 STEEL WELD PLATES AND ANGLES

- A. Provide steel weld plates and angles not specified in other Sections, for items supported from concrete construction as needed to complete the Work. Provide each unit with no fewer than two integrally welded steel strap anchors for embedding in concrete.

## 2.8 FINISHES, GENERAL

- A. Finish metal fabrications after assembly.

## 2.9 STEEL AND IRON FINISHES

- A. Galvanizing: Hot-dip galvanize items as indicated to comply with ASTM A 153/A 153M for steel and iron hardware and with ASTM A 123/A 123M for other steel and iron products.
- B. Shop prime iron and steel items not indicated to be galvanized unless they are to be embedded in concrete, sprayed-on fireproofing, or masonry, or unless otherwise indicated.
  - 1. Shop prime with primers specified in Section 099000 "Painting".
- C. Preparation for Shop Priming: Prepare surfaces to comply with Section 099000 "Painting".
- D. Shop Priming: Apply shop primer to comply with SSPC-PA 1, "Paint Application Specification No. 1: Shop, Field, and Maintenance Painting of Steel," for shop painting.

# PART 3 - EXECUTION

## 3.1 INSTALLATION, GENERAL

- A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal fabrications. Set metal fabrications accurately in location, alignment, and elevation; with edges and surfaces level, plumb, true, and free of rack; and measured from established lines and levels.

- B. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.
- C. Field Welding: Comply with the following requirements:
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove welding flux immediately.
  - 4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.
- D. Fastening to In-Place Construction: Provide anchorage devices and fasteners where metal fabrications are required to be fastened to in-place construction.
- E. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, or similar construction.

### 3.2 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas. Paint uncoated and abraded areas with the same material as used for shop painting to comply with SSPC-PA 1 for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 50 00

## SECTION 05 52 13 - PIPE AND TUBE RAILINGS

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Steel pipe and tube railings for handrail and guardrails.
2. Accessories required for a complete installation.

## B. Related Requirements:

1. Section 05 50 00 "Metal Fabrications".

## 1.2 ACTION SUBMITTALS

## A. Product Data: For the following:

1. Manufacturer's product lines of mechanically connected railings.
2. Railing brackets.
3. Grout, anchoring cement, and paint products.

## B. Shop Drawings: Include plans, elevations, sections, details, and attachments to other work.

## C. Samples: For each type of exposed finish required.

## D. Delegated-Design Submittal: For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

## 1.3 INFORMATIONAL SUBMITTALS

## A. Product Test Reports: For pipe and tube railings, for tests performed by a qualified testing agency, according to ASTM E 894 and ASTM E 935.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

## A. Delegated Design: Engage a qualified professional engineer, as defined in Section 01 45 00 "Quality Assurance and Quality Control," to design railings, including attachment to building construction.

- B. Structural Performance: Railings, including attachment to building construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:
1. Handrails and Top Rails of Guards:
    - a. Uniform load of 50 lbf/ ft. applied in any direction.
    - b. Concentrated load of 200 lbf applied in any direction.
    - c. Uniform and concentrated loads need not be assumed to act concurrently.
  2. Infill of Guards:
    - a. Concentrated load of 200 lbf applied horizontally on an area of 1 sq. ft.
    - b. Infill load and other loads need not be assumed to act concurrently.
- C. Thermal Movements: Allow for thermal movement resulting from maximum change (range) of 120 deg F.
- D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

## 2.2 GENERAL

- A. Where products and manufacturers are listed, make submittals for proposed comparable products and substitutions in accordance with Section 01 33 00 "Submittal Procedures".

## 2.3 MATERIALS

- A. Metals: Provide metal free from pitting, seam marks, roller marks, stains, discolorations and other imperfections where exposed to view on finished units.
- B. Steel and Iron: Provide steel and iron in the form indicated, complying with requirements:
1. Steel Pipe: ASTM A 53, Type F or Type S, Grade A, Standard Weight (Schedule 40), unless another grade and weight are required by structural loads.
  2. Provide galvanized finish for exterior installations and where indicated.
  3. Steel Tubing: ASTM A 500 cold formed, Grade A unless another grade and weight are required by structural loads.
  4. Plates, Shapes, and Bars: ASTM A 36
  5. Cast Iron: Either gray iron, malleable iron, ASTM A 47/A 47M, unless otherwise indicated
- C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.
1. For galvanized handrails and railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous metal components.
  2. For non-galvanized handrails and railings, provide non-galvanized ferrous metal fittings, brackets, fasteners and sleeves, except galvanize anchors embedded in exterior concrete constructions.



- D. Fillers: provide fillers made from steel plate, or suitably crush resistant materials, where needed.
- E. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes compatible in fabricated items.

## 2.4 FASTENERS

- A. General: Provide the following:
  - 1. Un-galvanized-Steel Railings: Plated steel fasteners complying with ASTM B 633, Class Fe/Zn 5 for zinc coating.
  - 2. Hot-Dip Galvanized Railings: hot-dip zinc-coated steel fasteners complying with ASTM F 2329 for zinc coating.
- B. Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors capable of sustaining, without failure, a load equal to 6 times the load imposed when installed in unit masonry and 4 times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

## 2.5 MISCELLANEOUS MATERIALS

- A. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.
- B. Etching Cleaner for Galvanized Metal: Complying with MPI#25.
- C. Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
- D. Shop Primers: Provide primers that comply with Section 099000 "Painting".
- E. Universal Shop Primer: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with MPI#79 and compatible with topcoat.
- F. Epoxy Zinc-Rich Primer: Complying with MPI#20 and compatible with topcoat.
- G. Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint systems indicated.
- H. Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.
- I. Polyurethane Topcoat: Complying with MPI #72 and compatible with undercoat.
- J. Bituminous Paint: Cold-applied asphalt emulsion complying with ASTM D 1187/D 1187M.

- K. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C 1107/C 1107M. Provide grout specifically recommended by manufacturer for interior and exterior applications.

## 2.6 FABRICATION

- A. Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.
- B. Form work true to line and level with accurate angles and surfaces.
- C. Welded Connections: Cope components at connections to provide close fit, or use fittings designed for this purpose. Weld all around at connections, including at fittings.
  - 1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
  - 2. Obtain fusion without undercut or overlap.
  - 3. Remove flux immediately.
  - 4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.
- D. Nonwelded Connections: Connect members with concealed mechanical fasteners and fittings. Fabricate members and fittings to produce flush, smooth, rigid, hairline joints.
- E. Form changes in direction by bending or by inserting prefabricated elbow fittings.
- F. Mill joints to a tight hairline fit. Cope or Miter corner joints. Form joints exposed to weather to exclude water penetration.
- G. For changes in direction made by bending, use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.
- H. Close exposed ends of railing members with prefabricated end fittings.
- I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect railing members to other work unless otherwise indicated.

## 2.7 STEEL AND IRON FINISHES

- A. Galvanized Railings:
  - 1. Hot-dip galvanize indicated steel railings.
  - 2. Comply with ASTM A 123/A 123M for hot-dip galvanized railings.
- B. Preparing Galvanized Railings for Shop Priming: After galvanizing, thoroughly clean railings of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

- C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning" or SSPC-SP 3, "Power Tool Cleaning."
- D. Primer Application: Apply shop primer to prepared surfaces of railings unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.
  - 1. Do not apply primer to galvanized surfaces.
- E. High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.
  - 1. Color: As selected by Owner from manufacturer's full range.

### PART 3 - EXECUTION

#### 3.1 INSTALLATION, GENERAL

- A. Set railings accurately in location, alignment, and elevation; measured from established lines and levels and free of rack.
  - 1. Do not weld, cut, or abrade surfaces of railing components that are coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
  - 2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
  - 3. Align rails so variations from level for horizontal members and variations from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.
- B. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.
  - 1. Coat, with a heavy coat of bituminous paint, concealed surfaces of aluminum that are in contact with grout, concrete, masonry, wood, or dissimilar metals.

#### 3.2 ANCHORING POSTS

- A. Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.
- B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with nonshrink, nonmetallic grout or anchoring cement, mixed and placed to comply with anchoring material manufacturer's written instructions.

- C. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members.

### 3.3 ATTACHING RAILINGS

- A. Attach railings to wall with wall brackets, except where end flanges are used. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads.
- B. Secure wall brackets and railing end flanges to building construction as follows:
  - 1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
  - 2. For hollow masonry anchorage, use toggle bolts.
  - 3. For wood stud partitions, use hanger or lag bolts set into studs or wood backing between studs. Coordinate with carpentry work to locate backing members.
  - 4. For steel-framed partitions, use hanger or lag bolts set into fire-retardant-treated wood backing between studs. Coordinate with stud installation to locate backing members.
  - 5. For steel-framed partitions, use self-tapping screws fastened to steel framing or to concealed steel reinforcements.
  - 6. For steel-framed partitions, use toggle bolts installed through flanges of steel framing or through concealed steel reinforcements.

### 3.4 ADJUSTING AND CLEANING

- A. Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.
- B. Galvanized Surfaces: Clean field welds, bolted connections, and abraded areas, and repair galvanizing to comply with ASTM A 780/A 780M.

END OF SECTION 05 52 13

## SECTION 055501 – ALUMINUM STAIR NOSING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes specifications for extruded aluminum stair nosing for existing concrete stair.
- B. Related sections:
  - 1. Section 03 30 00 – Cast in Place Concrete.

## 1.2 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site and visit the site and work scope.

## 1.3 ACTION SUBMITTALS

- A. In accordance with Section 01 33 00 “Submittal Procedures”, submit the following:
  - 1. Product Data: Submit manufacturer's technical data for each product indicated including recommendations for their application and use. Include test reports and certifications substantiating that products comply with requirements.

## 1.4 REFERENCES

- A. American Society for Testing and Materials (ASTM) Publications:
- B. ASTM B221 – Aluminum Alloy Extruded Bar, Rod, Wire, Shape, and Tube.
- C. ICC/ANSI A117.1 - International Code Council/American National Standards
- D. Institute Standard on Accessible and Useable Buildings and Facilities.
- E. Federal Test Method Standard - 501A – Standard for Fire Safety Criteria.

## 1.5 QUALITY ASSURANCES

- A. Stair nosing shall be provided and installed to comply with ICC/ANDI A117.1.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Retrofit stair nosing: Ultra Tread 3500 series by UPNOVR Inc.
  - 1. Extruded aluminum 6063-T6 alloy, with abrasive epoxy filled ribs designed for renovating existing stairs:
  - 2. Model: 3504, 4" wide x 5/16" thick
  - 3. Stair nosing flange: 1-1/8 inches inclined at 7 degree angle from vertical.
  - 4. Provide renovation stair tread with countersunk holes for installation.

### 2.2 MANUFACTURERS

- A. UPNOVR, Inc. 3 Crane Way, Hookset, New Hampshire 03106
- B. Approved Equal

## PART 3 - EXECUTION

### 3.1 RENOVATION STAIR NOSING INSTLLATION

- A. Prior to submitting shop drawings and fabrication, inspect existing stairs. Verify size and profile of stair tread is compatible with existing condition.
- B. Install renovation stair tread on existing stairs according to manufacturer's instructions.
- C. Center treads in width of stair with uniform space on both sides.
- D. Provide expansion inserts and bolts of size and type recommended by stair tread manufacturer and as required for securely anchoring tread to existing stair.
- E. Surface mount on existing stair tread. Install flush with concrete and tight to edge of riser. Ensure that installed treads are securely anchored, fasteners are tight and flush, and that exposed edges do not pose tripping hazard.
- F. Protect finish of nosing until completion of construction.

END OF SECTION 05 55 01

## SECTION 06 15 33 - TIMBER CROSSING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Composite decking (Trex, or approved equal).
2. Support framing.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For preservative-treated wood products and composite decking.

## 1.3 INFORMATIONAL SUBMITTALS

## A. Material Certificates:

1. For preservative-treated wood products. Indicate type of preservative used and net amount of preservative retained.

## B. Evaluation Reports: For the following, from ICC-ES:

1. Preservative-treated wood products.
2. Composite decking (Trex).
3. Decking fasteners.

## 1.4 DESIGN/PERFORMANCE REQUIREMENTS

## A. Composite Decking Structural Performance

1. Deck: Uniform Load – 100 lbs/sq.ft.

## B. Fire-Surface Burning Characteristics per ASTM E-84.

## 1.5 WARRANTY

- A. Composite Decking: Provide manufacturer's warranty against rot, decay, splitting, checking, splintering, fungal damage and termite damage for a period of 10-years.

## PART 2 - PRODUCTS

## 2.1 LUMBER, GENERAL

- A. Comply with DOC PS 20 and with grading rules of lumber grading agencies certified by ALSC's Board of Review as applicable. If no grading agency is indicated, comply with the applicable rules of any rules-writing agency certified by ALSC's Board of Review.
  - 1. Factory mark each item with grade stamp of grading agency.
  - 2. Provide dressed lumber, S4S, unless otherwise indicated.
- B. Maximum Moisture Content:
  - 1. Boards: 15 percent.
  - 2. Dimension Lumber: 19 percent.
  - 3. Timber: 19 percent.

## 2.2 COMPOSITE DECKING

- A. Wood-Plastic Composite Lumber:
  - 1. Material Description: Composite Decking consisting of recycled Linear Low Density Polyethylene (LLDPE) and recycled wood. The product is extruded into shapes and sizes as follows:
    - a. Trex Select Decking Boards; 0.875" x 5.5".
    - b. Lengths – 12, 16, and 20 feet.
    - c. Color – To be specified by owner from standard list of colors.

## 2.3 DIMENSION LUMBER FRAMING

- A. Deck Framing: No. 2 of the following species:
  - 1. Hem-fir (North); NLGA.
  - 2. Southern pine; SPIB.
  - 3. Douglas fir-larch; WCLIB or WWPA.
  - 4. Spruce-pine-fir; NLGA.
  - 5. Douglas fir-south; WWPA.
  - 6. Hem-fir; WCLIB or WWPA.
  - 7. Douglas fir-larch (North); NLGA.
  - 8. Spruce-pine-fir (South); NeLMA, WCLIB, or WWPA.

## 2.4 PRESERVATIVE TREATMENT

- A. Pressure treat boards and dimension lumber with waterborne preservative according to AWWA U1; Use Category UC4a for items in contact with the ground.
- B. Preservative Chemicals: Acceptable to authorities having jurisdiction.



1. Do not use chemicals containing arsenic or chromium.
- C. Use process that includes water-repellent treatment.
- D. Application: Treat all wood unless otherwise indicated.

## 2.5 FASTENERS

- A. General: Provide fasteners of size and type indicated, acceptable to authorities having jurisdiction, and that comply with requirements specified in this article for material and manufacture. Provide nails or screws, in sufficient length, to penetrate not less than 1-1/2 inches into wood substrate.
  1. Use stainless steel unless otherwise indicated.
  2. For pressure-preservative-treated wood, use stainless-steel fasteners.
  3. For composite wood decking, use stainless-steel fasteners.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. Set work to required levels and lines, with members plumb, true to line, cut, and fitted. Fit work to other construction; scribe and cope as needed for accurate fit.
- B. Framing Standard: Comply with AF&PA WCD1 unless otherwise indicated.
- C. Install composite decking to comply with manufacturer's written instructions.

END OF SECTION 06 15 33

## SECTION 074113 - METAL ROOF PANELS

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes metal roof panels, snow guards with related metal trim and accessories.
- B. Related Work Specified Elsewhere:
  - 1. Section 05 12 00– Structural Steel Framing.
  - 2. Section 05 50 00 – Metal Fabrications

## 1.2 PREINSTALLATION MEETINGS

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

## 1.3 ACTION SUBMITTALS

- A. In accordance with Section 01 33 00 “Submittal Procedures”, submit the following:
  - 1. Product Data: For each type of standing seam metal panel, accessory, and product indicated.
  - 2. Shop Drawings: Show layouts of metal panels. Include details of each condition of installation, panel profiles, and attachment to building. Provide details at a minimum scale 1-1/2-inch per foot of edge conditions, joints, fastener and sealant placement, flashings, openings, penetrations, roof accessories, lightning arresting equipment, and special details. Make distinctions between factory and field assembled work.
    - a. Indicate points of supporting structure that must coordinate with metal panel system installation.
    - b. Include data indicating compliance with performance requirements.
    - c. Include structural data indicating compliance with requirements of authorities having jurisdiction.
  - 3. Samples for Initial Selection: For each exposed product specified including sealants. Provide representative color charts of manufacturer's full range of colors.
  - 4. Samples for Verification: Provide 12-inch long section of each metal panel profile. Provide color chip verifying color selection.
  - 5. Calculations and drawings for both the panels and connections that have been signed and sealed by a Professional Engineer licensed to practice engineering in the Commonwealth of Virginia.

#### 1.4 INFORMATIONAL SUBMITTALS

- A. Product test reports to justify the roof panel type and connections being used.
- B. Warranties: Sample of special warranties.

#### 1.5 CLOSEOUT SUBMITTALS

- A. Maintenance data.

#### 1.6 QUALITY ASSURANCE

- A. Installer Qualifications: An entity that employs installers and supervisors who are trained and approved by manufacturer with a minimum 5 (five) years' experience.
- B. Manufacturer/ Sources: provide metal roof panel assembly and accessories from a single manufacturer.
- C. For approval of comparable products: Submit product data including certified independent test data indicating compliance with requirements in accordance with project substitution requirements, within time allowed for substitution review.

#### 1.7 WARRANTY

- A. Special Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace components of metal panel systems that fail in materials or workmanship within specified warranty period.
  - 1. Warranty Period: **Two** years from date of Substantial Completion.
- B. Special Warranty on Panel Finishes: Manufacturer's standard form in which manufacturer agrees to repair finish or replace metal panels that show evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Finish Warranty Period: **20** years from date of Substantial Completion.
- C. Special Weather-tightness Warranty: Manufacturer's standard form in which manufacturer agrees to repair or replace standing-seam metal roof panel assemblies that fail to remain weathertight, including leaks, within specified warranty period.
  - 1. Warranty Period: **20** years from date of Substantial Completion.

## 1.8 DELIVERY, STORAGE, AND HANDLING

- A. Protect products of metal panel system during shipping, handling, and storage to prevent staining, denting, deterioration of components or other damage. Protect panels and trim bundles during shipping.
  - 1. Deliver, unload, store, and erect metal panel system and accessory items without misshaping panels or exposing panels to surface damage from weather or construction operations.
  - 2. Store in accordance with Manufacturer's written instructions. Provide wood collars for stacking and handling in the field.

## PART 2 - PRODUCTS

### 2.1 PERFORMANCE REQUIREMENTS

- A. Structural Performance: Provide metal panel systems capable of withstanding the effects of loads, as shown in the contract documents.
  - 1. Wind Uplift Testing: Certify capacity of metal panels by actual testing of proposed assembly per ASTM E1592.
- B. Air Infiltration: ASTM E 1680: Maximum 0.07 cfm/sq. ft. at static-air-pressure difference of 6.24 lbf/sq. ft.
- C. Water Penetration under Static Pressure: No water penetration when tested according to ASTM E 1646: No uncontrolled water penetration at a static pressure of 12lb/sq.ft.
- D. Hydrostatic-Head Resistance: No water penetration when tested according to ASTM E 2140.
- E. Wind-Uplift Resistance: Provide metal roof panel assemblies that comply with UL 580 for wind-uplift-resistance class indicated.
  - 1. Uplift Rating: UL 90.
- F. FM Global Listing: Provide metal roof panels and component materials that comply with requirements in FM Global 4471 as part of a panel roofing system and that are listed in FM Global's "Approval Guide" for Class 1 or noncombustible construction, as applicable. Identify materials with FM Global markings.
  - 1. Fire/Windstorm Classification: Class 1A-75.
  - 2. Hail Resistance: SH.
- G. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes by preventing buckling, opening of joints, overstressing of

components, failure of joint sealants, failure of connections, and other detrimental effects. Base calculations on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.

1. Temperature Change Range: 120 deg F, ambient; 180 deg F, material surfaces

## 2.2 METAL ROOF PANELS

- A. Trapezoidal-Rib, Seamed-Joint, Standing-Seam Metal Roof Panels : Formed with raised trapezoidal ribs at panel edges and intermediate stiffening ribs symmetrically spaced between ribs; designed for sequential installation by mechanically attaching panels to supports using concealed clips located under one side of panels, engaging opposite edge of adjacent panels, and mechanically seaming panels together.
  1. Basis-of Design Product: Subject to compliance with requirements, provide MBCI: Double -Lock® or comparable product by one of the following:
    - a. CETRIA Architectural systems
    - b. Exceptional Metals
    - c. Met-Span
  2. Aluminum-Zinc Alloy-Coated Steel Sheet: ASTM A 792/A 792M, structural quality, Grade 50, Coating Class AZ50 , prepainted by the coil-coating process per ASTM A 755/A 755M.
    - a. Nominal Thickness: 22 gage coated thickness.
    - b. Panel Surface: Smooth with minor ribs in pan.
    - c. Exterior finish: Fluoropolymer two-coat metallic color system
    - d. Color: As selected by Architect to match existing Canopy.
  3. Joint Type: Double folded.
  4. Panel Coverage: 18 inches.
  5. Panel Height: 3.0 inches.

## 2.3 MISCELLANEOUS MATERIALS

- A. Miscellaneous Metal Sub-framing and Furring: ASTM C 645; cold-formed, metallic-coated steel sheet, ASTM A 653/A 653M, G90 (Z275 hot-dip galvanized) coating designation or ASTM A 792/A 792M, Class AZ50 (Class AZM150) coating designation unless otherwise indicated. Provide manufacturer's standard sections as required for support and alignment of metal panel system.
- B. Panel Accessories: Provide components required for a complete, weathertight panel system including trim, copings, fasciae, mullions, sills, corner units, clips, flashings, sealants, gaskets, fillers, closure strips, and similar items. Match material and finish of metal panels unless otherwise indicated.
  1. Closures: Provide closures at eaves and ridges, fabricated of same metal as metal panels.

2. Backing Plates: Provide metal backing plates at panel end splices, fabricated from material recommended by manufacturer.
  3. Closure Strips: Closed-cell, expanded, cellular, rubber or crosslinked, polyolefin-foam or closed-cell laminated polyethylene; minimum 1-inch- (25-mm-) thick, flexible closure strips; cut or premolded to match metal panel profile. Provide closure strips where indicated or necessary to ensure weathertight construction.
- C. Flashing and Trim: Provide flashing and trim formed from same material as metal panels as required to seal against weather and to provide finished appearance. Locations include, but are not limited to, eaves, rakes, corners, bases, framed openings, ridges, fasciae, and fillers. Finish flashing and trim with same finish system as adjacent metal panels.
- D. Gutters and Downspouts: Formed from same material as roof panels according to SMACNA's "Architectural Sheet Metal Manual." Finish to match metal roof panels and roof fascia and rake trim.
- E. Panel Fasteners: Self-tapping screws designed to withstand design loads.
- F. Panel Sealants: Provide sealant type recommended by manufacturer that are compatible with panel materials, are nonstaining, and do not damage panel finish.
1. Sealant Tape: Pressure-sensitive, 100 percent solids, gray polyisobutylene compound sealant tape with release-paper backing; 1/2 inch (13 mm) wide and 1/8 inch (3 mm) thick.
  2. Joint Sealant: ASTM C 920; as recommended in writing by metal panel manufacturer.
  3. Butyl-Rubber-Based, Solvent-Release Sealant: ASTM C 1311.

## 2.4 RAIL-TYPE SNOW GUARDS

- A. Flat-Mounted, Rail – Type Snow Guards:
1. Alpine Snow Guards; Model No. PP145
  2. LMCurbs; S-5! SnoFence.
  3. Riddell & Company, Inc.; Snobar
  4. Snow Management Systems; Vermont Snow guard
- B. Description: Units fabricated from metal baseplate anchored to fixed bracket and equipped with two bars.
- C. Brackets and Baseplate: Stainless steel.
- D. Bars: Stainless steel; mill finished.

## 2.5 FABRICATION

- A. General: Fabricate and finish metal panels and accessories at the factory, by manufacturer's standard procedures and processes, as necessary to fulfill indicated performance requirements demonstrated by laboratory testing. Comply with indicated profiles and with dimensional and structural requirements.
- B. On-Site Fabrication: Subject to compliance with requirements of this Section, metal panels may be fabricated on-site using UL-certified, portable roll-forming equipment if panels are of same profile and warranted by manufacturer to be equal to factory-formed panels. Fabricate according to equipment manufacturer's written instructions and to comply with details shown.
- C. Provide panel profile, including major ribs and intermediate stiffening ribs, if any, for full length of panel.
- D. Fabricate metal panel joints with factory-installed captive gaskets or separator strips that provide a weathertight seal and prevent metal-to-metal contact, and that minimize noise from movements.
- E. Sheet Metal Flashing and Trim: Fabricate flashing and trim to comply with manufacturer's recommendations and recommendations in SMACNA's "Architectural Sheet Metal Manual" that apply to design, dimensions, metal, and other characteristics of item indicated in the spec 076200 "Sheet Metal Flashing and Trim".

## 2.6 FINISHES

- A. Panels and Accessories:
  - 1. Two-Coat Fluoropolymer: AAMA 621. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat.

## PART 3 - EXECUTION

### 3.1 EXAMINATION

- A. Examine metal panel system substrate and supports with Installer present. Inspect for erection tolerances and other conditions that would adversely affect installation of metal panel installation
  - 1. Inspect metal panel support substrate to determine if support components are installed as indicated on approved shop drawings. Confirm presence of acceptable supports at recommended spacing to match installation requirements of metal panels.
  - 2. Panel Support Tolerances: Confirm that panel supports are within tolerances acceptable to metal panel system manufacturer but not greater than the following:

- a. 1/4 inch in 20 foot in any direction
- b. 3/8 inch (9 mm) over any single roof plane

### 3.2 PREPARATION

- A. Miscellaneous Supports: Install subframing, furring, and other miscellaneous panel support members and anchorages according to ASTM C 754 and metal panel manufacturer's written recommendations.
- B. Examine substrates and condition for snow guard, with Installer present, for compliance with requirements for installation tolerances, attachment, and other conditions affecting performance of the Work

### 3.3 METAL PANEL INSTALLATION

- 1. Mechanically-Seamed, Trapezoidal Standing Seam Metal Roof Panels: Install weathertight metal panel system in accordance with manufacturer's written instructions, approved shop drawings, and project drawings. Install metal roof panels in orientation, sizes, and locations indicated, free of waves, warps, buckles, fastening stresses, and distortions. Anchor panels and other components securely in place. Provide for thermal and structural movement.
- 2. Attach panels to supports using clips, screws, fasteners, and sealants recommended by manufacturer and indicated on approved shop drawings.
  - a. Fasten metal panels to supports with concealed clips at each location indicated on approved shop drawings, with spacing and fasteners recommended by manufacturer.
  - b. Seamed Joint: Crimp standing seams with manufacturer-approved, motorized seamer tool so clip, metal roof panel, and factory-applied sealant are completely engaged.
  - c. Provide weatherproof jacks for pipe and conduit penetrating metal panels of types recommended by manufacturer.
  - d. Dissimilar Materials: Where elements of metal panel system will come into contact with dissimilar materials, treat faces and edges in contact with dissimilar materials as recommended by manufacturer.

### 3.4 ACCESSORY INSTALLATION:

- A. General: Install metal panel trim, flashing, and accessories using recommended fasteners and joint sealers, with positive anchorage to building, and with weather tight mounting. Provide for thermal expansion. Coordinate installation with flashings and other components.
  - 1. Install components required for a complete metal panel assembly, including trim, copings, flashings, sealants, closure strips, and similar items.



2. Comply with details of assemblies utilized to establish compliance with performance requirements and manufacturer's written installation instructions.
3. Provide concealed fasteners except where noted on approved shop drawings.
4. Set units true to line and level as indicated. Install work with laps, joints, and seams that will be permanently weather resistant.

- B. Joint Sealers: Install joint sealers where indicated and where required for weathertight performance of metal panel assemblies, in accordance with manufacturer's written instructions.

### 3.5 FIELD QUALITY CONTROL

- A. Testing: Contractor will engage a qualified independent testing agency to perform field quality-control testing.

### 3.6 CLEANING AND PROTECTION

- A. Remove temporary protective coverings and strippable films, if any, as metal panels are installed, unless otherwise indicated in manufacturer's written installation instructions. On completion of metal panel installation, clean finished surfaces as recommended by metal panel manufacturer. Maintain in a clean condition during construction.
- B. Replace damaged panels and accessories that cannot be repaired to the satisfaction of the Architect

END OF SECTION 07 41 13

## SECTION 076000 – SHEET METAL GUTTERS AND DOWNSPOUTS

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Manufacturing and installation of gutters and downspouts and adapter as indicated on the contract documents.

## 1.2 ACTION SUBMITTALS

- A. Product Data: Product Data including manufacturer's material and finish data, installation instructions.
- B. Shop Drawings: Show layout and types of gutters and downspouts, anchorage details, methods of jointing, accessories, and attachments to other construction.

## 1.3 QUALITY ASSURANCE

- A. Installer Qualifications: Engage an experience Installer who has completed sheet metal work similar in material, design, and extent to that indicated for this Project and with a record of successful in-service performance.
- B. General: Install sheet metal to withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failing
- C. Comply with applicable provisions of the following specification and documents:
  1. Architectural Sheet Metal Manual by SMACNA requirements
  2. ASTM Specifications.

## 1.4 SUBMITTALS:

- A. In accordance with Section 01 33 00 "Submittal Procedures", submit the following:
  1. Product Data: Product Data including manufacturer's material and finish data, installation instructions.
  2. Shop Drawings: Show layout and types of gutters and downspouts, anchorage details, methods of jointing, accessories, and attachments to other construction.
  - 3.

## PART 2 - PRODUCTS

## 2.1 MATERIALS

## A. Hanging Gutters:

1. Fabricate to size and profile indicated, complete with end pieces, outlet tubes, and other accessories as required.
2. Fabricate to size and profile indicated, complete with end pieces, outlet tubes, and other accessories as required.
3. Gutter Material: Coil-Coated Galvanized Steel Sheet: Zinc-coated, commercial-quality steel sheet conforming to ASTM A 755, G 90 (ASTM A 755M, Z 275) coating designation, oil coated with high-performance fluoropolymer coating as specified, not less than 0.0276 inch thick.
4. Fabricate sections in maximum lengths practical; not less than 96 inch long.
5. Furnish flat-stock gutter spacers and gutter brackets fabricated from same metal as gutters, of size recommended by SMACNA but not less than twice gutter thickness
6. Fabricate expansion joints, expansion-joint covers, gutter bead reinforcing bars, and gutter accessories from same metal as gutters.
7. Gutter supports shall be adjustable minimum 1 IN wide by minimum .080 IN thick hanger, provided in sufficient number to be located at maximum 36 IN on center, or minimum 0.032 IN thick continuous cleats.

## B. Downspouts:

1. Fabricate downspouts to size and profile indicated complete with formed or mitered elbows.
2. Downspout Material: Coil-Coated Galvanized Steel Sheet: Zinc-coated, commercial-quality steel sheet conforming to ASTM A 755, G 90 (ASTM A 755M, Z 275) coating designation, oil coated with high-performance fluoropolymer coating as specified, not less than 0.0276 inch thick.
3. Shape: Rectangular
4. Furnish with metal hangers, from same material as downspouts, and anchors
5. Downspouts shall be fabricated in minimum 10 FT lengths with section ends formed for minimum 1/2 IN telescoped and locked joints.
6. Downspouts shall be complete with indicated elbows and offsets

## C. Adapter:

1. Use High Density Polyethylene downspouts adapter from downspouts to embedded drain pipe.

## D. Sleeve Material:

1. Sleeve PVC pipe complying with ASTM D 1785 joined with PVC fittings complying with ASTM D 2466 and solvent cement complying with ASTM D 2564.

## 2.2 COIL-COATED GALVANIZED STEEL SHEET FINISH:

1. High-Performance Organic Coating Finish: Apply the following system by coil-coating process on galvanized steel sheet as recommended by coating manufacturers and applicator.
  - a. Fluoropolymer 2-Coat Coating System: Manufacturer's standard 2-coat, thermocured system composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2. Color and Gloss: As indicated by manufacturer's color and gloss designations.
    - 1) Color and Gloss: As selected by Architect from manufacturer's full range of choices for color and gloss.
    - 2) Resin Manufacturers: Subject to compliance with requirements, provide fluoropolymer coating systems containing resins produced by one of the following manufacturers:
      - a) Ausimont USA, Inc. (Hylar 5000)
      - b) Elf Atochem North America, Inc. (Kynar 500)
2. Coil-Coated Steel Sheet Manufacturers: Subject to compliance with requirements, provide products by one of the following:
  - a. Berger Building products Corp
  - b. Klauer manufacturing Co.
  - c. Garrety manufacturing, Inc.
  - d. Or Approved equal

## PART 3 - EXECUTION

## 3.1 INSTALLATION

- A. Shop assemble work in largest practical sections; minimize field connections. Grind smooth parts exposed to view; remove weld marks and leave free of fabrication marks. Miter corners and edges unless otherwise shown. Make members true to length so assembling may be done without fillers. Bends, twists, open joints in finished members, or projecting edges or corners at connections will not be permitted. Miter, cope, and block carefully to produce tight joints. Provide lugs, clips, connections, bolts, and fastenings necessary to complete fabrication.
- B. General: Fabricate items in thickness or weight needed to comply with performance requirements but not less than that listed for each application and metal.
- C. Provide dissimilar metals and materials protection where dissimilar metals come in contact or where sheet metal contacts mortar, concrete masonry or concrete.
- D. Install products in accordance with manufacturer's instructions, SMACNA, and as indicated on Drawings.
- E. Installation – gutters and downspouts:
  - 1. Install gutters below slope line of roof, supported on adjustable hangers spaced maximum 30 IN on center or by continuous cleats.
  - 2. Join gutter sections with flat locked, riveted and sealed joints with hard setting sealant fill to provide completely water tight system.
  - 3. Adjust gutters to slope uniformly to downspout outlets, with high point midway between outlets.
  - 4. Install downspouts in locations shown on the Drawings.
  - 5. Install downspouts supported by leader straps or concealed rack and pin type fasteners at top, bottom and intermediate points not exceeding 5 FT on center.
  - 6. Provide downspout anchor straps per SMACNA as appropriate for downspout style.
  - 7. Provide gutter to downspout connection per SMACNA Figure 1-33B, Detail 1
  - 8. Seal all joints in downspout for a complete watertight system.
  - 9. Paint downspouts to match the canopy/roof.
  - 10. Provide all miscellaneous sheet metal items not specifically covered elsewhere, as indicated or required to provide a weather tight installation.

END OF SECTION 076000

## SECTION 07 62 00 - SHEET METAL FLASHING AND TRIM

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section Includes:
  - 1. Low-slope roof sheet flashing.

## 1.2 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Shop Drawings: For sheet metal flashing and trim.
  - 1. Include plans, elevations, sections, and attachment details.
  - 2. Include pattern of seams and details of termination points, expansion joints and expansion-joint covers, direction of expansion, roof-penetration flashing, and connections to adjoining work.
- C. Samples: For each exposed product and for each color and texture specified.

## 1.4 QUALITY ASSURANCE

- A. Fabricator Qualifications: Employs skilled workers who custom fabricate sheet metal flashing and trim similar to that required for this Project and whose products have a record of successful in-service performance.
  - 1. For Roof edge flashings that are SPRI ES-1 tested, shop shall be listed as able to fabricate required details as tested and approved.

## 1.5 WARRANTY

- A. Special Warranty on Finishes: Manufacturer agrees to repair finish or replace sheet metal flashing and trim that shows evidence of deterioration of factory-applied finishes within specified warranty period.
  - 1. Finish Warranty Period: 20 years from date of Substantial Completion.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

- A. General: Sheet metal flashing and trim assemblies shall withstand wind loads, structural movement, thermally induced movement, and exposure to weather without failure due to defective manufacture, fabrication, installation, or other defects in construction. Completed sheet metal flashing and trim shall not rattle, leak, or loosen, and shall remain watertight.
- B. Sheet Metal Standard for Flashing and Trim: Comply with NRCA's "The NRCA Roofing Manual" and SMACNA's "Architectural Sheet Metal Manual" requirements for dimensions and profiles shown unless more stringent requirements are indicated.
- C. SPRI Wind Design Standard: Manufacture and install roof edge flashings tested according to SPRI ES-1 and capable of resisting the following design pressure:
  - 1. Design Pressure: As indicated on Drawings.
- D. Thermal Movements: Allow for thermal movements from ambient and surface temperature changes.
  - 1. Temperature Change: 120 deg F (67 deg C), ambient; 180 deg F (100 deg C), material surfaces.

## 2.2 COIL-COATED GALVANIZED STEEL SHEET FINISH

- A. General: Protect mechanical and other finishes on exposed surfaces from damage by applying strippable, temporary protective film before shipping.
  - 1. Exposed Coil-Coated Finish:
    - a. Two-Coat Fluoropolymer: AAMA 2605. Fluoropolymer finish containing not less than 70 percent PVDF resin by weight in color coat. Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.
    - b. Color and Gloss: As selected by Architect from manufacturer's full range of choices for color and gloss.
  - 2. Coil-Coated Steel Sheet Manufacturers: Subject to compliance with requirements, provide products by one of the following:
    - a. CSC Curtis Steel Company
    - b. Copper Sales, Inc.
    - c. MM Systems Corporation.
    - d. Petersen Aluminum Corporation.
    - e. Vincent Metals.

## 2.3 FABRICATION, GENERAL

- A. General: Custom fabricate sheet metal flashing and trim to comply with details shown and recommendations in cited sheet metal standard that apply to design, dimensions, geometry, metal thickness, and other characteristics of item required. Fabricate sheet metal flashing and trim in shop to greatest extent possible.
1. Obtain field measurements for accurate fit before shop fabrication.
  2. Form sheet metal flashing and trim to fit substrates without excessive oil canning, buckling, and tool marks; true to line, levels, and slopes; and with exposed edges folded back to form hems.
  3. Conceal fasteners and expansion provisions where possible. Do not use exposed fasteners on faces exposed to view.

## 2.4 LOW-SLOPE ROOF SHEET METAL FABRICATIONS

- A. Roof Edge Flashing: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long sections. Furnish with 6-inch- (150-mm-) wide, joint cover plates. Shop fabricate exterior corners.
1. Fabricate from the Following Materials:
    - a. Galvanized Steel: [0.033 inch) 22 gauge thick.
- B. Roof Ridge Copings: Fabricate in minimum 96-inch- (2400-mm-) long, but not exceeding 12-foot- (3.6-m-) long sections. Fabricate joint plate of same thickness as copings. Furnish with continuous cleats to support edge of external leg and interior leg. Miter corners fasten and seal watertight.
1. Fabricate from the Following Materials:
    - a. Galvanized Steel: [0.040 inch) 22 gauge thick.

## PART 3 - EXECUTION

### 3.1 INSTALLATION, GENERAL

- A. General: Anchor sheet metal flashing and trim and other components of the Work securely in place, with provisions for thermal and structural movement. Use fasteners, solder, protective coatings, separators, sealants, and other miscellaneous items as required to complete sheet metal flashing and trim system.
1. Install sheet metal flashing and trim true to line, levels, and slopes. Provide uniform, neat seams with minimum exposure of solder, welds, and sealant.
  2. Install sheet metal flashing and trim to fit substrates and to result in watertight performance. Verify shapes and dimensions of surfaces to be covered before fabricating sheet metal.
  3. Space cleats not more than 12 inches (300 mm) apart. Attach each cleat with at least two fasteners. Bend tabs over fasteners.



4. Install exposed sheet metal flashing and trim with limited oil canning, and free of buckling and tool marks.
5. Torch cutting of sheet metal flashing and trim is not permitted.

### 3.2 ROOF FLASHING INSTALLATION

- A. General: Install sheet metal flashing and trim to comply with performance requirements, sheet metal manufacturer's written installation instructions, and cited sheet metal standard. Provide concealed fasteners where possible, and set units true to line, levels, and slopes. Install work with laps, joints, and seams that are permanently watertight and weather resistant.
- B. Roof Edge Flashing: Anchor to resist uplift and outward forces according to recommendations in cited sheet metal standard unless otherwise indicated. Interlock bottom edge of roof edge flashing with continuous cleat anchored to substrate.

### 3.3 CLEANING AND PROTECTION

- A. Clean exposed metal surfaces of substances that interfere with uniform oxidation and weathering.
- B. Clean and neutralize flux materials. Clean off excess solder.
- C. Clean off excess sealants.
- D. Remove temporary protective coverings and strippable films as sheet metal flashing and trim are installed unless otherwise indicated in manufacturers written installation instructions.

END OF SECTION 07 62 00

## SECTION 079200 JOINT SEALANTS

## PART 1: GENERAL

**1.1 SUMMARY:**

- A. This Section includes specifications for sealants and backer rod for control, expansion and isolation joints in precast and cast in place concrete slab.
- B. Related Work Specified Elsewhere:
  - 1. Section 033000 or 034100 – Cast-in-place Concrete or Precast Structural Concrete.
  - 2. Section 09 10 00 – Tactile Detectable Warning Surface Tile and Striping Tape
  - 3. Section 099000 – Painting.

**1.2 ACTION SUBMITTALS:**

- A. In accordance with Section 01 33 00 - Submittal Procedures, submit the following:
  - 1. Product Data: For each joint-sealant product indicated.
  - 2. Samples for Initial Selection: Manufacturer's color charts consisting of strips of cured sealants showing the full range of colors available for each product exposed to view.
  - 3. Product Certificates: Signed by manufacturers of joint sealants certifying that products furnished comply with requirements and are suitable for the use indicated.
  - 4. SWRI Validation Certificate: For each elastomeric sealant specified to be validated by SWRI's Sealant Validation Program.
  - 5. Qualification Data: For firms and persons specified in "Quality Control" 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.
  - 6. Compatibility and Adhesion Test Reports: From sealant manufacturer indicating the following:
    - a. Materials forming joint substrates and joint-sealant backings have been tested for compatibility and adhesion with joint sealants.
    - b. Interpretation of test results and written recommendations for primers and substrate preparation needed for adhesion.
  - 7. Product Test Reports: From a qualified testing agency indicating sealants comply with requirements, based on comprehensive testing of current product formulations.

8. Warranties: Special warranties specified in this Section.

### 1.3 PERFORMANCE REQUIREMENTS

- A. Provide elastomeric joint sealants that establish and maintain watertight and airtight continuous joint seals without staining or deteriorating joint substrates.

### 1.4 QUALITY ASSURANCE:

- A. Installer Qualifications: An experienced installer who has specialized in installing joint sealants similar in material, design, and extent to those indicated for this Project and whose work has resulted in joint-sealant installations with a record of successful in service performance.
- B. Source Limitations: Obtain each type of joint sealant through one source from a single manufacturer.
- C. Product Testing: Obtain test results for "Product Test Reports" Paragraph in "Submittals" Article from a qualified testing agency based on testing current sealant formulations within a 36-month period.
  1. Testing Agency Qualifications: An independent testing agency qualified according to ASTM C 1021 to conduct the testing indicated, as documented according to ASTM E 548.
  2. Test elastomeric joint sealants for compliance with requirements specified by reference to ASTM C 920, and where applicable, to other standard test methods.
  3. Test elastomeric joint sealants according to SWRI's Sealant Validation Program for compliance with requirements specified by reference to ASTM C 920 for adhesion and cohesion under cyclic movement, adhesion-in peel, and indentation hardness.
- D. Mockups: Before installing joint sealants, apply elastomeric sealants as follows to verify selections made under sample Submittals and to demonstrate aesthetic effects and qualities of materials and execution:
  1. Joints in mockups of assemblies specified in other Sections that are indicated to receive elastomeric joint sealants, which are specified by reference to this Section.

### 1.5 PROJECT CONDITIONS

- A. Environmental Limitations: 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.
  2. When ambient and substrate temperature conditions are outside limits permitted by joint sealant manufacturer or are below 40 deg F.
  3. When joint substrates are wet.

- B. Joint-Width Conditions: Do not proceed with installation of joint sealants where joint widths are less than those allowed by joint sealant manufacturer for applications indicated.
- C. Joint-Substrate Conditions: Do not proceed with installation of joint sealants until contaminants capable of interfering with adhesion are removed from joint substrates.

## 1.6 WARRANTY

- A. General Warranty: Special warranties specified in this Article shall not deprive Owner of other rights Owner may have under other provisions of the Contract Documents and shall be in addition to, and run concurrent with, other warranties made by Contractor under requirements of the Contract Documents.
- B. Special Installer's Warranty: Written warranty, signed by Installer agreeing to repair or replace elastomeric joint sealants that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: Two years from date of Substantial Completion.
- C. Special Manufacturer's Warranty: Written warranty, signed by elastomeric sealant manufacturer agreeing to furnish elastomeric joint sealants to repair or replace those that do not comply with performance and other requirements specified in this Section within specified warranty period.
  - 1. Warranty Period: 20 years from date of Substantial Completion.
- D. Special warranties specified in this Article exclude deterioration or failure of elastomeric joint sealants from the following:
  - 1. Movement of the structure resulting in stresses on the sealant exceeding sealant manufacturer's written specifications for sealant elongation and compression caused by structural settlement or errors attributable to design or construction.
  - 2. Disintegration of joint substrates from natural causes exceeding design specifications.
  - 3. Mechanical damage caused by individuals, tools, or other outside agents.
  - 4. Changes in sealant appearance caused by accumulation of dirt or other atmospheric contaminants.

## PART 2 – PRODUCTS

### 2.1 MATERIALS

- A. Compatibility: Provide joint sealants, backings, and other related materials that are compatible with one another and with joint substrates under conditions of service and application, as demonstrated by sealant manufacturer based on testing and field experience.

- B. Colors of Exposed Joint Sealants: As selected by the Owner from manufacturer's full range for this characteristic.

## 2.2 PERFORMANCE REQUIREMENT OF ELASTOMERIC JOINT SEALANTS

- A. Elastomeric Sealant Standard : Comply with ASTM C 920 and other requirements indicated for each liquid-applied chemically curing sealant in the Elastomeric Joint-Sealant, including those referencing ASTM C 920 classifications for type, grade, class, and uses.
- B. Additional Movement Capability: Where additional movement capability is specified in the Joint, provide products with the capability, when tested for adhesion and cohesion under maximum cyclic movement per ASTM C 719, to withstand the specified percentage change in the joint width existing at the time of installation and remain in compliance with other requirements of ASTM C 920 for uses indicated.
- C. Stain-Test-Response Characteristics: Where elastomeric sealants are specified in the Elastomeric Joint-Sealant Schedule to be non-staining to porous substrates, provide products that have undergone testing according to ASTM C 1248 and have not stained porous joint substrates indicated for Project.

## 2.3 ELASTOMERIC JOINT-SEALANT

- A. Single-Component Nonsag Urethane Sealant: Where joint sealants of this type are required, provide products complying with the following:
1. Products: Available products include the following
    - Vulkem 116, Tremco
    - Sikaflex – 1c SL, 2c SL; Sika Corporation.
    - MasterSeal NP 1, BASF the Chemical Company.
    - Or Approved Equal
  2. Type and Grade: S (single component).
  3. Class: 25.
  4. Uses Related to Exposure: T (traffic)
  5. Uses Related to Joint Substrates: M, G, A, and, O.

## 2.4 JOINT- SEALANT BACKING

- A. General: Provide sealant backings of material and type that are non-staining; are compatible with joint substrates, sealants, primers, and other joint fillers; and are approved for applications indicated by sealant manufacturer based on field experience and laboratory testing.
- B. Cylindrical Sealant Backings: ASTM C 1330, of type indicated below and of size and density to control sealant depth and otherwise contribute to producing optimum sealant performance:
1. Type C: Closed-cell material with a surface skin.

- C. Bond-Breaker Tape: Polyethylene tape or other plastic tape recommended by sealant manufacturer for preventing sealant from adhering to rigid, inflexible joint-filler materials or joint surfaces at back of joint where such adhesion would result in sealant failure. Provide self-adhesive tape where applicable.

## **2.5 MISCELLANEOUS MATERIALS**

- A. Primer: Material 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.
- B. Cleaners for Nonporous Surfaces: Chemical cleaners acceptable to manufacturers of sealants and sealant backing materials, free of oily residues or other substances capable of staining or harming joint substrates and adjacent nonporous surfaces in any way, and formulated to promote optimum adhesion of sealants with joint substrates.
- C. Masking Tape: Non-staining, non-absorbent material compatible with joint sealants and surfaces adjacent to joints.

## **PART 3 – EXECUTION**

### **3.1 PRODUCT DELIVERY AND STORAGE**

- A. Deliver materials to Project site in original unopened containers or bundles with labels indicating manufacturer, product name and designation, color, expiration date, pot life, curing time, and mixing instructions for multicomponent materials.
- B. Store and handle materials in compliance with manufacturer's written instructions to prevent their deterioration or damage due to moisture, high or low temperatures, contaminants, or other causes.

### **3.2 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.

### **3.3 PREPARATION**

- A. Surface Cleaning of Joints: Clean out joints immediately before installing joint sealants to comply with joint sealant manufacturer's written instructions and the following requirements:
  - 1. Remove all foreign material from joint substrates that could interfere with adhesion of joint sealant, including dust, paints (except for permanent, protective coatings test-

- ed and approved for sealant adhesion and compatibility by sealant manufacturer), old joint sealants, oil, grease, waterproofing, water repellents, water, surface dirt, and frost.
2. Clean porous joint substrate surfaces by brushing, grinding, blast cleaning, mechanical abrading, or a combination of these methods to produce a clean, sound substrate capable of developing optimum bond with joint sealants. Remove loose particles remaining from above cleaning operations by vacuuming or blowing out joints with oil-free compressed air.
  3. Remove laitance and form-release agents from concrete.
- B. Joint Priming: Prime joint substrates 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.
- C. Masking Tape: Use masking tape where required to prevent contact of sealant with adjoining surfaces that otherwise would be permanently stained or damaged by such contact or by cleaning methods required to remove sealant smears. Remove tape immediately after tooling without disturbing joint seal.

### 3.4 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. Sealant Installation Standard: Comply with recommendations of ASTM C 1193 for use of joint sealants as applicable to materials, applications, and conditions indicated.
- C. Install sealant backings of type indicated to support 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 sealant backings.
  2. Do not stretch, twist, puncture, or tear sealant backings.
  3. Remove absorbent sealant backings that have become wet before sealant application and replace them with dry materials.
- D. Install bond-breaker tape behind sealants where sealant backings are not used between sealants and back of joints.
- E. Install sealants by proven techniques to comply with the following and at the same time backings are installed:
1. Place sealants so they directly contact and fully wet joint substrates.
  2. Completely fill recesses provided for each joint configuration.
  3. Produce uniform, cross-sectional shapes and depths relative to joint widths that allow optimum sealant movement capability.
- F. Tooling of Non-sag Sealants: Immediately after sealant application and before skinning or curing begins, tool sealants according to requirements specified below to form smooth, uni-

form beads of configuration indicated; to eliminate air pockets; and to ensure contact and adhesion of sealant with sides of joint.

1. Remove excess sealants from surfaces adjacent to joint.
2. Use tooling agents that are approved in writing by sealant manufacturer and that do not discolor sealants or adjacent surfaces.
3. Provide concave joint configuration per Figure 5A in ASTM C 1193, unless otherwise indicated.

### **3.5 CLEANING**

- A. Clean off excess sealants 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.

### **3.6 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 so installations with repaired areas are indistinguishable from the original work.

END OF SECTION 079200



## SECTION 091000 – TACTILE DETECTABLE WARNING SURFACE AND STRIPING TAPE

## PART 1 – GENERAL

## 1.1 SUMMARY:

- A. This section includes Requirements for furnishing and installing permanently embedded Cast In Place Tactile (CIP) or Surface Applied Tile (SA) surface applied detectable warning surface tile, in an inline truncated dome pattern on ramps and platform surfaces as indicated on the contract drawings.
- B. Section 03 41 00 – Precast Structural Concrete

## 1.2 ACTION SUBMITTALS

- A. Product data for each specified product per Section 01 33 00 “Submittal Procedures”.
- B. Shop drawings, showing detailed plans of tile and striping tape profile, and installation methods
- C. Two (2) tile samples, minimum size 6” x 8” of the kind proposed for use.
- D. Two (2) striping tape samples, minimum size 3” x 8” of the kind proposed for use.
- E. Material Test Reports: Submit test reports from qualified independent testing laboratory indicating that materials proposed for use are in compliance with requirements and meet the properties indicated. All test reports shall be conducted on a wet concrete tactile panel system as certified by a qualified independent testing laboratory.
- F. Maintenance Instructions: Submit copies of manufacturer’s specified maintenance practices for each type of tactile tile, tape and accessory as required.

## 1.3 INFORMATIONAL SUBMITTALS

- A. Product certificates.
- B. Product test reports.
- C. Sample warranty.

**1.4 CLOSEOUT SUBMITTALS**

- A. Maintenance data.

**1.5 WARRANTY**

- A. Installed tiles and striping tape shall be warranted for a minimum of five (5) years against failure of adhesives, fasteners and sealants.

**PART 2 – PRODUCTS****2.1 PERFORMANCE REQUIREMENTS:**

- A. American Society for Testing and Materials (ASTM):

1. B117 Test Method of Salt Spray (Fog) Testing
2. C501 Test Method for Relative Resistance to Wear of Unglazed Ceramic Tile by the Taber Abraser
3. C1026 Test Method for Measuring the Resistance of Ceramic Tile to Freeze-Thaw Cycling
4. C1028 Test Method for Determining the Static Coefficient of Friction of Ceramic Tile and Other like Surfaces by the Horizontal Dynamometer Pull Method
5. D543 Test Method for Resistance of Plastics to Chemical Reagents
6. D570 Test Method for Water Absorption of Plastics
7. D638 Test Method for Tensile Properties of Plastics
8. D790 Test Method for Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials
9. D695 Test Method for Compressive Properties of Rigid Plastics

- B. Americans with Disabilities Act (ADA):

Provide tactile warning surfaces, which comply with the detectable warnings on walking surfaces, section of the Americans with Disabilities Act (Title 49 CFR TRANSPORTATION, PART 37.9 STANDARDS FOR ACCESSIBLE TRANSPORTATION FACILITIES, Appendix A, Section 4.29.2 DETECTABLE WARNINGS ON WALKING SURFACES).

**2.2 TILES:**

- A. ADA and CCR compliant; a homogenous glass and carbon reinforced composite which is colorfast and UV stable with fiberglass reinforced truncated domes for enhanced durability. The tile shall incorporate an in-line dome pattern of truncated domes 0.2" in height, 0.9" diameter at the base, and 0.4" diameter at top of dome spaced 2.35" nominal as measured side by side. The tile shall be installed with six countersunk fastening holes, and perimeter beveled edges. For wheelchair safety the field area shall consist of a non-slip surface with a minimum of 40 - 90° raised points 0.045" high, per square inch;
- a. Cast in Place Tactile (CIP), (Wet – Set) Composite Tactile as manufactured by ADA Solutions, Inc., Tel: 800-372- 0519, or approved equal.
  - b. Surface Applied Tactile (SA), Composite Tactile as manufactured by ADA Solutions, Inc., Tel: 800-372- 0519, or approved equal.
2. Color: Safety Yellow, (Federal Color # 33538) colorfast, UV stabilized coating. The color is uniform throughout and does not rely on any type of paint coating to achieve color stability.
  3. Size: 24" minimum- 36" x 48" x 3/8" nominal
  4. Fasteners: The Tactile Warning Surface Tile shall have minimum twelve (2' x 3' Tactile Warning Surface Tile) to twenty four (3' x 5' Tactile Warning Surface tile) countersunk fastening holes. Color matched, stainless steel 304, flat head drive anchor: 1/4" diameter x 1 1/2" long.
  5. Adhesive:
    - a. Polyether Structural Adhesive/ Sealant by Chem Link (m-1)
    - b. Urethane Elastomeric Adhesive by Bostik (Hydroment Ultra-Set Advanced or Durabond D-818)
    - c. Approved Equal.
  6. Sealants:
    - a. Dingle Component Urethane Sealant:
      - I. Sources: BASF NP by BASF Building Systems or Sikaflex Corp.
      - II. Colors: Black, Limestone, Redwood Tan
    - b. Polyether Structural Adhesive/ Sealant by Chem Link (m-1)
      - I. Colors: Black, Gray, Limestone, white
      - II. Approved Equal
- B. Performance: Tiles shall meet or exceed the following criteria:
1. Water Absorption: 0.35% maximum, when tested in accordance with ASTM D570.
  2. Slip Resistance: 0.90 minimum combined wet/ dry static coefficient of friction on top of domes and field area, when tested in accordance with ASTM C1028.
  3. Compressive Strength: 28,900 psi minimum, when tested in accordance with

ASTM D695.

4. Tensile Strength: 11,600 psi minimum, when tested in accordance with ASTM D638.
  5. Flexural Strength: 29,300 psi minimum, when tested in accordance with ASTM C790.
  6. Gardner Impact: 450 inch-pounds per inch minimum, when tested in accordance with Geometry "GE" of ASTM D5420.
  7. Chemical Stain Resistance: No reaction to 1% hydrochloric acid, urine, calcium chloride, stamp pad ink, gum and red aerosol paint, when tested in accordance with ASTM D543.
  8. Wear Depth: 0.03" maximum, after 1000 abrasion cycles of 40 grit Norton Metallite sandpaper, when tested in accordance with ASTM C501.
  9. Flame Spread: 20 maximum, when tested in accordance with ASTM E84.
  10. Accelerated Weathering: No deterioration, fading or chalking for 2000 hours, when tested in accordance with ASTM G155.
- C. Tactile warning tiles adhered to concrete shall meet or exceed the following performance criteria:
1. Accelerated Aging and Freeze Thaw of Adhesive System: No cracking, delamination, warping, checking, blistering, color change, loosening, etc. when tested in accordance with ASTM C1026.
  2. Salt and Spray Performance: No deterioration after 200 hours of exposure, when tested in accordance with ASTM B117.

## 2.3 STRIPING TAPE AND STENCILING:

- A. Plastic-Backed Preformed Tape Pavement Marking Material VDOT Type B, Class IV: Plastic - backed preformed tape shall conform to the requirements of ASTM D4505 for a Type I or VI, Grade B, C, D, or E, material and any additions and/or exceptions indicated herein. Tape shall be suitable for use on hydraulic cement concrete surfaces and shall be capable of being applied to previously apply marking material of the same composition under normal conditions of use. Tape shall be selected from VDOT approved products list.
1. Thickness (no adhesive): The thickness shall be at least 60 mils and no more than 90 mils.
  2. Skid resistance: Skid resistance requirements for a Type I material shall be the

same as those for a Type VI material.

3. Initial retro-reflectivity: Initial retro-reflectivity requirements for a Type VI material shall be the same as those for a Type I material.
4. Maintained retro-reflectivity, durability and adhesion: Maintained retro-reflectivity, durability, and adhesion shall conform to the following requirements after being installed on the test deck for 1 year:
  - a. Maintained retro-reflectivity: The photometric quantity to be measured is the coefficient of retro-reflected luminance (RL) in accordance with the requirements of ASTM E1743 for 15-meter geometry and ASTM E1710 for 30-meter geometry. RL shall be expressed in millicandelas per square foot per foot-candle and shall be at least either 150 for 15-meter or 100 for 30-meter when measured in the skip line or centerline areas.
  - b. Durability: Tape shall have a durability rating of at least 4.
  - c. Adhesion: No line shall be displaced, be torn or missing.

B. Polyester-Resin Pavement Marking Material VDOT Type B, Class II: Polyester-resin is a two-component pavement marking material suitable for use on hydraulic cement concrete surfaces.

1. Physical requirements (uncatalyzed material):
  - a. Viscosity: Viscosity (25 degrees C) determined in accordance with the requirements of ASTM D562 shall be 80 to 90 Krieb units.
  - b. Weight per gallon: The weight per gallon shall be at least 11.5 pounds.
  - c. Drying time: The catalyst/resin ratio shall be adjusted by the operator so that the applied line shall dry to a no-tracking condition in 15 minutes or less when applied at an application temperature of 77 degrees F to 100 degrees F, a substrate temperature of at least 60 degrees F, a wet thickness of 15 to 25 mils, and with 10 to 15 pounds of glass beads conforming to the requirements of VDOT Section 234 applied per gallon.
  - d. Catalyst: The catalytic component of the system shall be a commercially available type recommended by the manufacturer of the polyester. The peroxide shall not be exposed to any form of heat, such as direct sunlight, radiators, open flame, or sparks as heat may cause the organic peroxide to decompose violently or burn if ignited. The peroxide shall not come into contact with easily oxidized metals, such as copper, brass, mild steel, or galvanized steel as this can also initiate a violent reaction.

- e. Weight loss: Beaded catalyzed material shall have a weight loss of not more than 125 milligrams after 1,000 revolutions when abraded in accordance with the requirements of Federal Test Method Standard No. 141b, Method 6192, and using CS-17 wheels with a 1,000-gram load on each wheel.
- f. Shelf life: The shelf life of un-catalyzed material shall be at least 6 months when stored in a cool area below 85 degrees F.
- g. Durability and wear resistance: Material shall be designed to provide a life expectancy of at least 5 years under average daily passenger traffic.
- h. Hiding: The marking shall show a dry hiding quality that will yield a contrast ratio of at least 0.96 with the Morest Black and White Power Chart, Form 03B, when drawn down at a 15-mil wet film thickness. Readings will be determined in accordance with the requirements of ASTM E 1349 using CIE 1931, 2 degrees standard observer and CIE standard Illuminant D65.

## PART 3 – EXECUTION

### 3.1 PREPARATION:

- A. Furnish products as indicated.
- B. Ensure substrates are in suitable condition and in compliance with the Tactile Warning Surface manufacturer recommendations, to receive work of this Section.

### 3.2 INSTALLATION:

- A. Ensure that surfaces being prepared and fabricated to receive the tiles and striping tape are constructed and prepared correctly and adequately for tile installation.
- B. Immediately prior to installing the detectable warning surface tile and striping tape, the concrete surfaces must be inspected to ensure that they are as specified in the contract documents while maintaining a slump range of 4-7 inches to permit the solid placement of the ADA Replaceable Composite (Wet-Set) Tactile Unit (ADAREP) in the wet cement.
- C. Install the CIP Tactile units per the manufacturer's instructions.
  - 1. CIP Tiles shall be tamped or vibrated into the fresh concrete to ensure that there are no voids or air pockets, and the field level of the CIP Tile is flush to the adjacent concrete surface or as the drawing indicate to permit proper water drainage and eliminate tripping hazards between adjacent finishes.

- D. Install the SA Tactile units per the manufacturer's instructions.
1. Apply adhesive on the backside of the SA Tactile following the perimeter boarder and internal cross pattern established by the SA Tile manufacturer. Sufficient adhesive must be placed on the prescribed areas to have full coverage across minimum of 2 inches width of adhesive locator. Check with manufacturer if direct that full coverage adhesive is required to optimize the Tile performance and load bearing capacity.
  2. Allow 1/8" separation between successive SA tiles for expansion/ contraction.
  3. Drill holes true and straight to a depth of 2" by 1/4" using recommended bit. As necessary, additional countersunk holes may be added.
  4. Mechanically fasten SA Tile to the concrete substrate using a 32 oz to 48 oz hammer to set the composite sleeve anchors. Ensure that the fastener has been set to full depth straight and true. Care should be taken when setting the fastener to avoid any advertent blows with the hammer to the SA Tile.
  5. Plastic-backed preformed tape shall be installed in accordance with the manufacturer's recommendations and as denoted herein. Tape shall not be applied over existing pavement markings of other materials unless the existing marking is 90 percent removed. Primer/adhesive shall be used for all installations except when tape is applied immediately following the final rolling of the new asphalt concrete surface and shall be from the same manufacturer as the tape. Tape for pavement line markings shall be applied by an application cart as recommended by the manufacturer. Tape shall be tamped into place with a tamper cart with the weight as recommended by the manufacturer.
- E. Polyester resin material shall be applied only on hydraulic cement concrete pavements. Polyester resin shall not be applied over existing pavement markings of other materials unless the existing marking is 90 percent removed. Polyester resin may be applied over existing polyester resin markings. Glass beads shall be applied to the surface at the rate of 8 pounds per gallon of material.

END OF SECTION 09 10 00

## SECTION 09 90 00 - PAINTING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. The work specified in this Section consists of painting all exposed canopy steel and Railings.
- B. Related work specified elsewhere.
  - 1. Section 03 30 00 – Cast in Place Concrete
  - 2. Section 05 12 00 – Structural Steel Framing
  - 3. Section 05 50 00 – Metal Fabrications
  - 4. Section 05 52 13 – Pipe and Tube Railings

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product. Include preparation requirements and application instructions under section 01 33 00 “Submittal Procedures”.
- B. Samples: Submit specified colors for each surface-finishing product with detailed painting schedule of type of paint, number of coatings to materials to be painted.
- C. Submit manufacturer's specifications, data, and installation instructions for review.
- D. Submit statement of VOC compliance with local regulations.

## 1.3 QUALITY ASSURANCE

- A. Regulatory Requirements:
  - 1. Comply with referenced ASTM, SSPC, and NACE standards as applicable to the coatings indicated.
  - 2. Comply with Federal and State toxicity and air quality regulations and with Federal requirements on content of lead, mercury, and other heavy metals. Do not use solvents in paint products that contribute to air pollution.
  - 3. National Paint and Coatings Association (NPCA): Guide to U.S. Government Paint Specifications.
  - 4. American Society of Testing Materials (ASTM): Conform to ASTM D16 for interpretation of terms used in this Section.



5. Painting and Decorating Contractors of America (PDCA): Painting - Architectural Specifications Manual.
  6. Steel Structures Painting Council (SSPC): Steel Structures Painting Manual.
  7. AISC's "Code of Standard Practice for Steel Buildings and Bridges."
- B. Qualifications:
1. Manufacturers: Company specializing in manufacturing products specified with minimum 5 years documented experience.
  2. Volatile Organic Compounds (VOC): Use only products in compliance with VOC content limits required by state and local regulations.
- C. Applicator: Company specializing in performing work having minimum 5 years' documented experience and approved by manufacturer.
- D. Material Quality: provide manufacturer's best quality trade sale paint material of various coating types specified. Paint material containers not displaying manufacturer's product identification will not be acceptable.

## PART 2 - PRODUCTS

### 2.1 GENERAL:

1. To the maximum extent practicable, use the materials of one manufacturer throughout the project. No claims as to the suitability of a material specified, or of inability to produce first-class work with these materials, will be considered unless such claims are made in writing and submitted prior to the start of the Work.
2. Provide a primer suitable for each substrate type and which is manufactured or recommended by the paint manufacturer as part of a complete painting system.
3. Provide ready mixed products, except field catalyzed coatings. Provide accessory materials such as linseed oil, shellac, thinners, cleaners and other materials not specifically indicated but required to achieve finishes specified.
4. Use only one lot of paint for any individual element to be painted. Do not mix lots of paint.
5. Previously Primed Surfaces:
  - a. If surfaces have been primed off-site at the mill, factory, or shop, omit specified primer, but only if the off-site primer is acceptable to the paint system manufacturer for best performance of the specified paint system.
  - b. For touch-up of off-site primer, use primer of the same composition as the mill, factory, or shop primer.
6. Color selection by Owner.

### B. EXTERIOR PAINTING SYSTEMS

1. Steel/Metal (Un-galvanized) Primer:
  - a. Initial Shop Coat: One (1) coat zinc-rich, epoxy primer; 3-5 mm thickness; spray application acceptable; color selected by the Owner.
  - b. Intermediate Field Coat: One (1) coat cross linked epoxy 1-2.5 mm thickness roller/brush application acceptable.
2. Steel/Metal (galvanized) Primer:
  - a. Intermediate Field Coat: One (1) coat cross linked epoxy 1-2.5 mm thickness; roller/brush application acceptable.
3. All Steel/Metal Surfaces Finish Paint:
  - a. Shop Coat: Two (2) coats Acrylic/Aliphatic Polyester Polyurethane spray application.
4. Concrete Stair and Ramp walls / stringer units: Exterior Acrylic, Semi-Gloss: Two coats over block filler with total dry film thickness not less than 2.5 mils, excluding the block filler. MPI Paint Systems EXT 4.2A.
  - a. Block Filler: High performance latex block filler used for filling open textured concrete masonry block before application of top coats: MPI Product No. 4.
  - b. Undercoat: Quick-drying, semi-gloss, acrylic paint for use on the exterior over concrete masonry block: MPI Product No. 11.
  - c. Finish Coat: Quick-drying, semi-gloss, acrylic paint for use on the exterior over concrete masonry block: MPI Product No. 11.

### PART 3 - EXECUTION

#### 3.1 PREPARATION

- A. Mix paints at the factory; do not alter or reduce materials except as directed by manufacturer.
- B. Color selection by Owner.

#### 3.2 APPLICATION

- A. Apply all coatings in the shop under controlled environment per Manufacturer recommendations.
- B. Do not apply materials when surface and ambient temperatures are outside the temperature ranges required by the Manufacturer.
- C. Provide adequate ventilation of all interior spaces during application and curing of all painting products.
- D. Moisture Content: Measure moisture content of surfaces using an electronic moisture meter. Do not apply finishes unless moisture content of surfaces is below the Manufacturer recommendations.
- E. Oil, grease, salts, or other surface contaminations must first be removed.

END OF SECTION 09 90 00

## SECTION 26 00 00 - ELECTRICAL

## PART 1 - GENERAL

## 1.1 DESCRIPTION

- A. The work under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.
- B. It is the intent of these Specifications for the Contractor to provide an electrical system complete, fully operational, fully adjusted, and ready for use.
- C. All contract requirements indicated in the Division 26 documents, including drawings and specifications, shall be considered supplemental to and in addition to the contract requirements indicated in the documents of other trades and the Division 01 requirements.

## 1.2 REQUIRED WORK DESCRIBED IN OTHER SECTIONS

A.	General Requirements	26 00 10
B.	Schedule of Submittal Data	26 00 70
C.	Low-Voltage Electrical Power Conductors and Cables	26 05 19
D.	Grounding and Bonding for Electrical Systems	26 05 26
E.	Division 26 Demolition	26 05 30
F.	Raceway and Boxes for Electrical Systems	26 05 33
G.	Vibration and Seismic Controls for Electrical Systems	26 05 48
H.	Identification for Electrical Systems	26 05 53
I.	Miscellaneous Equipment	26 05 90
J.	Testing	26 05 93
K.	Panelboards	26 24 16
L.	Wiring Devices	26 27 26
M.	Low-Voltage Circuit Protective Devices	26 28 00
N.	Lighting	26 50 00

## 1.3 PARTIAL LIST OF WORK NOT INCLUDED IN DIVISION 26

- A. Installing access doors:
- B. Painting (except as otherwise specified herein):
- C. Furnishing of motors.
- D. Furnishing of individual motor controllers that are factory-mounted and integral parts of pieces of equipment.
- E. Furnishing, installing, and connecting telephone wiring, cables, and equipment unless

ELECTRICAL

26 00 00 - 1

otherwise indicated:

- F. Other Divisions shall furnish and install control wiring and conduit for equipment and systems as needed.
  - 1. Any control wiring not provided under another Division shall be furnished and installed under Division 26, including but not limited to conduit, other raceway components, and control wiring.

## PART 2 - PRODUCTS

### 2.1 EQUIPMENT

- A. General: All equipment shall be new, of the capacity and type specified herein, and as shown on the Drawings. Equipment shall be of a manufacturer and model number listed by a Nationally Recognized Testing Lab and shall be in accordance with the space limitations of the project.
- B. Single Source: To maximize ease of maintenance and part replacement, equipment of a similar nature shall be provided by a single manufacturer.
- C. Approved Equal: Equipment and materials selected by the Contractor within the context of "equal as approved by the Engineer", "approved equal", "equivalent as determined by the Engineer" and similar terminology shall be submitted to the Engineer for review, approval and inclusion into the Contract Documents prior to the finalization of the contract between the Owner and the Contractor, and prior to the shop drawing submittal phase of the Project. All equipment and materials submitted to the Engineer under the terms of "approved equal" during the shop drawing phase of the Project without prior review and approval shall be returned to the Contractor without review under the status of "No Action".

### 2.2 MATERIAL

- A. All material required for a complete and proper installation shall be as specified and as selected by the Contractor subject to the approval of the Architect.
- B. Material shall be new, listed and approved by UL, and bear the inspection label if subject to such approval.

### 2.3 CONTRACTOR APPROVALS

- A. The contractor shall submit in writing and obtain written approval from the Owner, Architect, and/or Engineer for all equipment substitutions, installation deviations from that shown on the contract drawings, and all other miscellaneous approvals required from the Owner, Architect, and/or Engineer as referenced throughout these specifications.
- B. A request for a substitution constitutes that the Contractor:
  - 1. Has investigated the proposed product and determined that it is equal to or superior in all respects to that specified.

2. Will provide the same warranties for the substitution as for the product specified.
3. Will coordinate the installation of the substitution into the work, and make such other changes as may be required to make the work complete in all respects.
4. Waives all claims for additional costs, under his responsibility, which may subsequently become apparent.
5. Will absorb all costs incurred by the substitution when affecting other trades including but not limited to electrical, structural, architectural, etc.
6. Will absorb any cost incurred by the Owner's Representative in review of the substituted product if the acceptance of the substituted item creates the need for system modification and/or redesign, or if the substituting Contractor exhibits negligence in his substituting procedure thus submitting inferior, misapplied or miss-sized equipment.

### PART 3 - EXECUTION

#### 3.1 CONDITIONS

- A. Inspection: Prior to proceeding with the work of this Division, carefully inspect the installed work of all other trades and verify that all such work is complete to the point where this installation may properly commence. Verify that the work of this Division may be completed in strict accordance with all pertinent codes and regulations, the reviewed shop drawings, and the manufacturers' recommendations.
- B. Discrepancies: In the event of discrepancy, immediately notify the Owner's Representative. Do not proceed in areas of discrepancy until all such discrepancies have been resolved. If there is a discrepancy between the Drawings and the Specifications, the Specifications shall typically govern. However, any discrepancy of this type shall be immediately brought to the attention of the Owner's Representative for formal interpretation prior to proceeding with the work.
- C. Interpretation of Documents: Any and all contractual requirements may be indicated solely on the Drawings, solely in the Specifications, in both the Specifications and on the Drawings, in reference standards indicated in the Specifications and/or in the Owner's and Contractor's Contract. If Contract requirements are indicated in both the Specifications and the Drawings, the Contractor shall comply with both requirements unless the requirements are mutually exclusive of each other. If Contract requirements are indicated in both a reference standard and the Specifications, the more stringent requirement shall apply. Any and all contractual requirements shall be interpreted within the overall context of the complete scope of work. All materials, equipment, systems and installation methods shall be suitable for the intended service, coordinated with other trades and be complete, fully operational, adjusted, tested and ready for use by the Owner.

#### 3.2 INSTALLATION OF EQUIPMENT

- A. Locations: Install all equipment in the locations shown on the approved shop drawings,

except where specifically approved otherwise on the job by the Architect and/or Owner's Representative.

- B. Interferences: Avoid interference with structure and with work of other trades, while preserving adequate headroom and clearing all doors and passageways to the approval of the Architect and/or Owner's Representative. Inspection: Check each piece of equipment in the system for defects. Verify that all parts are properly furnished and installed, function properly, and that all adjustments have been made.

### 3.3 CONNECTIONS TO EQUIPMENT

- A. Equipment provided under other Divisions: The Contractor shall make final electrical connections to all items for a complete and operational system.

### 3.4 CLOSING-IN OF UNINSPECTED WORK

- A. General: Do not allow or cause any of the work of this Division to be covered up or enclosed until it has been inspected, tested, and approved by the Architect and/or Owner's Representative and by the authorities having jurisdiction.
- B. Uncovering: Should any of the work of this Division be covered up or enclosed before it has been completely inspected, tested and approved, the Contractor shall provide all services, labor, materials and equipment necessary to uncover such work without additional cost to the Owner. After the work has been completely inspected, tested, and approved, the Contractor shall provide all services, labor, materials and equipment to make all repairs necessary to restore the work to its original and proper condition at no additional cost to the Owner.

### 3.5 COOPERATION WITH OTHER TRADES

- A. Coordinate and cooperate with other trades in order that all systems in the scope of the Contract may be installed in the best arrangement. Coordinate and cooperate as required with all other trades which share space in common areas and maximize the access to each system and their respective components.

### 3.6 CLEANING

- A. It is the intent of these Specifications that all work, including the inside of equipment, be left in a clean condition. All construction dirt shall be removed from material and equipment. Level of cleanliness shall be defined as "broom" clean unless noted otherwise. All exterior surfaces of Division 26 equipment shall be wiped down and cleaned of all dust and dirt. All interior surfaces of electrical equipment including but not limited to switchboards, motor controllers, and panelboards shall be wiped down and vacuum cleaned so as to be delivered to the Owner in factory new condition. Surfaces to be painted shall be cleaned and prepared in accordance with architectural division of the contract and as noted in other sections herein.

### 3.7 COMPLETENESS

- A. It is the intent of these Specifications to provide complete systems. Completeness shall

mean that all materials, equipment, and systems as installed and operating on this project have been installed properly with the best practices of the trade; are suitable for the intended purpose, location, and environment; properly fit within the physical space limitations for the project; are in conformance with applicable codes and reference standards; have been started-up, tested, adjusted, and commissioned for the intended use; have maintained applicable UL Listings; are in compliance with manufacturer's recommendations and warranty requirements; ready for the Owner's use, and in the opinion of the Architect, performing as designed.

### 3.8 ADJUSTMENT OF CONTROLS

- A. The Contractor shall provide the personnel and equipment to completely adjust the controls to the satisfaction of the Architect. At the completion of the project, the Architect will arrange a meeting at the job site to allow the Contractor to demonstrate the proper operation of the electrical controls.

### 3.9 NOISE

- A. It is the intent of these Specifications to provide a system free from objectionable audible noise and vibration. Any equipment that is generating objectionable noise or vibration, in the opinion of the Architect, shall be corrected and dampened as required to eliminate the objectionable level.

END OF SECTION 26 00 00

## SECTION 26 00 10 - GENERAL REQUIREMENTS

## PART 1 - GENERAL

## 1.1 DESCRIPTION

## A. General

1. The work under this Section shall conform to the requirements of the "General Conditions" and "Supplementary Conditions" of these Specifications.

## B. Work Included

1. The work included in this Section consists of the general requirements for the work more specifically described in Division 26.

## C. Definitions

1. The Contractor shall provide all supervision, labor, material, equipment, machinery, and any and all other items necessary to complete the mechanical and electrical systems. All items of equipment are specified in the singular; however, the Contractor shall provide the number of items of equipment as indicated on the Drawings, and as required for complete systems.

## D. Intent

1. It is the intention of these Specifications and Drawings to call for finished work which has been completed, tested, adjusted, commissioned, fully operational, approved by the local code authorities, and ready for the Owner's use. Wherever the word "provide" is used, it shall mean "furnish and install complete and ready to use."
2. It is the intention of these specifications and drawings that wherever the word "weather" is used throughout the various Division 26 specification sections it refers to "locations exposed to weather". "Locations exposed to weather" shall mean areas exposed to outside environmental temperature, humidity, or moisture conditions. These locations include but are not limited to areas on the exterior of the building, on the roof, above or below the station platform, and other areas as indicated on the drawings or in the specifications.
3. All labor, materials, apparatus, and appliances essential to the complete functioning of the systems described and indicated herein, or which may be reasonably implied as essential whether mentioned in the Drawings and Specifications or not, shall be furnished and installed by the Contractor.
4. In addition to the requirements indicated throughout the Drawings and Specifications, as completely installed and operating on this project; equipment and systems provided for this project shall meet the following minimum



requirements without additional cost to the Project:

- a. Be suitable for the intended service, location, and environment;
- b. Properly fit within the physical space limitations for the project;
- c. Meet the minimum requirements of applicable codes and reference standards as determined and approved by the local code authorities;
- d. Maintain applicable UL listings;
- e. Be coordinated with the work of other trades in a timely manner;
- f. Not be purchased or installed prior to the resolution of any conflicts or coordination that could result in additional cost to the Owner;
- g. Be in accordance with the manufacturer's recommendations and warranty requirements; and
- h. Be ready for use by the Owner.

5. In cases of doubt as to the Work intended, or in the event of need for explanation thereof, the Contractor shall request supplementary instructions from the Architect.

E. Codes, Rules, Regulations, Permits and Fees

1. Refer to the architectural specification Divisions for additional requirements. The architectural specification Divisions shall govern these requirements. The following information shall be in addition to the architectural specification Divisions.
2. The Contractor shall give all necessary notices, obtain all permits and pay all government sales taxes, fees, and other costs, including utility connections or extensions, in connection with the Contractor's work; file all necessary plans, prepare all documents and obtain all necessary approvals of all governmental departments having jurisdiction; obtain all required certificates of inspection of the Contractor's work and deliver same to the Architect before request for acceptance and final payment for work.
3. The Contractor shall comply with the most recently revised versions of all applicable laws, rules, regulations, and ordinances of Federal, State, and Local Authorities. Modifications required by the above said Authorities shall be made without additional charge to the Owner.
4. The Contractor shall comply with applicable building codes as adopted and modified by the Local Code Authorities. Modifications required by the above said building codes shall be made without additional charge to the Owner.
5. All equipment shall comply with all applicable requirements of laws, codes, ordinances, legislation, etc., of all Federal, State and Local Authorities, whether indicated on the Contract Documents or not.
6. Where Contract Drawings and Specifications requirements are in excess of Code requirements and are permitted under the Code, the Contract Drawings and Specifications shall govern.

7. All rules and regulations of the State Fire Insurance Regulatory Body, Underwriters Laboratories, Americans with Disabilities Act (ADA), National Electrical Code (NEC, NFPA 70), and NFPA 130 (Standard for Fixed Guideway Transit and Passenger Rail Stations) shall be complied with whether indicated in the Contract Drawings and Specifications or not.
8. All materials, equipment, and systems provided on this project shall be in compliance with the applicable energy codes and the energy efficiency ASHRAE Standard 90.1 as adopted by the applicable building codes. All panelboard enclosures and bus plugs shall have sufficient space to permit check metering with metering CT's as required by ASHRAE 90.1.
9. Where alterations to or deviations from the Contract Drawings and Specifications are required by the above authorities report the requirements to the Architect and secure Architect's approval before starting the alterations.
10. Third Party Certification: All packaged equipment shall be independently Third Party labeled as a system for its intended use by a Nationally Recognized Testing Laboratory (NRTL), such as UL or ETL, in accordance with OSHA Federal Regulations 29CFR1910.303 and .399, as well as NFPA Pamphlet #70, National Electrical Code (NEC), Article 90-7.

## 1.2 QUALITY ASSURANCE

### A. Surveys and Measurements

1. The Contractor shall base all measurements, both horizontal and vertical, from established benchmarks. All work shall agree with these established lines and levels. Verify all measurements at site and check the correctness of same as related to the work.
2. Should the Contractor discover any discrepancy between actual measurements and those indicated, which prevents following good practice or the intent of the Drawings and Specifications, the Contractor shall notify the Architect, and shall not proceed with the work until instruction has been received from the Architect.

### B. Drawings

1. Electrical design drawings are diagrammatic and indicate the general arrangement of systems and work included in the Contract. Drawings are not to be scaled. The Architectural Drawings and Details shall be examined for exact location of fixtures and equipment. Where they are not definitely located, this information shall be obtained from the Owner's Representative.
2. The Contractor shall follow Drawings in laying out work and check Drawings of other trades to verify spaces in which work will be installed. Maintain maximum headroom and space conditions at all points. Where headroom or space conditions appear inadequate, the Owner's Representative shall be notified before proceeding with installation.

3. If directed by the Owner's Representative, the Contractor shall, without extra charge, make reasonable modifications in the layout as needed to prevent conflict with work of other trades or for proper execution of the work, if such directions are made prior to the performance of the affected work.

C. Cooperation with Other Trades

1. The Subcontractors shall give full cooperation to other trades and shall furnish in writing to the General Contractor any information necessary to permit the work of all trades to be installed satisfactorily and with the least possible interference or delay.
2. Where Division 26 work will be installed in close proximity to, or will interfere with work of other trades, coordination among trades in working out space conditions to make a satisfactory adjustment shall be accomplished. The Contractor shall prepare composite shop drawings and sections at a suitable scale not less than  $1/4" = 1'-0"$ , clearly showing how work of all affected trades is to be installed. If work is installed before coordinating with other trades, or so as to cause any interference with work of other trades, then the necessary changes in work shall be made to correct the condition without extra charge.
3. The Contractor shall obtain and transmit between affected trades, all necessary templates, patterns, setting plans, and shop details for the proper installation of work and for the purpose of coordinating adjacent work.

D. Protection

1. The Contractor shall protect all work and material from damage by the Contractors' work or workmen, Subcontractors' work or workmen, and shall be liable for all damage thus caused.
2. The Contractor shall be responsible for work and equipment until work is final inspected, tested, and accepted; the Contractor shall protect work against theft, injury or damage; and shall carefully store material and equipment received on site which are not immediately installed. The Contractor shall close open ends of work with temporary covers or plugs during storage and construction to prevent entry of obstructing material.
3. All stored on-site or installed absorptive materials are protected at all times from moisture damage.

E. Material and Workmanship

1. Work shall be executed in strict accordance with the best practice of the trades in a thorough, substantial, workmanlike manner by competent workmen. The Contractor shall furnish the services of a full-time, experienced superintendent, who shall be constantly in charge of the installation of the work, together with all skilled workmen, fitters, metal workers, welders, helpers, and laborers required to unload, transfer, erect, connect, adjust, start, operate, and test each system.

## F. Manufacturer's Recommendations

1. In addition to the requirements indicated in the drawings and specifications; manufactured products, articles, materials, and equipment shall be applied, installed, connected, erected, used, cleaned, conditioned, inspected, started-up, tested, operated, and commissioned in accordance with the manufacturer's current printed recommendations. Keep copies of such printed recommendations at job site and make them available as required. When conditions on this project are not covered by the manufacturer's printed recommendations, at the discretion of and as requested by the owner's representative, the manufacturer's authorized representative shall review the conditions and provide written supplemental recommendations to address the special situation. If the manufacturer's recommendations are in conflict with the requirements of the drawings and specifications, the Contractor shall advise the Owner's representative of the conflict prior to purchase and installation.

## G. Space Limitations

1. MEP systems and equipment shall be provided and installed to accommodate the structural systems, architectural systems, other trades, and the physical space limitations of the project.
2. Equipment shall be provided which will fit into the physical spaces provided and indicated, allowing ample room for access, servicing, removal and replacement of parts, etc. Adequate space shall be allowed for clearance in accordance with the Code requirements, the requirements of the local inspection department, and the equipment manufacturers' recommendations.
3. In the preparation of Drawings, a reasonable effort to accommodate equipment manufacturers' space requirements has been made. However, since space requirements, equipment arrangement, access and service clearances, conduit, piping, ductwork and other connections, manufacturers' recommendations, and other variables vary according to each manufacturer; due to the multiple manufacturers listed for each product and the possible number of different equipment combinations; the responsibility for access, proper fit, coordination, and accommodating the space limitations of the project rests with the Contractor. Refer to shop drawing submittal requirements herein for additional requirements.
4. Refer to the drawings for additional requirements.
5. Physical dimensions and arrangements of equipment to be installed shall be subject to the Architects' review.

## H. Coordination with Installation Conditions

1. The requirements of the Division 26 systems shall be coordinated with the installation conditions. The Contractor shall visit the site, survey the installation conditions, and verify exact measurements. Means and methods of access, rigging, and modifications to installation conditions to accommodate the

installation of new Division 26 work shall be the responsibility of the Contractor. Disassembly, reassembly, and certification testing of equipment as required to accommodate the installation conditions shall be included in the base bid. Prior to the ordering, purchasing, and fabricating of Division 26 systems, coordination with installation conditions shall be completed by the Contractor.

I. Coordination Between Divisions:

1. The Division 26 Contractors shall cooperate with the General Contractor and the other Division Contractors to provide coordination between these Division trades in a timely manner. For all equipment requiring electrical service provided under other Divisions, it shall be the responsibility of the Division 26 Contractors to acquire from the other Division Contractors the electrical characteristics of the actual equipment to be provided. Should there be a discrepancy between the electrical service characteristics of the equipment to be provided and what is indicated on the documents, the contractor shall obtain written direction from the Owner's representative prior to proceeding. This coordination and transfer of information shall take place in a timely manner prior to the purchasing and installation of the electrical service.

J. Commissioning:

1. The Contractor shall provide adequate personnel with the appropriate level of specialized training, experience, and expertise at the general contractor and sub-contractor levels to properly install, check, verify, supervise, start-up, trouble-shoot, de-bug, pre-test, commission, and make the necessary corrections to all electrical systems in accordance with the Contract Documents. The Contractor shall be responsible for the operational demonstration of the completed electrical systems to the Owner's Representative, Architect and Engineer. The Contractor shall complete the electrical systems in accordance with the contract documents including start-up, trouble-shooting, de-bugging, pre-testing, and commissioning of the electrical systems prior to requesting that the Owner's Representative, Architect, and Engineer attend the operational demonstrations of the electrical systems. Additional costs incurred by the Owner related to re-reviewing, re-witnessing, re-testing, re-inspecting, and re-commissioning all or part of the MEP systems due to incomplete or non-compliant work shall be reimbursed by the Contractor to the Owner. Refer to the various sections of the specifications for additional commissioning requirements.

K. Additional Information

1. Information provided by the Engineer to the Contractors during construction must be reviewed and approved by the Architect and Owner's Representative. The Contractor shall not proceed without prior review and authorization from the Architect and Owner's Representative. The Contractor shall not proceed with work that will increase the cost of the project or impact the project schedule without prior review and authorization from the Architect and Owner's Representative. If information provided by the Engineer to the Contractor will increase the cost of the project or impact the project schedule, the Contractor

shall advise the Architect and Owner's Representative in a reasonably timely manner so as to minimize the cost and impact to the project. Refer to the General Conditions of the Contract and the Architectural documents for additional information.

### 1.3 SHOP DRAWINGS, PRODUCT DATA AND SAMPLES

- A. After the Contract is awarded but prior to proceeding with the Work requiring final reviewed shop drawings, product data and samples, the Contractor shall provide the Architect and Engineer with a submittal log schedule indicating when each submittal is to be sent to the Architect and Engineer for review in order for the Architect and Engineer to schedule personnel and plan accordingly. Unless otherwise indicated, a minimum period of two (2) weeks, exclusive of transmittal time, will be required in the Engineer's office each time a shop drawing, product data and/or samples are submitted or resubmitted for review. This time period will commence once the shop drawing, product data and/or samples are received in the Engineer's office contingent upon the shop drawing, product data and/or samples being received in the Engineer's office before 3:00 PM. If the shop drawing, product data and/or samples are received in the Engineer's office after 3:00 PM, the time period will not start until the next business day. This time period shall be considered by the Contractor when scheduling the Work. The submittal log schedule should be updated and reissued by the Contractor on a regular basis to avoid submittal review delays. If a submittal arrives before or after the scheduled time indicated within the Contractor's submittal log schedule, or if a number of submittals arrive at the same time without scheduled notification, the Architect and Engineer may not be able to review all of the submittals within the minimum two (2) week time period. The Contractor shall obtain complete shop drawings, product data and samples from the manufacturers, suppliers, vendors, subcontractors, and sub-subcontractors for all materials, systems and equipment specified herein; and submit data and details of such materials, systems and equipment for review by the Architect and Engineer. Prior to submission of the shop drawings, product data and samples to the Architect and Engineer, the Contractor shall review and certify that the shop drawings, product data and samples are in compliance with the Contract Documents. The Contractor shall check all materials and equipment after their arrival on the job site and verify their compliance with the Contract Documents. The Contractor shall provide adequate personnel with the appropriate level of specialized training, experience and expertise at the general contractor and sub-contractor levels to properly check, verify, and correct if necessary shop drawing submittal data to ensure compliance with the Contract Documents prior to delivery to the Architect and Engineer. The Division 26 shop drawing submittal requirements, including but not limited to the Division 26 certification requirements, shall be in addition to the requirements indicated in the Architectural Divisions of the Contract Documents.
- B. The Architect's approval and Engineer's review of shop drawings, product data, and samples shall not relieve the Contractor of the responsibility for dimensions or errors that may be contained therein, or for deviations from requirements in the Contract Documents. It shall be clearly understood that the Engineer's noting 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 shall govern the Work and are neither waived nor superseded in any way by the review of shop drawings, product data and samples.

- C. Before submitting shop drawings, product data and samples the Contractor shall certify that data and details set forth on each shop drawing, product data, or samples for each item of equipment and materials complies with the Contract Documents for this Project. Such certification shall be made by the Owner, a Partner, a Corporate Officer of the Contractor, or by a person duly authorized to sign binding agreements for the Contractor. Unless certified, shop drawings, product data and samples will not be reviewed, and will be returned unchecked to the Contractor. Certifications shall be in the form of rubber stamp impressions which state:

I hereby certify that this shop drawing, product data, and/or sample has been checked prior to submittal and that it has been coordinated with existing conditions and complies in all respects with the requirements of the Contract Documents and physical space limitations for the Project.

(Name of the Electrical Subcontractor)

Signed: \_\_\_\_\_

Position: \_\_\_\_\_

Date: \_\_\_\_\_

- D. The Contractor shall submit shop drawings, product data and/or samples, equipment and other items listed in Section 26 00 70 and for any other equipment for which such submittals may be required in various Sections of the Specifications. Prior to submitting shop drawings, product data and samples for all items of equipment listed in Section 26 00 70 and shown with an asterisk (\*), each submittal package including subsequent submittal packages shall be certified by the manufacturer as to performance and compliance with Contract Documents. Such certification shall be made by the Owner, a Partner, a Corporate Officer of the manufacturer, or be a person duly authorized to sign for the Owner, Partner, or corporation.

1. Unless certified, shop drawings, product data and/or samples will not be reviewed and will be returned unchecked to the Contractor. The certification shall be as follows:

I hereby certify that the equipment shown on this shop drawing, product data and/or sample, has been coordinated with existing conditions and complies in all respects with the requirements of the Contract Documents

for this Project. I further certify that all data shown herein as to performance dimensions, construction, materials and other pertinent items is true and correct.

(Name of the Manufacturer)

Signed: \_\_\_\_\_

Position: \_\_\_\_\_

Date: \_\_\_\_\_

- E. Inadequate or incomplete shop drawings, product data and/or samples will not be reviewed by the Architect or the Engineer and shall be returned to the Contractor for resubmittal.
- F. The Contractor shall observe the following rules when submitting shop drawings, product data and samples:
1. Identification: Each shop drawing shall indicate in the lower right hand corner, and each product data brochure shall indicate on the front cover the following: title of the sheet or brochure; name and location of the Project, names of the Architect and Engineer, Contractor, Subcontractor, manufacturer, supplier, vendor; the date of submittal; and the date of each correction and revision. So far as is practical, each shop drawing, product data and/or sample shall bear a cross-reference note to the page number or numbers of sheets of the Drawings and/or Specifications showing the Work. Unless the above information is included, the submittal will be returned for resubmittal.
  2. Quality Assurance: Product submittal data shall contain a Statement of Compliance. The Statement of Compliance shall individually list each specification paragraph by its alphanumeric designation along with a statement of "Complies" (C) or a statement of "Does not comply" (NC) for each of these alphanumeric designations. If an NC statement is provided, supplemental information shall be provided in the Statement of Compliance that explains the non-compliance and what will be provided to meet the intent of the specification. At the Contractor's option it will also be acceptable to make a copy of the specifications and mark "C" or "NC" by each specification paragraph. A hand written marked-up specification section will be acceptable. Along with this specification copy mark-up, provide an abbreviated version of the Statement of Compliance that addresses only the NC statements and deviations from the contract documents. If there is a conflict between the Statement of Compliance and the product literature, the Statement of Compliance will govern. Submittal data received without a Statement of Compliance will be returned without review.
  3. Shop drawings shall be done in an easily legible scale and shall contain sufficient plans, elevations, sections and schematics to clearly describe the



apparatus. Drawings shall be prepared by an engineer-draftsman skilled in this type of work. Unless otherwise indicated, all sheet metal, piping and similar shop drawings shall be drawn to at least 1/4" = 1'-0" scale. Typical floor sheet metal ductwork shop drawings may be drawn at 1/8"=1'-0" scale. The Contractor shall submit shop drawings as described below. Shop drawings which do not comply with these requirements will be returned for resubmittal. Refer to "Cooperation with Other Trades", this section, for additional composite shop drawing requirements. Unless otherwise indicated in the Contract Documents, the submittal shall consist of three prints of the shop drawings. The Architect and Engineer will each retain one print and the remaining copies will be returned to the Contractor.

4. Product data to be submitted shall be published by the manufacturers and shall contain complete and detailed engineering and dimensional information. The Contractor shall submit product data as described below. Product data which does not comply with these requirements will be returned for resubmittal. Unless otherwise indicated in the Contract Documents, the Contractor shall submit eight (8) copies of each product data brochure. The Architect and Engineer will each retain one copy of the submittal and the remaining copies will be returned to the Contractor. Product data submitted shall contain only information relevant to the particular equipment or material to be furnished. The Contractor shall not submit catalogs which describe several different items in addition to those items to be used, unless all irrelevant information is marked out, or unless relevant information is clearly marked. The submittal shall consist of product data from each manufacturer. Product data from each manufacturer shall be identified and submitted separately.
5. Coordination between Divisions: Each Division 26 shop drawing and product data submitted for review, which indicates electrical service to be provided to other Division equipment, shall contain a statement indicating that the Division 26 Contractor has acquired from the other Division Contractor the necessary electrical characteristics of the actual other Division equipment to be provided.
6. Shop Drawing and Product Data - Submittal Review Status:
  - a. Shop drawing and product data submittals will be returned marked "REVIEWED NO EXCEPTIONS", "REVIEWED EXCEPTIONS NOTED", "INFORMATION ONLY", "REVISE AND RESUBMIT", or "REJECTED".
  - b. If stamped "REVISE AND RESUBMIT" or "REJECTED", the shop drawing or product data shall be revised in accordance with the Contract Documents. If marked "REVIEWED, EXCEPTIONS NOTED" documentation that addresses only the noted exceptions in the form of a letter, supplemental information, or complete resubmittal shall be forwarded to the Owner, Architect and Engineer for record purposes only. If marked "REVIEWED NO EXCEPTIONS" or "INFORMATION ONLY" no additional submittal will be required.

- c. If the copy stamped "REVIEWED NO EXCEPTIONS" or "INFORMATION ONLY" is altered for any reason after it has been stamped, the "REVIEWED NO EXCEPTIONS" or "INFORMATION ONLY" shall automatically be voided and the submittal status revised to "REVIEWED EXCEPTIONS NOTED", "REVISE AND RESUBMIT", or "REJECTED" depending on the alterations.
- d. All work shall be done in accordance with shop drawings stamped "REVIEWED NO EXCEPTIONS", "REVIEWED EXCEPTIONS NOTED", or "INFORMATION ONLY" insofar as these are in agreement with the Contract Documents. Wherever differences occur between the shop drawings and the Contract Documents, the Contract Documents shall govern the Work.

G. Record Shop Drawings

- 1. After receiving the Engineer's and Architect's final approval for each shop drawing, the Contractor shall provide the Engineer with AutoCAD files of each final approved shop drawing. All of the previous review comments by the Engineer and Architect associated with each shop drawing shall be incorporated into the AutoCAD files of each shop drawing prior to sending the AutoCAD files to the Engineer. The AutoCAD files shall be in AutoCAD 2005 version software or later version as approved by the Engineer. The Contractor shall be responsible for contacting the Engineer to determine the approved AutoCAD software to use prior to preparing the AutoCAD files.

H. Maximum Headroom Requirements

- 1. All material for systems and equipment shall be installed to accommodate the structural systems, architectural ceiling construction, base building and future tenant lighting systems, and other physical space limitations of the project. All systems and equipment shall be installed to maximize headroom clearance below the bottom of material. Shop drawing submittal drawings for equipment, piping, ductwork, conduit, and other systems that will be located where headroom clearances are limited; shall be prepared to address these issues. Conflicts with lighting, structure, and other physical space limitations of the projects shall be indicated on the shop drawing submittal data and clearly marked so as to bring the situation to the attention of the Engineer.

I. Equipment and Layout Deviations

- 1. Layout, connections, supports, access & maintenance clearances, related architectural enclosures, and structural supports have been based on selected products and manufacturers. In some cases, the manufacturer's model number has been provided. Other products by specified manufacturers may be used if they comply with requirements of the contract documents including but not limited to capacity ratings. However, where the Contractor proposes to use an item of equipment that has alternative but equivalent minimum capacity ratings or that requires any redesign of the structure, partitions, foundations, piping,

wiring or any other part of the mechanical, electrical, structural, civil, utility, or architectural systems; all such redesign, and all new drawings and detailing required therefore, shall be prepared by the Contractor at the Contractor's own expense as approved by the Owner's Representative. Where such approved deviation requires a different quantity, capacity, and arrangement of ductwork, piping, wiring, conduit, other electrical service components, equipment, utilities, structure, architectural features, insulation, controllers, motors, and starters from that specified or indicated on the drawings, the Contractor shall furnish and install any such ductwork, piping, wiring, conduit, other electrical service components, equipment, utilities, structure, architectural features, insulation, controllers, motors, starters and any other additional equipment required by the system, at no additional cost to the Owner.

1.4 RESPONSE TO SHOP DRAWING, SUBMITTAL, AND FIELD REPORT REVIEW COMMENTS

- A. Contractor shall respond in written form to each shop drawing, submittal, or field report review comment from the Engineer within 10 business days from the date indicated on the Engineer's review form. Contractor's written response to each review comment should indicate the date and specifically what corrective action was or will be taken and include the name of the person and associated company responding to each review comment. Refer to the Architectural documents for additional requirements.

1.5 WARRANTY, SERVICE, AND REPLACEMENT PARTS

- A. All equipment supplied for this Contract shall be free from defects in material, workmanship, and title, and shall be of the kind and quality described herein. If it appears within one (1) year from the date of the building final acceptance by the Owner that the equipment does not meet the warranties specified above or the equipment is recalled by the equipment manufacturer, the Contractor shall correct any defect or replace any recalled equipment, including nonconformance with these Specifications, at no additional cost to the Owner.
- B. The manufacturers for each of the various selected Division 26 pieces of equipment provided on this project shall certify that authorized factory support and an adequate supply of replacement parts will be available to the Owner for a minimum of ten (10) years from the date of the Owner's acceptance of the system. The requirement for replacement parts shall apply to all specialty items and proprietary components that are only available from the system manufacturer.

1.6 CONFERENCE PRIOR TO START OF WORK

- A. Immediately upon the award of this Contract, but prior to commencing any Work, the Contractor together with designated major Subcontractors shall confer with the Owner's Representative, the Architect and Engineer concerning the Work under this Contract.
- B. Contractors and Subcontractors attending this meeting shall include but not be limited to the following: General; Mechanical; Plumbing; Fire Protection; Automatic Temperature Controls and Building Management; Sheet Metal; Insulation; Electrical; Fire Alarm; and

Testing, Balancing and Adjusting. Contractor and Subcontractor representatives shall be familiar with the Drawings, Specifications and shop drawing submittal requirements and be prepared to intelligently discuss the project requirements.

- C. The conference will be at a mutually agreed place and acceptable time.

## 1.7 ELECTRONIC FILE TRANSFER AGREEMENT

- A. Release of the Dewberry CAD, BIM, and other electronic files will require the User of the files to sign the Dewberry Electronic File Transfer Agreement.

## PART 2 - PRODUCTS

### 2.1 MATERIALS

- A. Materials and equipment shall be new and in good condition. The commercially standard items of equipment and the specific names mentioned herein are intended to identify standards of quality and performance necessary for the proper functioning of the Work.
- B. Since manufacturing methods vary, reasonable minor variations are expected; however, performance and material requirements specified are the minimum standards acceptable. The Engineer retains the right to judge equality of equipment that deviates from the Contract Drawings and Specifications.

### 2.2 EQUIPMENT GUARDS

- A. Provide equipment guards for the safe operation of equipment as recommended by the equipment manufacturer and as required by applicable codes.

### 2.3 EQUIPMENT MOUNTING/SUPPORT DEVICES

- A. Unless otherwise required to accommodate the particular requirements and unique conditions of this project, all floor, wall or ceiling mounting/support devices shall be factory fabricated devices as provided by the equipment manufacturer for the intended application. In addition to the factory-fabricated devices, the Contractor shall provide additional support members, framework, mounting hardware, brackets, steel angles, anchors, restraints, support stands, attachment devices, and other miscellaneous mounting and support devices as required for adequate equipment support.
- B. The Engineer retains the right to judge the quality of the design, application, and installation of all field and shop fabricated mounting/support devices using steel angle, steel channels, Uni-Strut, brackets, all-thread rods, etc. Any mounting or support devices that will rust, corrode, or in the opinion of the Engineer become unsightly or a maintenance problem will not be acceptable.
- C. Support devices not factory finished shall be hot dipped galvanized or properly primed and painted with a minimum of two coats of rust inhibiting paint. Refer to the Architectural Painting Systems for additional requirements.

- D. All-thread rods shall be galvanized or cadmium plated.

## 2.4 EQUIPMENT PADS AND ANCHOR BOLTS

- A. Unless otherwise noted furnish and install galvanized anchor bolts for all equipment placed on concrete slabs. Minimum dimension between anchor bolts and edge of slab shall not be less than 3". Bolts shall be of the size, type and number recommended by the manufacturer of the equipment and shall be located by means of suitable templates provided by the equipment manufacturer. When equipment is placed on vibration isolators, the equipment shall be secured to the isolator and the isolator secured to the floor, pad, or support as recommended by the vibration isolation manufacturer.

## 2.5 SEALANTS AND ADHESIVES

- A. All sealants and adhesives shall comply with the current Volatile Organic Compound (VOC) content limits of the latest edition of the South Coast Air Quality Management District (SCAQM) Rule 1168 entitled "Adhesive and Sealant Applications". Piping sealants shall have no more than 250 grams/liter VOC content for all sealants and adhesives to be used within the building interior locations..
- B. The Contractor shall submit Material Safety Data Sheets (MSDS) clearly highlighting the Volatile Organic Compound (VOC) content for each adhesive and sealant used within the building interior locations.

## PART 3 - EXECUTION

### 3.1 SCAFFOLDING, RIGGING, HOISTING

- A. The Contractor shall furnish all scaffolding, rigging, hoisting, and services necessary for erection and delivery of any equipment and apparatus furnished to the job site. Remove same from job site when no longer required.

### 3.2 SLEEVES, CUTTING, AND PATCHING

- A. The Contractor shall be responsible for the timely placing of openings and sleeves for all conduit passing through walls, partitions, beams, floors, and roof while the same are under construction. A conduit sleeve shall be round and one size larger than the size of conduit it serves, except where "Thunderline/Link Seal" casing seals are used in sleeves through walls below grade. Sleeves set in concrete floor construction shall be 18 gauge galvanized steel. Sleeves shall extend two inches above the finished floor. All conduit passing through concrete or masonry walls shall have standard weight galvanized steel sleeves or plastic "hole-outs". Block-out(s) and core drill(s) shall have a 2" curb made of 2" x 2" x 1/4" angle iron welded at corners set in mastic or 2" wide by 2" high concrete curb extending above finished floor. Sleeves shall be set flush with finished wall. Caulk around conduit penetrating floors, roof, and fire-rated wall construction with sufficient layers of fire safing insulation and further seal off opening between conduit and sleeve with a fire rated non-hardening mastic. Fill all unused sleeves and block-out space with fire safing material. All fire safing materials shall be UL listed and comply with ASTM E 814 (UL 1479). The fire safing system used shall maintain the fire resistance rating of

the building component that is penetrated.

- B. Sleeves penetrating walls below grade shall be "WS Wall Sleeves" by Pipeline Seal and Insulator, Inc. Houston, Texas, with 2" water seal stop. The water seal stop shall be located in the middle of the wall. Seal off annular opening between pipe and sleeve with "Thunderline/Link-Seal" casing seal as manufactured by Pipeline Seal & Insulator, Inc., Houston, Texas. The pipe sleeve shall be sized to accommodate the "Thunderline/Link-Seal" casing seal. Casing seals shall be Model "C" and shall be sized per the manufacturer's recommendations.
- C. If holes and/or sleeves are not properly installed and cutting and patching becomes necessary, it shall be done at no expense to the Owner. The Contractor shall undertake no cutting or patching without first securing the Architect's written approval.
- D. The location and size of all penetrations and openings through existing walls, slabs, beams, roofs and other existing building construction shall be provided by the contractor to accommodate the new work. Penetrations and openings through existing building construction shall be reviewed by the structural engineer and architect prior to cutting the penetration. Unless otherwise required by the architectural and structural divisions, metal sleeve inserts will not be required in conduit penetrations except as required to meet UL fire rating requirements. The contractor shall perform a structural survey, including x-rays or graphs of all floor slabs and supporting walls to locate existing structural bars, cables, in slab conduits and any other interferences that may be in conflict with proposed sleeve/penetration locations. The x-ray or graph shall be performed prior to any cutting or chipping of structural supporting walls. In the event of a conflict, the contractor shall notify the architect prior to proceeding with the work.

### 3.3 EXCAVATION AND BACKFILL

- A. The Contractor shall make all necessary excavations, cutting of paving, concrete, etc., and do all backfilling and paving repairs necessary for the proper execution of the Work. Remove all dirt and debris out of and away from the building as directed. Backfill shall be mechanically compacted to a density of 95% of the maximum dry density at optimum moisture content as determined by the Standard Proctor Compaction Test.
- B. Backfill shall be compacted and repairs to paving or concrete shall be accomplished to the satisfaction of the Architect and the Local Authorities.
- C. See the various Sections of the Division for additional excavation and backfill requirements.

### 3.4 PAINTING

- A. Painting, except as specified or indicated otherwise, shall be done under another Division. This Division shall cooperate with the other Division to determine the size of equipment, sizes and lengths of pipes, etc., to be painted.
- B. Equipment furnished under this Division shall be factory-finished. If the factory finish is damaged during shipment, installation, etc., it shall be repainted subject to the Architect's

approval.

### 3.5 DRAYAGE AND HAULING

- A. Include all drayage, hauling, hoisting, and placement in the building of equipment specified herein. The Contractor shall be responsible for the timely introduction of equipment to the Project. If any item of equipment is received prior to the time it is required, the Contractor shall be responsible for its proper storage and protection until such time as it may be required. The Contractor shall pay for all cost of demurrage or storage.

### 3.6 IDENTIFICATION OF CIRCUITS AND EQUIPMENT

- A. Electrical equipment shall be identified by means of nameplates permanently attached to the equipment. Refer to Section 26 05 53 for additional requirements.
- B. Cardholders and directory cards shall be provided for circuit identification in panelboards. Cardholder shall be located on inside of panel door. Directory cards shall be typewritten. Circuit descriptions shall include locations and names of items of equipment served.
- C. Circuits and pull wires in empty conduit shall have tags attached to wiring at points where runs are interrupted at junction boxes or terminated in panels, boxes, etc. Feeder or branch circuit numbers shall be indicated.
- D. Tag symbols shall correspond to the identifications on the record drawings.
- E. The Contractors shall coordinate the equipment tag designations and nameplates used to identify each piece of equipment so as to match and correspond to the equipment tag designations indicated on the contract documents. This includes, but is not limited to, the Contractor's shop drawings; submittals; record drawings; wiring diagrams; testing reports; Operating and Maintenance (O&M) manuals.

### 3.7 EQUIPMENT NOISE AND VIBRATION

- A. It is the intention to specify and for the Contractor to provide equipment and systems that, as defined herein, shall be quiet and free of apparent noise and vibration in operation.
- B. It shall be the responsibility of the Contractor to obtain equipment that is quiet in operation as compared to the other available equipment of its size, capacity, and type, and to install equipment so that a minimum amount of noise and/or vibration is transmitted to the building.
- C. Any additional precautions deemed necessary to provide a quiet installation shall be done as part of the Work of the Contractor, subject to review by the Engineer, without additional cost to the Owner. After the system is in operation, it shall be the responsibility of the Contractor to make any changes to equipment or Work installed as may be required to provide a system which is quiet in operation as defined herein.

### 3.8 SPARE PARTS

- A. The Contractor shall provide all necessary spare parts for the equipment supplied in this Project as indicated hereafter and in various other Sections of the Specifications. Spare parts shall be obtained from the original equipment manufacturer.

### 3.9 DOCUMENTATION

- A. For all testing, training and review procedures the Contractor shall maintain adequate records in written form that clearly documents the event. The written documentation for each testing, training and review procedure shall include but not be limited to the following: Name and company of attending personnel, general description of procedure(s), date(s), time of day, deficiencies found, corrective action taken, and nature of final results. Documentation records shall be kept in an orderly, legible and up to date format. Contractor's documentation records shall be accessible for review by the Owner Representative upon request. Each testing, training and review procedure document shall bear the name and signature of the authorized representative of the General Contractor, Mechanical Contractor, and manufacturer or Subcontractor if applicable.

### 3.10 COMPLETION, COMMISSIONING AND FINAL REVIEW OF THE DIVISION 26 SYSTEMS

- A. Start-up: After the Contractor and equipment manufacturer representative determine that the equipment and related systems have been properly installed and are ready for start-up; the equipment manufacturer representative shall perform the manufacturer's start-up and check-out procedures to ensure proper operation of the equipment in accordance with the contract documents and the manufacturer's recommendations. Start-up and check-out of each piece of equipment shall be in accordance with the equipment manufacturer's recommendations and warranty requirements. Start-up services shall be performed by factory-trained personnel of the equipment manufacturer or factory-trained personnel authorized by the manufacturer and their official representatives. Start-up personnel shall be certified by the equipment manufacturer as properly trained in the manufacturer's start-up and check-out procedures. Provide documentation of the start-up and check-out procedures in accordance with the contract documents and the manufacturer's recommendations. Documentation of the start-up and check-out procedures shall be included within and submitted with the Operational and Maintenance Manuals.
- B. Trouble-shooting, Debugging, and Pre-testing: After Start-Up but prior to the Operational Demonstrations; the contractor shall perform operational pre-testing, trouble-shooting, and de-bugging of all equipment and systems. At the completion of the Trouble-shooting, Debugging, and Pre-testing process, all equipment and systems shall be complete and operating in accordance with the requirements of the contract documents. Trouble-shooting, Debugging, and Pre-testing of equipment and systems shall be performed to the extent necessary for the Contractor to determine that all systems are complete and operating in accordance with the Contract Documents. Prior to final Commissioning and Operational Demonstrations all equipment and systems shall be certified by the Contractor as complete and operating in accordance with the Contract Documents.



- C. Operational Demonstrations and Final Commissioning: Prior to Substantial Completion and within a schedule mutually agreed to by the contractor and the Owner's Representative, the Contractor shall demonstrate the operation of all equipment and systems as necessary to demonstrate compliance with the Contract Documents. Additional costs incurred by the Owner related to re-reviewing, re-witnessing, re-testing, re-inspecting, and re-commissioning all or part of the MEP systems due to incomplete or non-compliant work shall be reimbursed by the Contractor to the Owner.
- D. Final Review and Owner Acceptance:
1. After completion of the Operational Demonstrations, Final Commissioning, and Owner's Close-out Package requirements; at a time designated and mutually agreed by the Contractor and Owner's Representative; a final walk-through review of the project will be performed by the Contractor and Owner's Representative. The review will be of a general nature with the intent of addressing outstanding issues prior to the Owner's final acceptance of the project.
  2. The entire system shall be clean and operating properly with all systems balanced and all controls adjusted. All prohibited markings shall be removed from all switchboards, panelboards, motor control centers, switches, etc., and the equipment shall be clean and in operating condition.
  3. Certificates, Documents, and Close-out Package required herein shall be complete, in order and presented to the Architect at least two weeks prior to the review.
  4. After the review, any changes or corrections noted as necessary for the Work to comply with these Specifications and the Drawings shall be accomplished without delay in order to secure final acceptance of the Work.
- E. Schedule: The Contractor shall complete the systems in accordance with the Contract Documents including start-up, trouble-shooting, de-bugging, pre-testing, and commissioning of the systems a minimum of three (3) weeks prior to the date of "Substantial Completion". The three (3) weeks prior to the date of "Substantial Completion" shall be reserved by the Contractor for the Owner's Representative, Architect, and Engineer to witness the operational demonstrations of the completed fully commissioned systems. If more than three (3) weeks is deemed necessary by the Contractor for the operational demonstrations, the Contractor shall notify the Owner's representative in written form and determine an operational demonstration schedule mutually agreeable to the Owner's Representative and Contractor that completes the operational demonstrations prior to "Substantial Completion". Additional costs incurred by the Owner related to reviewing, witnessing, testing, inspecting, and commissioning of the systems by the Architect and Engineer after the date of "Substantial Completion" shall be reimbursed by the Contractor to the Owner. As part of the shop drawing submittal process, the Contractor shall provide a detailed schedule of completion indicating when each MEP system will be complete and ready for owner acceptance. The schedule shall indicate time periods and milestone dates of Start-up; Trouble-shooting, Debugging, and Pre-testing; Operational Demonstrations and Final

Commissioning; Final Review and Owner Acceptance.

### 3.11 RECORD DRAWINGS

- A. The Contractor shall maintain on a daily basis at the project site a complete set of "Record Drawings". The "Record Drawings" shall consist of a set of black line prints and AutoCAD files of the Contract Drawings for this Division. The black line prints shall be marked and the AutoCAD files shall be electronically updated regularly by the Contractor during the construction period to reflect an accurate dimensional record of all buried or concealed work. In addition, the set of black line prints shall be marked and the set of AutoCAD files shall be electronically updated regularly to show the precise location of concealed work and equipment including buried, concealed or embedded piping, conduit and valves and all changes and deviations in the mechanical work from that shown on the Contract Documents. This requirement shall not be construed as authorization for the Contractor to make changes in the layout or work without definite instructions from the Architect. The set of black line prints and AutoCAD files of the Contract Drawings for this Division shall remove or blacken out the Engineer's seal and Engineer's firm name.
- B. Prior to commencing work, the Contractor shall need to purchase from the Architect or Engineer a set of black line prints to be used for the "Record Drawings" and obtain from the Engineer a set of AutoCAD files of the Contract Drawings for this Division in preparing "Records Drawings" for the project based on the Contractor's work. The AutoCAD files shall be in AutoCad 2005 version software or later version as provided by the Engineer. In order to obtain a set of AutoCAD files of the Contract Drawings for this Division from the Engineer, the Contractor shall need to contact the Engineer, Architect or Client and obtain a written release and indemnification statement from the Engineer. This release and indemnification statement shall be signed by an owner, partner, corporate officer or other person duly authorized to agree to and sign legally binding documents for the Contractor's respective company. Upon the Engineer receiving the signed unedited release and indemnification statement back from the Contractor, the Engineer will forward the AutoCAD files of the Contract Drawings for this Division to the Architect or Client who in turn will forward the AutoCAD files of the Contract Drawings for this Division to the Contractor for his use in preparing "Records Drawings" for the project based on the Contractor's work. If the Contractor desires to have architectural and structural information in preparing "Records Drawings" for the project, the Contractor shall need to contact the Architect and Structural Engineer to obtain the pertinent architectural and structural information directly from the Architect and the Structural Engineer.
- C. Record dimensions shall clearly and accurately delineate the Work as installed; locations shall be suitably identified by at least two dimensions to permanent structures.
- D. The owner's representative shall retain the right to periodically review the "Record Drawings" as the project progresses. Final acceptance of as-built "Record Drawings" shall be conditional upon the Contractor clearly "red-marking" all changes from the contract documents, including "request for information" changes and other supplemental instruction changes, directly on the black line set of prints and clouding all of the changes in the electronic AutoCAD files. All of the clouded changes on each drawing in

the electronic AutoCAD files shall be on a separate drawing layer which can be turned off without affecting the appearance of each drawing.

- E. The Contractor shall mark all "Record Drawings" on the front lower right hand corner with a rubber stamp impression or an AutoCAD image that states the following:

"RECORD DRAWINGS (3/8" high letters)  
To be used for recording Field  
Deviations and Dimensional Data  
Only". (5/16" high letters)

- F. Upon completion of work, the Contractor shall certify all "Record Drawings" on the front lower right hand corner adjacent to the above marking with a rubber stamp impression or an AutoCAD image that states the following:

RECORD DRAWING CERTIFIED CORRECT (3/8" high letters)

(Name of Electrical Subcontractor)

By: \_\_\_\_\_

Date: \_\_\_\_\_

For all black line prints to be used for the "Record Drawings", the Contractor must sign the above certification. For all AutoCAD files to be used for the "Record Drawings", the Contractor must fill in the name of the person responsible for certifying the above certification. Both the black line prints and the AutoCAD files shall be certified by the same person.

- G. Prior to final acceptance of the Work of this Division, the Contractor shall submit properly certified "Record Drawings" to the Architect for review and shall make changes, corrections, or additions as the Architect may require to the "Record Drawings". After all changes have been made to the "Record Drawings", the Contractor shall deliver to the Owner the final set of "Record Drawings" consisting of the black line prints and the AutoCAD files. The AutoCAD files to be delivered by the Contractor to the Owner shall be in AutoCAD 2005 version software or later version as originally provided to the Contractor by the Engineer.
- H. Within 90 days after the date of system acceptance, record drawings of the actual installation of the location, luminaire identifier, control and circuiting for each piece of lighting equipment shall be provided to the Building Owner.
- I. Within 30 days after the date of system acceptance, record drawings of the actual installation of the single line diagram and building electrical distribution system, including floor plans indicating location and area served for all distribution, shall be provided to the Building Owner.

### 3.12 OWNER'S CLOSE-OUT PACKAGE

- A. Contractor shall provide a master project close-out log and corresponding schedule for submission to the Owner and Engineer for review and approval.
- B. Contractor shall provide the Owner with two (2) copies of all warranties bound in a notebook with a corresponding warranty log. Warranty log shall clearly indicate the subcontractor, address, telephone number, and contact person.
- C. Contractor shall provide the Owner with one (1) complete set of approved submittals and a copy of the final submittal log.
- D. Contractor shall provide the Owner with a complete list of all subcontractors and major suppliers with address, telephone number, and contact persons.
- E. Contractor shall provide the Owner with a complete inventory of attic stock materials and spare parts as applicable and a copy of the transmittal signed by the Owner's representative acknowledging receipt of the items.
- F. Contractor shall provide the Owner and Engineer with documentation of compliance for all specified requirements associated with equipment start-up, commissioning, demonstrations, training and warranties. Documentation shall include, but not be limited to, equipment start-up sheets as completed by the manufacturer's representative.
- G. Contractor shall provide the Owner and Engineer with documentation of acceptable performance of the electrical service systems. The Owner reserves the right to contract with an independent consultant to perform additional electrical service testing. If it is determined that the electrical service systems are not operating properly in accordance with the contract documents, all costs associated with additional tests and time required to correct and uncover the deficiencies by the independent consultant will be the responsibility of the Contractor unless the deficiencies are not design related.
- H. When the Contractor considers the work to be ready for final acceptance, the Contractor shall provide the Owner and Engineer with written certification stating the following:
  - 1. All work has been completed in accordance with the Contract Documents.
  - 2. All field review items and other deficiencies identified by the Certificate of Substantial Completion have been properly corrected.
  - 3. All work has been inspected for compliance with the Contract Documents.
  - 4. All electrical systems have been tested in the presence of the Owner's representative and are fully operational in compliance with the Contract Documents.
  - 5. As-built documents have been reviewed, are complete and are accurate.
- I. The Contractor shall provide the Owner with a letter from the Engineer of Record stating that the equipment installed fully complies with the Contract Documents.

END OF SECTION 26 00 10

**SECTION 26 00 70**  
**SCHEDULE OF SUBMITTAL DATA**

**PART 1 - GENERAL**

**1.1 GENERAL REQUIREMENTS**

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

**1.2 WORK INCLUDED**

- A. Furnish the shop drawing submittal data for the Architect's and Engineer's review as indicated herein.

**1.3 RELATED WORK SPECIFIED ELSEWHERE**

- A. Division 26: All Sections

**PART 2 - SHOP DRAWING SUBMITTAL DATA**

**2.1 GENERAL**

- A. The submittal data to be furnished for this Project shall comply with the Specifications hereinbefore. The referenced Sections herein scheduled are for general information purposes only and shall not be construed to be limiting to the submittal data scheduled and/or required within the individual Sections of these Specifications.

**2.2 CONTRACT REQUIREMENTS**

- A. Shop drawing submittal data shall clearly and concisely address all Contract Document requirements. Standard manufacturer data that does not indicate these requirements shall be supplemented with additional information provided by the Contractor or equipment manufacturer. Refer to Section 26 00 10 for additional requirements including submittal log schedule requirements.

**2.3 DEVIATIONS FROM THE CONTRACT DOCUMENTS AND PERTINENT DATA**

- A. All deviations from the contract documents shall be noted in the form of a cover letter included with the shop drawing submittal package. All pertinent data such as material options, equipment arrangements, control options, diagrams, etc. that applies to this Project shall be clearly marked. All data and diagrams that do not apply to this Project shall be omitted from the package or clearly marked-out.

## 2.4 QUALITY ASSURANCE

- A. Product submittal data shall contain a Statement of Compliance. The Statement of Compliance shall individually list each specification paragraph by its alphanumeric designation along with a statement of "Complies" (C) or a statement of "Does not comply" (NC) for each of these alphanumeric designations. If an NC statement is provided, supplemental information shall be provided in the Statement of Compliance that explains the non-compliance and what will be provided to meet the intent of the specification. At the Contractor's option it will also be acceptable to make a copy of the specifications and mark "C" or "NC" by each specification paragraph. A hand written marked-up specification section will be acceptable. Along with this specification copy mark-up, provide an abbreviated version of the Statement of Compliance that addresses only the NC statements and deviations from the contract documents. If there is a conflict between the Statement of Compliance and the product literature, the Statement of Compliance will govern. Submittal data received without a Statement of Compliance will be returned without review.

## 2.5 SPECIAL REQUIREMENTS

- A. The shop drawing submittals for the Operation and Maintenance (O&M) Manuals shall require an Owner/Consultant review period of four weeks. The Contractor shall plan for and arrange the shop drawing submittal review schedule to accommodate this requirement.

## 2.6 SPARE PARTS

- A. The submittal data for each piece of equipment shall include a detailed itemized list of recommended spare parts. Spare parts shall be clearly identified by name and part number.

## 2.7 ORGANIZATION OF PACKAGES

- A. Unless otherwise noted in the specifications and in the following schedule of shop drawing, the Contractor shall provide a single shop drawing submittal package for each of the listed specification sections. Unless specifically noted otherwise, multiple submittal packages per section will not be acceptable under the terms of the Contract.

## 2.8 COORDINATION BETWEEN DIVISIONS

- A. The Division 26 Contractors shall cooperate with the General Contractor and the other Division Contractors to provide coordination between the Division trades in a timely manner. For all equipment requiring electrical service provided under other Divisions, it shall be the responsibility of the Division 26 Contractors to acquire from the other Division Contractors the electrical characteristics of the actual equipment to be provided. Should there be a discrepancy between the electrical service characteristics of the equipment to be provided and what is indicated on the documents, the contractor shall obtain written direction from the Owner's representative prior to proceeding. This coordination and transfer of information shall take place in a timely manner prior to the purchasing and installation of the electrical service.

## 2.9 MANUFACTURER'S CERTIFICATION

- A. All items or equipment listed herein with asterisks (\*) shall be certified by the manufacturer. Refer to Section 26 00 10 for certification requirements.

## 2.10 SHOP DRAWING SUBMITTAL SCHEDULE

- A. Provide a comprehensive list of all associated Divisions shop drawing submittal packages and a schedule indicating the date when each package will be submitted to the contractor and the date when each package will be submitted to the design team. The intent of this list and schedule is to allow the contractor and design team to plan ahead and schedule the necessary review and coordination resources in advance of the arrival of shop drawing submittal packages. Shop drawing submittal schedule shall be submitted to the Architect not less than four weeks prior to the submission of the first shop drawing submittal packages. Shop drawing submittal schedule shall be periodically updated by the contractor and issued to the Architect to reflect current status of the project. Shop drawing submittal packages shall be listed on the schedule not less than four weeks prior to submission to the contractor and not less than six prior to the submission to the design team. Packages not listed on this schedule will required up to two additional weeks of review time.

## 2.11 SHOP DRAWING SUBMITTAL DATA

- A. The submittal data to be furnished for this Project shall include but not be limited to the following:

1. Section 26 05 19 Low-Voltage Electrical Power Conductors and Cables
2. Section 26 05 26 Grounding and Bonding for Electrical Systems
3. Section 26 05 33 Raceway and Boxes for Electrical Systems
4. Section 26 05 48 Vibration and Seismic Controls for Electrical Systems \*
5. Section 26 05 53 Identification for Electrical Systems
6. Section 26 24 16 Panelboards
7. Section 26 27 26 Wiring Devices
8. Section 26 28 00 Low-Voltage Circuit Protective Devices
9. Section 26 50 00 Lighting
12. Drawing Packages:
  - a. Drawings shall be limited to a maximum of one (1) packages.

END OF SECTION 26 00 70



## SECTION 26 05 19 – LOW-VOLTAGE ELECTRICAL POWER CONDUCTORS AND CABLES

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific Attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Provide the wires and cables as shown on the contract documents and as specified herein.

## 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 33 – Raceway and Boxes for Electrical Systems
- B. Section 26 05 53 – Identification for Electrical Systems
- C. Section 26 05 93 – Testing

## 1.4 REFERENCE STANDARDS

- A. All wire shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. NFPA 20, 70, 72, 101, 110, 130
  - 2. ASTM B-3
  - 3. UL 44, 83, 1569, 2196

## 1.5 SUBMITTALS

- A. Submit manufacturers' literature, illustrations, specifications, engineering data, conductor supports, and insulation resistance test results for the wiring specific to this project.

## PART 2 - PRODUCTS

## 2.1 GENERAL

- A. Except as otherwise indicated, provide UL listed wire, cable and connectors of manufacturer's standard materials, as indicated by published product information and designed and constructed in accordance with applicable industry standards. All wire shall bear the stamped seal of approval of the National Board of Fire Underwriters.

## 2.2 WIRING

## A. Material

1. All wire and cable shall be of soft drawn annealed copper wire having a conductivity of not less than 98% of that of pure copper. Each wire and cable shall be continuous without weld, splice, or joint throughout its length between panels, junction boxes, pull boxes, etc. Each wire and cable shall be uniform in cross-section.
2. All wire size #8 AWG and larger shall be stranded and sizes #10 AWG, #12 AWG and #14 AWG shall be solid.
3. Where permitted, "AC" armor clad cable shall be three wire solid copper conductor with two #12 or #10 AWG THW insulated phase conductors and one #12 or #10 AWG insulated copper ground conductor. Contractor shall verify use of "AC" cable with local authority.
4. Where required, "MC" armor clad cable shall be three wire solid copper conductor with two #12 or #10 AWG THW insulated phase conductors and one #12 or #10 AWG insulated copper ground conductor. Contractor shall verify required use of "MC" cable with local authority. Four and five wire cable shall be similar to three wire with additional copper insulated phase conductors and a common neutral in a 'multiwire branch circuit'.

## B. Insulation

1. All conductors shall be standard code type "THW", "THHN", "THWN" or "XHHW" insulated wire except as specified below, indicated on the contract documents, or as required per the NEC.
2. All conductors in buried conduit, conduit run in wet locations, conduit encased in concrete in contact with the earth and unprotected locations exposed to weather shall be type "THW", "THWN" or "XHHW".
3. All wire within lighting fixtures shall be temperature rated as required by the National Electrical Code, latest edition. Branch circuit wiring within 3 inches of a ballast shall be type "THHN" or "XHHW".
4. All wire to electric heaters shall be "THHN" or "XHHW".
5. In assembly occupancies not less than 1000 persons or in buildings above 75 feet in height, emergency system feeders shall meet NEC Article 700 circuit integrity requirements. Emergency systems shall be defined by authority having jurisdiction and adopted codes and shall include but not be limited to emergency lighting, fire alarm system, stair pressurization fans, and elevators. Emergency feeders shall be installed within fully sprinklered spaces for their entire lengths. Any emergency system feeder wholly or partially installed within a non-sprinklered space shall be routed within a minimum 2-hour fire rated enclosure or shall be concrete encased in accordance with NEC Article 700.

## C. Size

1. All wire shall be sized as indicated on the contract documents and as required by the adopted local codes for the load. However, the minimum wire size shall not be less than the following regardless of what wire size is indicated on the contract drawings.
  - a. Minimum size for power and lighting circuits - #10 AWG.
  - b. Minimum size for 120V circuits over 60 feet and 277V circuits over 100 feet to the first outlet, fixture, or device - #10 AWG.
  - c. Minimum size for control circuits - #14 AWG.
  - d. Feeder conductors shall be sized for a maximum voltage drop of 2% at design load.
  - e. Branch circuit conductors shall be sized for a maximum voltage drop of 3% at design load.

D. Marking

1. All conductors and cables shall be durably marked on the surface to indicate the following information:
  - a. The maximum rated voltage for which the conductor was listed.
  - b. The proper type letter or letters for the type of wire or cable.
  - c. The manufacturer's name, trademark, or other distinctive marking by which the organization responsible for the product can be readily identified.

2.3 COLOR CODING OF WIRE

A. General

1. Color code the entire power wiring system in the building.
  - a. 120/208(240) volt system:
    - 1) Phase A Black, Phase B Red, Phase C Blue
    - 2) Neutral White, Ground Green, Isolated Ground Green with Yellow Stripes
  - b. 277/480 volt system:
    - 1) Phase A Brown, Phase B Orange, Phase C Yellow
    - 2) Neutral Gray, Ground Green, Isolated Ground Green with Yellow Stripes

## c. Extent

- 1) The color coding shall be continuous and shall extend throughout the entire building power wiring system to the last utilization device. Where insulation color coding is not available for conductors #8 AWG and larger, use color coded plastic electrician's tape per Section 26 05 53 at each conductor termination.

## 2.4 CONDUCTOR FITTING

## A. General

1. Provide all required fitting accessories.

## B. Terminal Blocks

1. Terminal blocks shall be rated for 600 volts and shall be of the screw type.

## C. Splices

1. Splices shall be made only in outlet boxes, junction boxes or splice boxes.
2. All #8 AWG and smaller conductors shall be spliced with preinsulated spring connectors. No other type of mechanical connector may be used for sizes #8 AWG and smaller wire. Connectors shall be Scotchlok, Buchanan B-Cap, or approved equal.
3. All #6 AWG and larger copper conductors terminated on lugs of switchboards, panelboards and motor control centers with copper bus shall be terminated with copper UL listed compression connectors such as Thomas & Betts #54100 or #54200 series connectors.
4. All #6 AWG and larger copper conductor two way splices shall be made with barrel connectors requiring compression on each end. Connectors shall be UL listed for the type of conductors to be connected.
5. All #6 AWG and larger copper conductor tapping and pigtailings shall be made using "C" type compression taps such as Thomas & Betts #54700 series connectors. Connectors shall be UL listed for type of conductors to be tapped.
6. Conductor termination provisions shall be listed and rated for use with conductor ampacities rated at 75°C minimum.
7. The manufacturer's recommended installing tools with required number of compressions shall be used for all terminations.
8. Stub splice connections for exterior lighting and similar applications shall be provided with a water resistant cover kit with connector, TE Connectivity Raychem GelCap SL or approved equal.

## 2.5 TYPE A.C. CABLE AND M.C. CABLE

### A. General

1. Type A.C. cable shall conform to Armored Cable: Type AC Article of the National Electrical Code.
2. Type M.C. cable shall conform to Metal-Clad Cable: Type MC Article of the National Electrical Code.

### B. Use

1. Type A.C. cable may be used in the following locations and applications only:
  - a. For final connections to receptacles, switches and light fixtures installed in walls, concealed spaces and hung ceilings.
  - b. Contractor shall provided ceiling grid lighting and receptacle J-boxes which shall be connected with EMT or rigid conduit back to panelboards.
2. Type M.C. cable shall be substituted for type A.C. cable for areas classified as "places of assembly" with occupancies over 50 as required by the N.E.C. Article 518. Type M.C. cable shall only be used for branch circuits as specified for A.C. cable.

## 2.6 CONDUCTOR SUPPORTS

- A. Conductors in vertical raceways shall be supported by cleats or bushings at the top of each vertical raceway or as close to the top as practical, plus a support for each additional interval of spacing as required in NEC Article 300.

## PART 3 – EXECUTION

### 3.1 GENERAL

- A. Install all wiring in accordance with the manufacturers' recommendations and the National Electrical Code (NFPA 70) as well as NFPA 130.

### 3.2 INSTALLATION

- A. All main power feeders shall be run their entire lengths in continuous pieces without joints or splices from points of origin to points of termination.
- B. All feeder and branch circuit conductors shall be continuous without welds, splices or joints throughout their lengths between panels, junction boxes, pull boxes etc.
- C. No wire shall be drawn into a conduit until all work of a nature which may cause injury is completed.
- D. All circuits shall be identified per Section 26 05 53.

- E. Conductor pulling tensions shall not exceed manufacturer's recommended values. Where necessary, UL listed lubricants, compatible with the type of insulation involved, may be used to facilitate cable pulling. Compounds similar to the following are acceptable:
  - 1. 3M – Type “WL”.
  - 2. American Polywater Corporation - Type "J" or “LZ”.
  - 3. Ideal Industries - "Wire Lube".
- F. At least 6 inches of free conductor shall be left at each outlet, junction, and switch point for splices or the connection of fixtures or devices.
- G. For wire-binding screw posts, wrap the freshly stripped end of the conductor two-thirds to three-quarters of the distance around the post. The loop shall be made so that rotation of the screw in tightening will tend to wrap the wire around the post rather than unwrap it.
- H. Cables and conduits shall be neatly routed parallel and perpendicular to building lines. Cables that are bundled together for support shall not exceed ten (10) in quantity in any one location. Multiple bundles neatly installed and separated by physical space shall be used where cable quantities exceed ten (10).

### 3.3 TESTING

- A. Insulation resistance of conductors #6 AWG and larger shall be tested as indicated below. Each conductor shall have its insulation resistance tested after the installation is completed and all splices, taps, and connections are made except connection to or into its source and point(s) of termination.
- B. Insulation resistance of conductors which are to operate at 600 volts or less shall be tested by using Biddle (or approved equal) Megger of not less than 1000 volts D.C. Resistance shall be measured by connecting one terminal of Megger to conductor and other terminal to conduit in which conductor is installed. Reading shall be observed after 15 seconds of operation of the Megger at slip speed. Insulation resistance of conductors rated at 600 volts shall be not less than the following for listed wire sizes:
 

1. #6,4, and 2	100,000 ohms
2. #1, 1/0, 2/0, 3/0, and 4/0	50,000 ohms
3. All sizes larger than 4/0	25,000 ohms
- C. Wire sizes #12, #10, and #8 shall be tested for continuity with standard ohm meter indicating at least 250,000 ohms to ground resistance.
- D. Conductors that do not exceed insulation resistance values listed above shall be removed and replaced and test repeated. The Contractor shall furnish all instruments and personnel required for tests, shall tabulate readings observed, and shall submit copies of test readings to the Engineer for review.

- E. These test reports shall identify each main feeder conductor tested, date and time of test, weather conditions, test equipment, calibration date, and relative humidity. Each test shall be signed by party making test and person witnessing it. Any conductor or splice which is found defective shall be promptly removed and replaced, and additional tests shall be performed.
- F. The above testing and report requirements shall apply to all main feeders. Branch circuits, control circuits, and signal circuits shall be checked in accordance with the National Electrical Code, latest edition.

END OF SECTION 26 05 19

## SECTION 26 05 26 – GROUNDING AND BONDING FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Provide the grounding as shown on the contract documents and as specified herein.

## 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33 - Raceways and Boxes for Electrical Systems

## REFERENCE STANDARDS

- A. The grounding system shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. NFPA 70 National Electrical Code

## 1.4 SUBMITTALS

- A. Submit ground rods, ground clamps and connectors, expansion joint connectors, and graphed results of Fall of Potential Test with weather conditions stated, equipment used, and equipment calibration date.

## PART 2 - PRODUCTS

## 2.1 GROUNDING EQUIPMENT

- A. The equipment grounding system shall be designed so all metallic structures, railings, enclosures, raceways, junction boxes, outlet boxes, cabinets, machine frames, portable equipment and other conductive items in close proximity with electrical circuits operate continuously at ground potential and provide a low impedance path for possible ground fault currents in conjunction with an equipment copper ground conductor. The system shall comply with the National Electrical Code, and as hereinafter specified. All branch circuits and feeders shall have green insulated equipment ground conductors sized in accordance with the NEC.
- B. The main equipment grounding system shall consist of the electrically continuous



metallic conduit system together with equipment copper ground wires extended from the main service disconnect switch or switchboard as indicated. Every item of equipment served by the electrical system shall be bonded to the building equipment ground. Portions of metallic piping and duct systems which are isolated by flexible connections, insulating couplings, etc., shall be bonded to the equipment ground system with a flexible bonding jumper.

- C. All expansion joints, isolated couplings, points of electrical discontinuity, or connections in conduit where firm mechanical bond is not possible shall be bonded with OZ Type "BJ" or approved equal bonding jumper.
- D. All flexible metal conduit connections not UL labeled as a grounding means shall have a ground conductor installed. Refer to Section 26 05 33.
- E. Grounding rods shall be 3/4 inch in diameter by 10 feet in length, made of copper-clad steel. Copper thickness shall be no less than 10 mils on the steel core of the rod.

### PART 3 - EXECUTION

#### 3.1 GENERAL

- A. The system neutral shall be grounded at the service entrance. The system neutral on interior wiring shall be kept isolated from other grounding systems throughout the building and shall be grounded only to the grounding electrode system.
- B. Each system of electrically continuous metallic piping and ductwork shall be electrically grounded in accordance with the requirements of the Code for "Grounding Electrodes" and for "Grounding Conductors" as they apply to the grounding of "conductor enclosures and equipment only". Metallic piping and duct systems which enter the building shall be grounded at the point of entry with a grounding bond wire to the electric service ground. Isolated metallic piping and duct systems shall be bonded to the building equipment grounding system.
- C. Bonding and grounding wires shall be sized, shall be run in conduit, and shall be clamped to various services in accordance with the requirements of the Local Authorities and the National Electrical Code. Where parallel conductors are used to comprise a single feeder, the equipment ground conductor in each conduit shall be fully rated sized in accordance with NEC Article 250.122.
- D. Grounding shall be done in accordance with the requirements of, and subject to the approval of the Architect, Engineer, and local inspection authorities. Approved materials, devices, and workmanship shall be utilized.

#### 3.2 GROUNDING ELECTRODE

- A. Grounding electrode conductors shall be bonded to structural steel, and supplemental made electrodes, as indicated on the contract documents. This bonding shall serve as the grounding electrode conductor in accordance with the requirements of the Code. The Contractor shall not connect any grounding bond wires to water piping systems

throughout the building except at one point.

B. The following shall not be used as ground electrodes:

1. Metal underground gas piping systems.
2. Aluminum.

END OF SECTION 26 05 26

## SECTION 26 05 30 - DIVISION 26 DEMOLITION

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements", "Conditions of the Contract" and "Supplementary Conditions". Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Furnish all labor, equipment and materials required to demolish, cap, patch, repair and dispose of the Division 26 systems no longer required as part of an active system of the Project as specified herein and as indicated on the Drawings.

## 1.3 SCOPE OF WORK

- A. It shall be the responsibility of the Contractor to review the Architectural Documents in addition to the Division 26 Documents to determine the complete scope of work

## 1.4 REFERENCE STANDARDS

- A. NFPA 70 National Electrical Code
- B. Underwriters' Laboratories, Inc. (UL)
- C. National Fire Protection Association (NFPA)
- D. National Electrical Manufacturers' Association (NEMA)
- E. American National Standards Institute, Inc. (ANSI)
- F. NFPA 130

## PART 2 - NOT USED

## PART 3 - EXECUTION

## 3.1 GENERAL

- A. Under this Division, the Contractor shall furnish all labor, equipment, appliances, and materials to perform all operations in connection with the demolition of the Division 26 systems as indicated on the Drawings and as specified herein and/or as required by the Local Building Code. The work shall include but not be limited to the following:
  - 1. Unless noted otherwise in the Architectural Documents, all existing electrical equipment within the building shall be demolished. The contractor shall review the existing conditions, in addition to the Architectural documents, and the

Division 26 documents, to determine the complete scope of work.

2. Field verify the exact sizes and locations of all existing electrical systems prior to demolition of any existing work. The demolition work shall be coordinated with the architectural scope of the Project to assure proper limits of demolition.
  3. Remove all existing electrical equipment, busways, conduit, raceways, light fixtures, wiring and associated equipment within the area to be demolished, whether specifically indicated or not, that is no longer required unless otherwise indicated.
  4. Openings remaining in enclosures as a result of demolition shall be sealed with sheet metal cap or other approved appropriate means, unless otherwise indicated.
  5. Where existing equipment is to be relocated, extreme care shall be taken to prevent damage during the removal and reinstallation. Where damage occurs, the equipment shall be replaced or repaired to the satisfaction and approval of the Architect at no additional cost to the Owner.
  6. Contractor shall be responsible for cutting, patching and restoration of existing finishes.
  7. Contractor shall be responsible for removal, disposal and salvage of equipment from job site.
  8. Contractor shall be responsible for cleaning, testing and repair of existing equipment to be reused.
  9. Contractor shall be responsible for sealing all existing floor slab penetrations in order to maintain the integrity of the fire rating of the existing floor slabs.
  10. Refer to Architectural Documents and the Division 26 documents for area and extent of demolition.
- B. Where a system to be demolished must remain operational throughout the construction process until a new system that will take its place is functional, the contractor shall provide all products, services, materials, labor and supervision to maintain the operational status of the affected system.

### 3.2 EXISTING CONDITIONS

- A. Under the scope of work, the Contractor shall perform a comprehensive field inspection of the existing conditions to thoroughly familiarize himself with the Project and determine the complete scope of new and demolition work. The Contractor shall verify in the field exact sizes, capacities, and locations of all existing equipment prior to installation of any proposed work. Proposed work shall be coordinated with existing conditions to assure proper installation. This field survey and determination of the complete scope of work shall be performed prior to the final bid. Specific attention is brought to physically larger and heavy pieces of equipment that are new to be installed or existing to be removed and the routing of such equipment with the available means and

site conditions.

### 3.3 CONFLICTS AND DEPARTURES

#### A. Conflicts

1. The Contractor shall remove all existing electrical equipment and associated accessories whether specifically indicated or not, that are no longer required. Any equipment which must remain as part of an active system and is in conflict with the proposed work shall be relocated at no additional expense. There shall be no additional expense to the Owner for this type of demolition work, unless, in the Architect's and Owner's opinion, it is beyond the scope and intent of the Contract Documents.

#### B. Departures

1. The Contract Drawings are diagrammatic and schematic in nature and do not indicate inferred details. Any departures from the Drawings that are necessary to comply with the intent of Documents, requirements of applicable Building Codes or the Authority having jurisdiction shall be detailed in the form of shop drawing submittal data and submitted for review by the Architect and Engineer. All demolition and any such revisions for departures shall be made in accordance with the reviewed shop drawings without increased expense to the Owner. Departures shall not be made without prior written approval by the Architect.

### 3.4 COOPERATION

- A. The Contractor shall comply with all the requirements of the Local Authorities having jurisdiction and the building Owner.
- B. The Contractor shall give advance notice to the Architect when work is to be performed.
- C. The Contractor shall cooperate and coordinate demolition of Division 26 systems as required with all of other trades. The Contractor shall supervise and assist in the removing and replacing of existing materials for installation of electrical items and items related to all other trades.

### 3.5 OCCUPIED AREAS

- A. Normal functions of occupied areas must continue during the construction phases. Every effort shall be made to insure such functions are not disturbed. The Contractor shall be responsible for the installation and removal of temporary systems as required to maintain the functions of occupied areas. The Contractor shall schedule any work which may be required in occupied areas during unoccupied hours. Coordinate all system outages with building owner prior to work.

### 3.6 BARRIERS

- A. Where required by applicable health and safety regulations, the Contractor shall furnish and maintain safety and dust barriers. If necessary, the Contractor shall furnish and

maintain temporary fencing and traffic barriers in accordance with all applicable health and safety regulations and as deemed necessary.

### 3.7 RESTORATION

- A. Demolition shall be carried out with caution to assure that existing conditions to remain will be undamaged. Existing conditions to remain that are damaged or defaced by work under this contract shall be restored or replaced equal to the conditions at the time of award of the Contract.
- B. Cut, patch, and restore all existing surfaces not receiving new finishes that have been disturbed during execution of this Contract. Materials and finishes used shall be similar, in all respect, to adjacent surfaces.
- C. Existing conduit and wiring which are to remain as part of an existing or proposed active system that the Contractor determines to be defective shall be brought to the attention of the Architect.
- D. Existing equipment to be removed shall be cleaned, repaired, and reused at the discretion of the Architect wherever applicable.

### 3.8 CONNECTIONS

- A. Connections to existing work shall be similar, in all respects, to the existing system and conditions unless otherwise indicated. Existing work shall be altered and/or temporarily removed and replaced as required for completion of requirements of the project.

### 3.9 SALVAGE

- A. The Owner assumes no responsibility for loss or damage to materials or structures on site for the salvage value of equipment which the Contractor may have reflected in his bid.
- B. All existing electrical equipment, conduit and wiring removed during construction no longer required as part of an active system and not to be reused shall be removed from the job site and properly disposed of by the Contractor.
- C. All existing electrical equipment not being reused shall be removed during construction and shall remain the property of the owner and shall be stored, removed from the job site, or disposed of as directed by the owner's representative.

### 3.10 CLEANING

- A. The Contractor shall clear away all debris and demolished material at frequent intervals. The Contractor shall not allow debris to accumulate to the extent that it will interfere with work, passage of the workmen, and the operation of the existing occupied areas.
- B. It is the intent of this Specification that all work, including the inside of equipment, be left in a clean condition. All construction dirt shall be removed from material and equipment.

### 3.11 INVENTORY

- A. Contractor shall provide a detailed inventory of all existing electrical equipment including switchboards, disconnects, panelboards, motor starters, etc. to be stored for later reuse. Inventory shall include type, size, capacities, and quantities of each item or piece of equipment.

### 3.12 TESTING

- A. Equipment
  - 1. Existing equipment, instruments, and accessories to remain shall be tested for defects and shall be adjusted, repaired or replaced where required. Conditions, qualifications, and procedures regarding adjustments, reparations, or replacement of existing equipment as deemed necessary by the Contractor shall be submitted to the Architect for approval. The Contractor shall not proceed with equipment replacement without the written approval of the Architect. The Architect shall determine whether replacement is required and shall specify the replacement equipment to be used.
- B. Additional Requirements
  - 1. For busway, conductors, panelboards, switchboards, etc., refer to the appropriate Specification Section and manufacturer's recommendations for testing requirements and additional requirements of existing equipment and systems to be a part of the new active system.

### 3.13 QUALIFICATIONS

- A. Only Contractors, Subcontractors, and workmen experienced and regularly engaged in the demolition of mechanical, plumbing, and electrical systems shall be permitted to perform the demolition of existing systems.

END OF SECTION 26 05 30

## SECTION 26 05 33 – RACEWAY AND BOXES FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Provide the raceway systems as shown on the contract documents and as specified herein. Provide raceway systems for electrical, telephone, fire protection and signal systems. All electric conductors shall be installed in conduit, except where armor clad cable is allowed. No metallic conduit smaller than 1/2" shall be installed.
- B. Furnish junction and pull boxes where required by the Code or where indicated or required to facilitate pulling wires, either feeders or branch circuits, regardless of whether shown on contract documents or not.
- C. The approval of the Architect shall be obtained for any outlet location about which there may be any question. Outlets previously placed without specific approval in locations not suitable to the furnished room or area shall be removed and relocated without cost to the Owner when so directed by the Architect. This shall include the cutting and patching of work of others as may be necessary.

## 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 27 26 – Wiring Devices
- C. Section 26 05 53 – Identification for Electrical Systems

## 1.4 REFERENCE STANDARDS

- A. All raceways shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. ANSI C80.1: Rigid steel conduits
  - 2. NFPA 70 National Electrical Code
  - 3. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Stations
  - 4. ACI 318 Building Code
  - 5. BOCA Codes as adopted by the local authority



6. ANSI/TIA-569-C
- B. All outlet boxes shall be designed, manufactured, tested and installed in compliance with the following standards:
  1. NFPA 70 National Electrical Code
  2. NFPA 130 Standard for Fixed Guideway Transit and Passenger Rail Stations
  3. Underwriters' Laboratories

#### 1.5 CONDUIT DIAGRAMS

- A. Provide shop drawing submittal data indicating layout of all conduits and junction boxes located within the concrete slabs. Shop drawings shall require review and approval by the structural engineer prior to conduit installation.

#### 1.6 GUARANTEE

- A. Contractor shall provide a one-year guarantee for items furnished that shall cover:
  1. Faulty or inadequate design
  2. Improper assembly or erection
  3. Defective workmanship and materials

### PART 2 – PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURERS

- A. If it complies with these Specifications, outlet boxes manufactured by one of the following manufacturers will be acceptable:
  1. Crouse-Hinds, Appleton, Steel City, Red Dot, or RACO

#### 2.2 OUTLET BOXES

- A. Boxes shall be steel, hot-dipped galvanized after fabrication, and shall have industry standard knockouts necessary to accommodate the conduits at point of installation. Sectionalized boxes shall be used wherever possible to group adjacent devices under a single plate. All boxes shall have lugs or ears inside to secure covers.
- B. Ceiling outlet boxes shall be not less than four inches square to provide a seat for the fixture canopy and listed for such use.
- C. Outlet boxes for wall fixtures where conduit is concealed shall be deep type, four inch square, and shall have device covers with center openings as required per fixture.
- D. Switch and receptacle outlet boxes:

1. Outlet boxes for switches and receptacles in finished walls shall be of suitable size for the device to be mounted and the partitions in which they are installed (boxes shall be deep type, 4" square minimum when containing more than one circuit). The boxes shall have covers with rectangular openings of proper size and shape. Provide covers with raised openings on all outlets in masonry walls with plaster or tile finishes. Wall switch outlets shall be set flush in walls. When located near doors, they shall be close to the trim on lock side of door.
2. Unless otherwise shown, specified, or directed, outlet boxes, etc., shall be located with their center lines at the following elevations above the finished floor line. Boxes shall be mounted vertically unless indicated otherwise.
  - a. Wall switches (toggle type) vertical 4'-0" (above floor).
  - b. Wall receptacles (duplex type) vertical 1'-6" (above floor).
  - c. Wall telephone outlets (desk type) vertical 1'-6" (above floor).
  - d. Wall telephone outlets (pay station) 4'-9" (above floor).

Other special outlets shall be installed as shown or specified in the symbol list on the contract documents. Confirm all mounting heights with Architect.

- E. Outlet, device, pull and junction boxes in walls or ceilings of concrete, tile, or other noncombustible material, shall be so installed that the front edge of the box or fitting will not set back of the finished surface more than 1/4 inch. In walls and ceilings constructed of wood or other combustible material, outlet boxes and fittings shall be flush with the finished surface or project there from. Plaster, drywall or plasterboard surfaces that are broken or incomplete shall be repaired so there will be no gaps or open spaces greater than 1/8 inch at the edge of the box or fitting.
- F. Outlet boxes for exposed switches, receptacles, and pull boxes shall be of the cast aluminum "condulet" type, Crouse-Hinds, Stonco or equal. Exposed shall be defined as located in view of a person within or outside occupiable space not concealed within plenum or wall spaces. Exposed shall include both interior and exterior locations where surface mounting or conduit supported stand alone boxes are required. Outlet boxes in outdoor or wet locations shall also have gasketed weatherproof aluminum cast-metal covers with individual gasketed spring-latched hinged outlet covers.
- G. Unused openings in boxes, raceways, auxiliary gutters, cabinets, equipment cases or housings shall be effectively closed to afford protection substantially equivalent to the wall of the equipment.
- H. Outlet boxes for 20 ampere 120 volt or 277 volt circuits shall have a green insulated #12 AWG solid copper conductor grounding pigtail with ground screw.
- I. The highest operable part of electrical and communication outlets shall be placed within the reach ranges as required in The American with Disabilities Act (ADA). These requirements do not apply where the use of special equipment dictates otherwise or

where electrical and communication outlets are not normally indicated for use by building occupants.

- J. Junction boxes shall be sized per NEC Article 314 to accommodate proper conductor fill without the use of extension rings where possible.
- K. Exterior junction and pull boxes and their associated fittings, connectors, covers, etc. that are mounted below grade and where susceptible to immersion by water shall be of the water tight type.

## 2.3 CONDUIT

### A. General:

- 1. Provide all new and full length materials. All rigid, EMT, PVC, ENT, and flexible conduit shall be UL listed. All conduit shall be suitable for the intended service and location. Any materials located within environmental air plenums shall be UL listed for the application or approved in writing by all applicable local code authorities.
- 2. Electrical Metallic Tubing (EMT):
  - a. EMT shall be aluminum or steel with a hot-dipped galvanized coating.
  - b. EMT shall be formed to permit the use of set screw or compression connectors.
  - c. EMT shall be in accordance with UL 797 and ANSI C80.3.
- 3. Rigid Conduit:
  - a. Rigid conduit shall be heavy wall, rigid steel conduit and shall have hot-dipped galvanized coating inside and out with overcoating of zinc-chromate, or transparent enamel or lacquer.
  - b. Running thread shall not be used. Where the use is required, use T&B “Erickson” type union or OZ type SSP split coupling.
- 4. PVC Conduit:
  - a. The PVC conduit shall consist of UL approved Schedule 80 extruded Type II high impact virgin polyvinyl chloride conduit, similar and approved equal to Carlon PVC conduit.
  - b. All types of conduit joints shall be made up using plastic couplings in accordance with the manufacturer’s recommendations. The tapered ends of joints shall be swabbed with bituminous or joint-sealing compound before the coupling is applied.
  - c. All below grade and concrete encased conduits shall include metallic tracer tape for above grade detection.

## 5. Flexible metal conduit:

- a. Flexible metallic conduit shall be galvanized steel.
- b. Continuity of the equipment ground across flexible conduit connections shall be maintained for all systems that are over 150 volts to ground. The continuity shall be maintained by installing a grounding conductor sized in accordance with Article 250 of the National Electrical Code. The grounding conductor shall be inside the flexible conduit and shall be connected to both ends of the flexible conduit by a suitable binding post. All grounding conductors shall be solid copper conductors.
- c. In conduit sizes 1-1/4" and smaller and lengths of 6 feet or less, water tight flexible conduit with watertight fittings which is UL rated as a grounding conductor may be used in lieu of a flexible metallic conduit and separate grounding conductor described above.

## 6. Electrical Nonmetallic Tubing (ENT).

- a. The contractor shall have the option to use ENT in lieu of conduit provided the following conditions are met:
  - 1) ENT shall only be used as permitted by the NEC within the concrete slabs provided fittings identified for these purposes are used for connections.
  - 2) The conduit proposed meets all applicable local and national codes.
  - 3) The material and conduit system provided are UL or ETL listed specifically for the intended service.
  - 4) The material and conduit system provided are recommended by the manufacturer for the intended service.
  - 5) ENT shall not be smaller than 1/2-in. electrical trade size or larger than 2-in. electrical trade size.
  - 6) Product data shall be submitted to the Owner's representative and the engineer for review prior to final acceptance by the Owner.

## B. Fittings:

1. Unions, couplings and fittings for rigid conduit shall be galvanized steel of conventional dimensions and shall be internally threaded at each end to fit the tapered thread standard for the corresponding size conduit.
2. Couplings and fittings for EMT shall be of steel, cast pot metal is not acceptable. Couplings shall be set screw or compression type.

3. All conduit shall be terminated into panels, cabinets, boxes and outlets with insulated throat connectors for ½” through 1” and for greater than 1” with insulated bushings and locknuts. All conduits not terminated into an enclosure shall have insulated bushings to protect the exposed rough edges of the conduit; bushing material shall be listed for the location and environment installed within.
4. EMT conduit shall be terminated with liquid tight compression connectors where exposed to weather, moisture or in concrete.
5. Liquid-tight flexible metal conduit into panels, cabinets, boxes and outlets shall be secured with insulated throat clamp. Where exposed to weather or moisture or where indicated on the drawings, flexible metal conduit shall have polyvinyl liquid-tight jacket.
6. Flexible metal conduit shall be terminated into cabinets, boxes and outlets and shall be secured using steel or malleable iron squeeze connectors.
7. Any conductors pulled through non-insulated connectors shall be removed and replaced with new after insulated connector is installed.

### PART 3 – EXECUTION

#### 3.1 INSTALLATION

##### A. General:

1. Install all conduit and outlet boxes as shown on the contract documents and as required for a complete system. Each metallic conduit system shall be installed complete before conductors are drawn in. All wiring in exposed locations shall be installed in conduit.

##### B. Runs:

1. Install all exposed conduit grouped together insofar as possible. Install all conduits parallel or perpendicular to the building surfaces. All conduit shall be concealed except where indicated on the drawings.
2. Metallic conduit shall be continuous from outlet to outlet and from outlet to cabinets, junction or pull boxes and shall enter and be secured at all boxes in such a manner that each system shall be electrically continuous throughout. The equipment grounding conductors shall be bonded to all raceway terminations, i.e. junction boxes, outlet boxes, etc. Where #8 or larger equipment grounding conductor is used, the bonding shall be achieved through the use of bonding bushings. The grounding conductor shall be run continuously with the insulation peeled back for connection to bonding bushing.
3. Wherever possible, conduit shall be typically routed tight to or near the bottom of slab. The exact position of all conduit shall be adjusted to accommodate the site conditions and coordination requirements of other trades. Unless otherwise

approved by the owner or specifically shown on the drawings, conduit shall be routed as nearly as possible parallel with or at right angles to the building walls. Conduit shall not block equipment service or removal access spaces. Prior to the installation of any conduit, its location shall be coordinated with the requirements of other trades.

C. Bends:

1. All bends shall be made with standard ells or field bends in which the conduit is bent to a radius not less than allowed in applicable National Electrical Code Article for conduit type. All bends shall be free from dents or flattening.
  - a. Conduit systems used for 120 volt or higher applications shall not have more than the equivalent of four quarter bends used in any run between terminals and cabinets, or between outlets and junction or pull boxes.
  - b. Refer to Section 26 05 81 for additional limitations on conduits for telephone, audiovisual, data, and other low-voltage applications.

D. Damaged Conduit:

1. Damaged conduit shall not be used and shall be removed.

E. Location: The location and application of raceway materials shall be in accordance with applicable codes, suitable for the intended application, and the following.

1. Rigid Steel Conduit:

- a. Unless otherwise specified herein, rigid steel conduit shall be used where conduit is underground outside the footprint of the building, exposed to the weather, in damp locations, where subject to striking after installation, and where conduit is greater than 4" in diameter.
- b. Where exposed to weather, conduit shall have a manufacturer applied plastic coating such as Robroy Industries "Plasti-bond" conduit. Complete with "Plasti-bond" fittings.
- c. Rigid steel conduit installed in the ground shall have watertight joints and shall be painted the entire length with two coats of protective finish. The first shall be a 5 mils thick coat of PPG "Coal Cat Epoxy Coating". All coating shall be applied in accordance with the manufacturer's recommendations. The entire length of metallic conduit, including fittings, in contact with the ground, to a point 6" above the ground (or concrete slab), shall be completely coated, subject to the Architect's approval.

2. EMT Conduit:

- a. For conduit 4" in diameter and smaller, conduit shall be EMT, except where rigid conduit is required.

- b. Aluminum EMT may be used when exposed to the weather with liquid tight fittings and not subject to striking or physical damage after installation. Aluminum EMT shall not be encased in concrete.
  - c. Steel EMT is to be used when conduit is encased in concrete with "liquid tight" connectors.
  - d. Unless otherwise indicated herein or structurally prohibited due to the size of the conduit, whenever and wherever possible, conduits shall be located within the concrete slabs. With the exception of the electrical distribution downstream of the in-slab junction boxes, routing conduit exposed in tenant area ceiling plenums will not be acceptable. Conduits embedded in structural slabs shall be installed in a manner approved by the structural engineer. Maintain a minimum concrete coverage of 1" except where penetration is made.
- 3. Flexible Metal Conduit:
  - a. Flexible metal conduit shall be used for connections to the following:
    - 1) Motors.
    - 2) Transformers.
    - 3) Control equipment and devices.
    - 4) Lighting fixtures not connected by rigid conduit.
    - 5) Appliances.
    - 6) Equipment and devices requiring adjustment or removal for maintenance.
  - b. Plastic jacketed liquid tight flexible conduit UL listed as a grounding means shall be used when exposed to weather or moisture in addition to a grounding conductor.
  - c. Refer to Section 26 05 26 for grounding requirements.
  - d. When flexible metallic conduit is used for vibration isolation, it shall be 18" minimum length and 36" maximum length with no support. When used to connect light fixtures, it shall be 6'-0" long with no support.
- 4. PVC Conduit:
  - a. Provide as indicated on the drawings and as specified herein.
  - b. PVC conduit shall be used, if approved by the local code authority, for exterior electric utility service entrance, telephone service, conduit below the lowest level concrete slab within the perimeters of the building and parking structure, site lighting applications, and as

indicated on the drawings. PVC conduit system shall be provided with pull boxes of approved sizes as required after two right angle bends and at intervals as required by the NEC and as indicated on the contract documents. Boxes shall be in accessible locations. Utility telephone, utility power and other conduits as indicated on the contract documents shall be encased in 3000 PSI concrete (3/4" maximum aggregate) with a minimum 3" of concrete cover.

- c. At the Contractor's option, PVC conduit may extend from a below grade under slab condition up through the concrete slab unless otherwise specified herein.
  - d. PVC conduit material shall not extend above the surface of concrete slabs within central plant areas, fire pump rooms, domestic water pump rooms, HVAC pump rooms, and as indicated on the drawings.  
Exception: If the PVC conduit terminates within an enclosed piece of equipment, such as a motor control center, it will be acceptable for the PVC conduit to extend above the concrete slab.
  - e. Unless otherwise indicated herein or structurally prohibited due to the size of the conduit, PVC conduit may be used within concrete slabs if acceptable to the local code authority. PVC conduit shall not be exposed to return air plenums. Conduits embedded in structural slabs shall be installed in a manner approved by the structural engineer. Maintain a minimum concrete coverage of 2" except where penetration is made. Refer to the additional requirements for conduits installed within concrete slabs specified herein.
  - f. PVC conduit shall not be located within environmental air plenums and other areas prohibited by applicable building codes.
5. Electrical Nonmetallic Tubing (ENT): The contractor shall have the option to use ENT in lieu of metal conduit provided the following conditions are met:
- a. ENT shall only be used as permitted by the NEC within the concrete slabs provided fittings identified for these purposes are used for connections.
  - b. ENT shall not be exposed to return air plenums or above the surface of the concrete slabs.
  - c. Metal conduit elbows and metal stub-outs shall be used at all locations where conduit must exit the slab.
  - d. All cut ends of tubing shall be trimmed inside and outside to remove rough edges.
  - e. ENT shall not be used for direct earth burial.
  - f. ENT shall not be used for the support of fixtures and other equipment.



- g. Bends of electrical nonmetallic tubing shall be so made that the tubing will not be damaged and that the internal diameter of the tubing will not be effectively reduced. ENT shall be installed as a complete system and shall be securely fastened in place within 3 feet of each device box, junction box, cabinet, or fitting. ENT shall be secured at least every 3 feet.

### 3.2 COORDINATION

- A. Coordinate all conduit runs with other sections of these Specifications requiring electrical connections.

### 3.3 CONNECTION

- A. Connect conduits and wires as shown on the contract documents as required for a complete system.

### 3.4 CONDUIT SUPPORT

- A. General:
  - 1. All horizontal conduits throughout the building shall be thoroughly and substantially supported with straps, hangers, or trapeze arrangements at the highest possible elevation to building structure and not to other trades equipment. Perforated extension bar hanger will not be accepted in any part of the work. All vertical conduits shall be substantially supported to carry the weight of the conduit and cable. All support items shall be galvanized.
- B. Grouping:
  - 1. Group conduits together and support on Unistrut or Kindorf channel supports. Hanger rod sizes shall be as recommended by the hanger manufacturer for the service intended.
- C. Support Spacing:
  - 1. Vertical – Maximum spacing of supports = 10'-0".
  - 2. Horizontal – Maximum spacing of supports = 8'-0".
  - 3. Where conduits are concrete encased and where conduits are direct buried below grade, provide snap lock type duct spacers every five feet along the entire length of run.
- D. Upper Attachment to Existing Structure:
  - 1. Refer to Section 26 00 10 "Equipment Mounting/Support Devices" for additional requirements.

### 3.5 BOX SUPPORT

- A. All boxes shall be rigidly supported to the building structure with bolts or anchors.

### 3.6 CLEANING

- A. All conduit and boxes stored on the job shall have end caps and shall be kept clean inside and outside during the duration of the construction.
- B. After installation, keep ends plugged until boxes are closed.
- C. Clean entire raceway system prior to installation of conductors and/or pull cords.
- D. Contractor shall pull a short mandrel or plug which approximates the diameter of the conduit in all building conduit systems 3" and larger. Contractor shall remove any burrs or obstructions prior to pulling conductors. This shall be performed before and after pouring of concrete in systems requiring concrete cover.
- E. Vacuum clean all dirt and debris from the outlet boxes before connections are made.

### 3.7 PULL WIRE

- A. A 1/8" braided polypropylene rope or #14 galvanized iron fish wire shall be left in all empty conduit systems. At least 12" of properly secured rope or wire shall be tied off at each end of the empty conduits.

### 3.8 COLOR CODED IDENTIFICATION

- A. All conduit and boxes shall be labeled and clearly marked as indicated in Section 26 05 53.

### 3.09 CONDUIT INSTALLED WITHIN CONCRETE SLABS

- A. Conduit shall be installed within concrete slabs meeting structural engineer's requirements. Installation shall minimize exposed conduit. Unless otherwise indicated, conduit shall be installed centered within slab to maintain maximum amount of concrete above and below conduit. In general, conduit within concrete slabs shall have a minimum of two conduit diameters worth of concrete between embedded conduits. Consult structural engineer where unable to maintain concrete cover or conduit separation.

### 3.10 EXPANSION JOINTS

- A. Raceways shall be provided with expansion fittings at all building expansion joints, parking structure expansion joints, and other areas where necessary to compensate for thermal expansion and contraction. Furnish and install O-Z/Gedney type "DX" or "AXDX" expansion fittings with bonding jumper where conduits cross building expansion joints. Install per manufacturer's recommendations. Expansion fittings shall be provided which allow for deflection and expansion in any direction.

END OF SECTION 26 05 33

## SECTION 26 05 48 - VIBRATION AND SEISMIC CONTROLS FOR ELECTRICAL SYSTEMS

## PART 1 – GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 DESCRIPTION OF WORK

- A. Furnish and install complete, fully adjusted, vibration and noise isolation systems and associated equipment as specified and as indicated on the contract documents.
- B. It is the objective of this Specification to provide the necessary design requirements for the control of noise and vibration in the buildings due to the operation of machinery or equipment, and/or due to interconnected piping, ductwork and conduit.
- C. The work of this section includes, but is not limited to the following:
  - 1. Vibration isolation elements for equipment.

## 1.3 RELATED WORK SPECIFIED ELSEWHERE

- A. Division 26 Schedule of Submittal Data: Section 26 00 70

## 1.4 SHOP DRAWING AND SUBMITTAL DATA

- A. Shop drawing submittal data shall clearly and concisely address all Specification requirements listed herein, certification data listed in Sections 26 00 10 and 26 00 70.
- B. In addition to these requirements, the submittal material shall include descriptive data for all products and materials including, but not limited to, the following:
  - 1. Descriptive Data:
    - a. Catalog cuts and data sheets on specific vibration isolators to be utilized showing compliance with the specifications.
    - b. An itemized list showing the items of equipment to be isolated, the isolator type and model number selected, isolator loading and deflection.
  - 2. Shop Drawings:
    - a. Drawings showing equipment base constructions for each machine,

including dimensions, structural member sizes and support point locations.

- b. Concrete and steel details for bases, including anchor bolt locations.

## 1.5 CODE AND STANDARD REQUIREMENTS

- A. 2011 ASHRAE HVAC Applications, Chapter 48

## 1.6 MANUFACTURER RESPONSIBILITIES

- A. Manufacturer of vibration isolation equipment shall have the following responsibilities:

1. Determine vibration isolation sizes and locations.
2. Provide equipment isolation systems as scheduled or specified.
3. Guarantee specified isolation system deflection.
4. Provide installation instructions, drawings and field supervision to assure proper installation and performance.
5. Additional responsibilities as specified herein and as indicated on the drawings.

## 1.7 MANUFACTURERS AND MANUFACTURER'S REPRESENTATIVES

- A. All vibration isolation devices shall be the product of a single manufacturer. Products of other manufacturer's are acceptable provided that their systems comply with the design intent for system performance, static deflection and structural design of the base manufacturer; and the performance of these other products are certified by the single manufacturer taking responsibility for the project.
- B. Unless otherwise noted the vibration isolation devices described herein are products of the VMC Group-Amber/Booth and Mason Industries.
- C. If it complies with these Specifications, equipment and systems manufactured by one of the following manufacturers will be acceptable:
- |    |                              |               |
|----|------------------------------|---------------|
| 1. | Mason Industries, Inc.       | Hauppauge, NY |
| 2. | Kinetics Noise Control, Inc. | Dublin, OH    |
| 3. | VMC Group-Amber/Booth        | Houston, TX   |
| 4. | Vibration Eliminator Co.     | Copiague, NY  |
- D. Vibration isolation manufacturer and manufacturer's representatives providing systems and products for this project shall have a minimum ten years experience designing and installing vibration isolation systems.
- E. The installation and final adjustment of all vibration isolation units and hangers shall be under the direct supervision of the vibration isolation manufacturer's representative.

## PART 2 - PRODUCTS

## 2.1 GENERAL

- A. Deflection Heights and Calibration: All vibration isolators shall have either known undeflected heights or calibration markings so that, after adjustment, when carrying their load, the deflection under load can be verified, thus determining that the load is within the proper range of the device and that the correct degree of vibration isolation is being provided according to the design.
- B. Linear Characteristics: All isolators shall operate in the linear portion of their load versus deflection curve. Load versus deflection curves shall be furnished by the manufacturer, and must be linear over a deflection range of not less than 50% above the design deflection.
- C. Spring Isolation: Where spring isolation systems are described in the following specifications, the mounting assemblies shall utilize bare springs with the spring diameter not less than 0.8 of the loaded operating height of the spring. Each spring isolator shall be designed and installed so that the ends of the springs remain parallel. The minimum deflection from loaded operating height to spring solid height shall be 50% of the rated static deflection of the spring.
- D. Neoprene Isolation: Where neoprene-in-shear isolation systems are described in the following specifications, the mounting assemblies shall utilize bare neoprene elements with unit type design molded in oil resistant neoprene. The neoprene shall be compounded to meet the following:
  - 1. Shore hardness of 35 to 65 5, after minimum aging of 20 days or corresponding oven-aging.
  - 2. Minimum tensile strength of 2000 PSI.
  - 3. Minimum elongation of 300 %.
  - 4. Maximum compression at 25 % of original deflection.
- E. Stiffness: The isolator ratio of lateral to vertical stiffness shall not be less than 0.9 nor more than 1.5.
- F. Natural Frequency: The theoretical vertical natural frequency for each support point, based upon load per isolator and isolator stiffness, shall not differ from the design objectives for the equipment as a whole by more than  $\pm 10\%$ .
- G. Corrosion Protection: All mounting systems exposed to weather and other corrosive environments shall be provided with factory applied corrosion protection. All metal parts of mountings (except springs and hardware) shall be hot dip galvanized. All vibration isolators shall be furnished with zinc electroplated or stainless steel hardware to prevent corrosion and bolt freeze-up and to maintain attractive appearance. Isolators exposed to weather shall have the spring cadmium plated and neoprene or powdered

coated. Nuts and bolts shall be cadmium plated.

- H. Wind Loading: Contractor shall provide isolators for equipment subject to wind loading with uplift restraints which comply with all minimum code requirements.

## 2.2 VIBRATION ISOLATORS

- A. Type A: Bare spring isolators shall incorporate the following:

1. Minimum 1/4" (6 mm) thick neoprene acoustical base pad on underside, unless designated otherwise.
2. Non-resonant with equipment forcing frequencies or support structure natural frequencies.
3. VMC Group-Amber/Booth Type SW, Mason Type SLF, or as approved.

- B. Type B: Spring isolators shall be same as Type A, except:

1. Provide built-in vertical limit stops with minimum 1/4" (6 mm) clearance under normal operation.
2. Tapped holes in top plate for bolting to equipment.
3. Capable of supporting equipment at a fixed elevation during equipment erection. Installed and operating heights shall be identical.
4. Spring package shall be of such design that it can be installed after equipment is erected and removed in the future without disturbing the installation.
5. VMC Group-Amber/Booth Type CT, Mason Type SLR, or as approved.

- C. Type C: Not Used.

- D. Type D: Elastomer Mounting Types/Elastomer Isolators, shall incorporate the following:

1. Bolt holes for bolting to equipment base.
2. Bottom steel plates for bolting or welding to sub-base as required.
3. Unit type design molded in oil-resistant neoprene.
4. VMC Group-Amber/Booth Type RVD, Mason Type ND or as approved.

- E. Type E: Elastomer hanger rod isolators shall incorporate the following:

1. Molded unit type neoprene element with projecting bushing lining rod clearance hole.

2. Neoprene element to be minimum 1 3/4" (45 mm) thick.
  3. Steel retainer box encasing neoprene mounting.
  4. Clearance between mounting hanger rod and neoprene bushing shall be minimum 1/8" (3 mm).
  5. VMC Group-Amber/Booth Type HRD, Mason Type HD, or as approved.
- F. Type F: Not Used.
- G. Type G: Pad type elastomer mountings to incorporate the following:
1. 0.750" (19 mm) minimum thickness.
  2. 50 psi (345 KN/m<sup>2</sup>) maximum loading.
  3. Ribbed or waffled design.
  4. .10" (2.5 mm) deflection per pad thickness.
  5. 1/16" (1.6 mm) galvanized steel plate between multiple layers of pad thickness.
  6. Suitable bearing plate to distribute load.
  7. VMC Group-Amber/Booth Type NR, Mason Type Super W, or as approved.

### PART 3 - EXECUTION

#### 3.1 GENERAL VIBRATION ISOLATION REQUIREMENTS

- A. The installation of all vibration isolation devices and systems shall be in accordance with the recommendations, instructions, and procedures of the vibration isolator manufacturer. Vibration isolators shall not cause any change of position of equipment or conduit resulting in conduit stresses or misalignment.
- B. Unless otherwise noted, all electrical equipment shall be isolated from the building structure by means of noise and vibration isolators as scheduled on the drawings and within these specifications.
- C. No rigid connections between equipment and building structure shall be made that degrades the noise and vibration isolation systems herein specified.
- D. Provide temporary anchors and supports as required for the installation of the isolation systems. All temporary supports and anchors shall be removed prior to final review of the systems.
- E. The contractor shall not install any equipment or conduit which makes rigid contact with the building unless permitted in this Specification. Building includes, but is not limited to, slabs, beams, columns, studs and walls.

- F. Isolation mounting deflection shall be at least the minimum specified.
- G. Coordinate work with other trades to avoid rigid contact with the building. Inform other trades following work, such as plastering, drywall, masonry, electrical, etc. to avoid any contact which would reduce the vibration isolation.
- H. Bring to the Architect's attention, prior to installation, any conflicts with other trades which will result in unavoidable rigid contact with equipment or conduit as described herein, due to inadequate space or other unforeseen conditions. Corrective work necessitated by conflicts after installation shall be at the responsible contractor's expense.
- I. Bring to the Architect's attention any discrepancies between the specifications and field conditions or changes required due to specific equipment selection, prior to installation. Corrective work necessitated by discrepancies after installation shall be at the contractor's expense.
- J. Request inspection of any installation to be covered or enclosed, prior to such closure.
- K. Manufacturer's Stock: The isolation manufacturer's representative shall maintain an adequate stock of springs and isolators of the type used so that any changes required during construction and checking can be accomplished promptly.
- L. Coordination: The contractor and isolator manufacturer's representative shall coordinate the vibration isolation supports with the manufacturers of the equipment to be isolated. Any changes from the documents deemed necessary to provide adequate noise and vibration isolation in accordance with the requirements of the 2011 ASHRAE HVAC Applications, Chapter 48, shall clearly indicated in the submittal shop drawing data. Prior to submitting detailed shop drawings to the Engineer for review, the equipment manufacturer shall approve the shop drawings in writing. Refer to Section 26 00 10 for additional requirements.

### 3.2 EQUIPMENT ISOLATION

- A. Floor mounted machines to be isolated shall be supported by a structural steel frame or concrete inertia base.
- B. Brackets, mounting plates, and miscellaneous metal angles shall be provided as required to accommodate the interface of the isolator and the respective isolated equipment. The position and size of the support devices shall be specified and provided by the isolator manufacturer. It shall be the responsibility of the isolator manufacturer to review the actual equipment being supplied to this project under other specification sections and coordinate the mounting arrangement of the isolators.
- C. The minimum operating clearance between the equipment frame or rigid steel base frame and the housekeeping pad or floor shall be 1" (25 mm). Minimum operating clearance between concrete inertia base and housekeeping pad or floor shall be 2" (50 mm).
- D. After the entire installation is complete and under full operational load, the isolators



shall be adjusted so that the load from the isolated equipment is fully transferred to the isolators.

- E. Prior to start-up, clean out all foreign matter between bases and equipment. Verify that there are no isolation short circuits in the base or isolators.
- F. Verify that all installed isolator and mounting systems permit equipment motion in all directions. Adjust or provide additional resilient restraints to flexibly limit start-up equipment lateral motion to 1/4" (6 mm).
- G. All conduit shall freely pass through walls and floors without rigid connections. Penetration points shall be sleeved or otherwise formed to allow passage of conduit and maintain 3/4" to 1 1/4" (20 to 32 mm) clearance around the outside surfaces. This clearance space shall be tightly packed with fiberglass, and caulked airtight after installation of conduit.
- H. Isolators shall be installed with the isolator hanger box attached to, or hung as close as possible to, the structure. Hanger rods shall be aligned to clear the hanger box.
- I. Isolators shall be suspended from substantial structural members where possible. Suspending isolators from slab diaphragm should be avoided when possible.
- J. The isolation system shall not be resonant with the structural steel support resonant frequencies or the driving frequencies of the supported equipment.
- K. External isolators may be omitted on transformers with factory installed internal vibration isolation mounts that are equivalent to the external vibration isolators specified herein for transformers.

### 3.3 INSPECTION

- A. After the completion of the vibration isolation systems in accordance with the contract documents, the local representative of the isolation materials manufacturer shall inspect the complete system and report in writing any installation errors, improperly selected isolation devices, and other faults that could affect the performance of the system. This report shall be submitted to the Contractor for corrective action. After the corrective action has been implemented, the local representative of the isolation materials manufacturer shall visit the site and verify the corrective action has been completed.
- B. After the corrective action has been completed, the local representative of the isolation materials manufacturer shall provide a submittal to architect via the contractor that certifies in writing that the vibration isolation systems have been installed in accordance with the manufacturer's recommendations and the requirements of the contract documents. All deviations from the contract document shall be noted in this final report.

END OF SECTION 26 05 48

## SECTION 26 05 53 – IDENTIFICATION FOR ELECTRICAL SYSTEMS

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work under this section shall conform to the requirements of Division 01, "General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Types of electrical identification work specified in this section include the following:
  - 1. Electrical power conductors.
  - 2. Electrical Equipment.
  - 3. Raceways including all conduit and junction boxes.
  - 4. Operational instructions and warnings.
  - 5. Danger signs.
  - 6. Equipment/system identification signs.

## 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- D. Section 26 24 16 - Panelboards
- E. Section 26 28 00 - Low-Voltage Circuit Protective Devices

## 1.4 REFERENCE STANDARDS

- A. All signs, labels, colors, lettering, styles and sizes of electrical identification shall be in accordance with the applicable requirements of the American National Standards Institute (ANSI).

## 1.5 SUBMITTALS

- A. Submit a list of equipment requiring a nameplate as specified herein identifying nomenclature and color field.

## PART 2 - PRODUCTS

## 2.1 ELECTRICAL IDENTIFICATION MATERIALS

## A. General

1. Except as otherwise indicated, provide manufacturer's standard identification products of categories and types required for each application. Where more than one single identification type is specified for an application, selection is Installer's option. However, identification product shall be consistent for each application.

## B. Color-Coded Plastic Tape

1. Wiring:
  - a. General: Provide manufacturer's standard self-adhesive vinyl tape not less than 3 mils thick by 3/4" wide for use on non-color coded wires.
  - b. Colors: Conforming to Section 26 05 19, "Low-Voltage Electrical Power Conductors and Cables".
2. Raceways:
  - a. General: Provide manufacturer's standard self-adhesive vinyl tape not less than 1-1/2" wide and not more than 2-1/2" wide for use on conduit.
  - b. Colors: Conforming to color scheme indicated for "circuit and conduit identification".

## C. Circuit and Conduit Identification

1. Mark with an indelible marker the painted covers of all junction boxes to indicate the circuits contained therein.
2. The covers of junction boxes shall be painted as follows:
 

SYSTEM	COLOR
Communications/Telephone/Data	Yellow
Control	Blue
Power (Normal)	Black
Security	Green
3. The color-code scheme of 2.1-C.2 above shall also apply to all conduit systems as follows:
  - a. All conduit shall be clearly marked, at intervals not to exceed 20 feet in length of conduit, with color-coded bands. Bands shall be 1-1/2 inches to 2-1/2 inches in width.
  - b. All conduit shall also be clearly marked with color coded bands as it passes through any barrier or obstruction such as a wall or floor. The

bands shall be installed within 12 inches of the obstruction and on both sides of the obstruction.

D. Self-Adhesive Plastic Signs

1. General: Provide manufacturer's standard, self-adhesive or pressure-sensitive, pre-printed, flexible vinyl signs for operational instructions or warnings; of sizes suitable for application areas and adequate for visibility, with proper wording for each application.
2. Colors: Unless otherwise indicated or required by governing regulations, provide black signs with white lettering.

E. Engraved Plastic Laminate Signs

1. General: Provide engraving stock melamine plastic laminate with engraver's standard letter style of sizes and wording indicated, with white lettering in a field to match color coding identified in 2.1- C.2 except as otherwise indicated, punched for mechanical fastening except where adhesive mounting is necessary because of substrate.
2. Thickness: 1/16."
3. Fasteners: Self-tapping stainless steel screws, except contact-type permanent adhesive where screws cannot or should not penetrate substrate.

F. Baked Enamel Danger Signs

1. General: Provide manufacturer's standard "DANGER" signs of baked enamel finish on 20 gage steel; of standard red, black and white graphics; 14" x 10" size except where 10" x 7" is the largest size which can be applied where needed, and except where larger size is needed for adequate vision; with recognized standard explanation wording e.g., HIGH VOLTAGE, KEEP AWAY.

## 2.2 LETTERING

- A. General: Coordinate names, abbreviations and other designations used in electrical identification work, with corresponding designations shown on construction documents, specified or scheduled. Provide numbers, lettering and wording as indicated or, if not otherwise indicated, as recommended by manufacturers or as required for proper identification and operation/maintenance of electrical systems and equipment. Comply with ANSI A13.1 pertaining to minimum sizes for letters and numbers.

## PART 3 - EXECUTION

### 3.1 APPLICATION AND INSTALLATION

- A. General Installation Requirements

1. Install electrical identification products as indicated, in accordance with manufacturer's written instructions, and requirements of NEC.
2. Coordination: Where identification is to be applied to surfaces, which require finish, install identification after completion of painting.

B. Operational Identification and Warnings

1. General: In addition to the requirements indicated herein, wherever reasonably required to ensure safe efficient operation and maintenance of electrical systems, electrically connected mechanical systems, general systems, and equipment, including prevention of misuse of electrical facilities by unauthorized personnel; install self-adhesive plastic signs or similar equivalent identification, instruction or warnings on switches, outlets and other controls, devices, and covers of electrical enclosures. Where detailed instructions or explanations are needed, provide plasticized tags with clearly written messages adequate for intended purposes.

C. Warning Signs

1. Entrances to rooms and other guarded locations that contain exposed live parts, including but not limited to all main electrical service entrance rooms, electrical vaults, and as otherwise indicated on the contract documents, shall be marked with conspicuous warning signs forbidding unqualified persons to enter. Refer to architectural specifications for additional requirements.

D. Equipment/System Identification

1. General: Install engraved plastic laminate sign on each major unit of electrical equipment in the building and parking structure; including central or master unit of each electrical system, unless unit is specified with its own self-explanatory identification or signal system. Except as otherwise indicated, provide single line of text, 1/2" high lettering on 1-1/2" high sign (2" high where 2 lines are required), white lettering in a field to match color coding identified in 2.1-C.2 Provide text matching terminology and numbering of the contract documents and shop drawings. Provide signs for each unit of the following categories of electrical work.
  - a. Panelboards, electrical cabinets, pull boxes, and enclosures (individual sub-components for distribution panelboards).
  - b. Disconnect switches.
  - c. Other equipment as indicated on the drawings and as specified herein.
2. Install engraved plastic laminate sign on each switchboard and panelboard supplied by a feeder to indicate the device or equipment where the power supply originates.

3. Install signs on the equipment at location for best convenience of viewing without interference with operation and maintenance of equipment. For recessed panels in finished areas, provide the sign on the inside of the panel door. Secure to substrate with fasteners, except use adhesive where fasteners should not or cannot penetrate the substrate.
4. The Contractors shall coordinate the equipment tag designations and nameplates used to identify each piece of the Division 21, 22, 23, 25, 26 and 28 equipment so as to match and correspond to the equipment tag designations indicated on the contract documents. This includes, but is not limited to, the Contractor's shop drawings; submittals; record drawings; wiring diagrams; testing reports; Operating and Maintenance (O&M) manuals.

E. Available Fault Current

1. Service equipment in other than dwelling units shall be legibly marked in the field with the maximum available fault current. The field markings shall include the date the fault current calculations were performed and be of sufficient durability to withstand the environment.

END OF SECTION 26 05 53

## SECTION 26 05 90 - MISCELLANEOUS EQUIPMENT

### PART 1 - GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirement of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

#### 1.2 WORK INCLUDED IN THIS SECTION

- A. Furnish and install various equipment where indicated on the contract documents and as specified herein.

#### 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 – Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33 – Raceway and Boxes for Electrical Systems

#### 1.4 REFERENCE STANDARDS

- A. NFPA 70 National Electrical Code
- B. Underwriters' Laboratories (UL)

#### 1.5 SUBMITTALS

- A. Submit manufacturer's literature, illustrations, specifications and engineering data for each type and size of equipment specific to this project.

### PART 2 - PRODUCTS

#### 2.1 HORN LOUDSPEAKERS

- A. The loudspeaker shall be a Bogen Model BDT30A, or approved equivalent, reentrant horn type loud-speaker. The loudspeaker shall be of weatherproof all-metal construction, with driver enclosed within a water-proof housing. The loudspeaker shall include a self-aligning, field replaceable diaphragm. Screw terminals shall be provided for connection to the audio line. A plastic cover shall be provided to protect the connectors and impedance selector switch, and to provide strain relief for the audio line. An all-purpose mounting bracket shall provide precise positioning in the vertical and horizontal planes with a single adjustment. The bracket shall include banding slots to permit mounting the loudspeaker on beams or pillars. Bracket and loudspeaker shall be finished in textured mocha enamel. The unit shall measure 9-5/8" diameter (each horn) x 12-1/8" D.
  - 1. Frequency Response: from 225 Hz to 14 kHz.
  - 2. Rated power output: 30 watts RMS continuous.

3. Dispersion: 100°, each horn.
4. Sound pressure level, measured four feet on axis with 30 watt input @ 1000 Hz, shall be at least 121 dB for each horn.
5. The unit shall incorporate a seven-position weather-sealed switch, to allow matching the loudspeaker to a 25V or 70V constant-voltage line.
6. Power handling capacity shall be adjustable at 70V to 30, 15, 7.5, 3.7 or 1.8 watts, and at 25V to 15, 7.5, 3.7 or 1.8 watts.
7. Finish: Enamel, 'mocha' color
8. Wiring: All wiring within poles, conduit, junction boxes, or other raceway shall be rated for 600V minimum.

### PART 3 - EXECUTION

#### 3.1 LOCATION

- A. Locate all equipment as indicated on the drawings. When equipment is located in public spaces contractor shall verify exact location, lengths and colors of equipment prior to order.

#### 3.2 CLEANING

- A. Clear all dirt and debris from the inside and outside of all specified equipment prior to operating and turning over to the Owner.

END OF SECTION 26 05 90



## SECTION 26 05 93 - TESTING

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 26 - Grounding and Bonding for Electrical Systems
- C. Section 26 24 16 - Panelboards
- D. Section 26 28 00 - Low-Voltage Circuit Protective Devices
- E. Section 26 50 00 - Lighting

## 1.3 WORK INCLUDED IN THIS SECTION

- A. During the progress of the work and upon completion, tests shall be made as specified herein and as required by authorities having jurisdiction including inspectors, Owner, Architect, or Engineer. Tests shall be conducted by the Contractor as part of the work of this Division and shall include the services of qualified personnel as well as all equipment, apparatus, and services required. Each wiring system with devices connected must test free from short circuits and from grounds and must have an insulation resistance between conductors and ground, based on maximum load, not less than the requirements of the latest edition of the National Electrical Code.
- B. Prior to the execution of testing, the Contractor shall notify the Engineer of proposed test procedures and forms. The procedures and documentation shall include the items listed herein, applicable code requirements, and manufacturer's recommended installation and acceptance test procedures.
- C. Tests shall include, but not be limited to, the following:
  - 1. Wire and cable insulation, refer to Sections 26 05 19 and 26 05 16.
  - 2. Grounding system continuity, refer to Section 26 05 26.
  - 3. Test all operations of the EMCS control of all the lighting contactors.
  - 4. Operation of electrical equipment and appliances whether provided under this Division or not including any portions of electrical power system as required by Engineer, Architect or Owner.
  - 5. Test the operation and program the timing schemes for the lighting relay, time clock, and contactor control systems. Confirm proper settings and programming

with Owner's Representative.

6. After work of project is complete and during Final Review, the contractor shall open (remove and reinstall covers upon inspection) all electrical equipment that was affected by work of this project for visual inspection to include but not limited to visually confirm terminations, cleanliness, color coding, circuit identification, grounding, and wiring. Coordinate inspection with Engineer.
7. Lighting control devices and control systems shall be tested to ensure that control hardware and software are calibrated, adjusted, programmed, and in proper working condition in accordance with the construction documents and manufacturer's installation instructions. For all occupancy sensors, time switches, programmable schedule controls, and photocells:
  - a. Confirm that the placement, sensitivity, and time-out adjustments for occupancy sensors yield acceptable performance, lights turn off only after the space is vacated and do not turn on unless the space is occupied.
  - b. Confirm that the time switches and programmable schedule controls are programmed to turn the lights off.
  - c. Confirm that the photosensor controls reduce electric light levels based on the amount of usable daylight in the space as specified.
  - d. The responsible party for this testing shall not be directly involved in either the design or construction of the project, and shall provide documentation certifying that the installed lighting controls meet or exceed all documented performance criteria. Certifications shall be specific enough to verify compliance.
- D. All tests to be witnessed by Engineer shall be completely pre-tested by Contractor and all systems shall be operational prior to Engineer's review. Should a second trip be necessary to re-review a test for an inoperable system, Contractor shall be responsible for compensating Engineer for his time based on Engineer's hourly rates and reimburse any travel expenses.
- E. All tests must be performed and test results received by Engineer including witnessing of tests prior to final review by Engineer.
- F. Contractor shall submit the required quantity of copies of each complete test report specified herein to the Engineer. Each test report shall include at a minimum all model numbers of test equipment with last calibration date, test personnel, date, time, weather conditions, witnesses, passing requirements, test procedures, test results, equipment settings, etc.
- G. The foregoing shall in no way relieve the Contractor of the warranty requirements.

END OF SECTION 26 05 93



## SECTION 26 24 16 - PANELBOARDS

### PART 1 - GENERAL

#### 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

#### 1.2 WORK INCLUDED IN THIS SECTION

- A. Provide dead front panelboards sized, rated, and complete with the quantity and size of circuit breakers as shown on the contract documents and as specified herein.

#### 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- C. Section 26 05 53 - Identification for Electrical Systems
- D. Section 26 05 93 - Testing
- E. Section 26 28 00 - Low-Voltage Circuit Protective Devices

#### 1.4 REFERENCE STANDARDS

- A. All panelboards shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. NFPA 70 National Electrical Code
  - 2. UL 67 Panelboards
  - 3. UL 50 Cabinets and Boxes
  - 4. NEMA PB1

#### 1.5 SUBMITTALS

- A. Submit manufacturers' literature, illustrations, engineering data, specifications, directory card sample and tabulation of panelboards and overcurrent devices including panel rating, dimensions, lugs, covers, breaker arrangement, breaker type, frame, trip and interrupting rating, ground bus and provision for future.

### PART 2 - PRODUCTS

#### 2.1 ACCEPTABLE MANUFACTURES

- A. If it complies with these Specifications, equipment manufactured by one of the following manufacturers will be acceptable:

1. Siemens, General Electric, Eaton Cutler-Hammer, Square D.

## 2.2 GENERAL

- A. Panelboards shall be standard catalog items complying with NEC, UL, and NEMA standards and bear the label of Underwriters' Laboratories.
- B. Panelboards shall be of the same manufacturer as the main switchboard.
- C. Panelboards shall be identified by laminated plastic nameplates indicating panelboard designation. Refer to Section 26 05 53 for identification requirements.

## 2.3 PANELBOARDS

- A. Provide copper full-size phase and neutral busses which have been rated in accordance with UL 67 heat-rise tests. Bus bar connections shall be column consecutive phase-sequence type. Both 120/208 volt and 277/480 volt panelboards shall have bus bars drilled and equipped with all hardware for bolt-in breakers. The use of aluminum bus within panelboards will not be acceptable.
- B. Provide bolted on grounding bus(es) with main lug(s) unless otherwise noted.
- C. Panelboard short circuit bracing and breaker interrupting capacity shall be as indicated on the manufacturer's short circuit and fault current coordination study. UL listed series ratings with the upstream protective devices is satisfactory for panels fed from the busway. Levels shall not be less than 14,000 amperes rms symmetrical for 277/480 volt service and 10,000 amperes rms symmetrical for 120/208 volt service.
- D. Provide manufacturers' standard #16-gage (minimum) galvanized sheet steel cabinets with enamel hinged front cover for door within in a door construction to box, each door shall include a master-keyed door lock, multiple knockouts, wiring gutters, and typed circuit directory depicting each pole position in a two column fashion. In lieu of locking door within a door panelboard cover construction, it will be acceptable to provide a door within a hinged/bolted panelboard cover construction.
- E. Busbars shall be sized to limit the temperature rise within the panelboard to 50°C with a 40°C ambient temperature. Busbars shall be round edge copper with bolted joint connections. Bolted joint connection locations shall be readily accessible for maintenance. The use of aluminum bus within panelboards will not be acceptable. Panelboard main lugs connected to #6 AWG or larger conductors shall be furnished to accommodate compression connectors. Adequate wiring space shall be provided to accommodate the compression connectors. Refer to Section 26 05 19 for compression connector requirements.
- a. All two-section panelboards shall have equivalent short circuit bracing and be connected with copper cable equal to or greater than the main bus amperage

capacity.

- b. Panelboard neutral bars shall be sized to accommodate the neutral feeder sizes indicated on the contract documents. This shall include but not be limited to the up-sizing of neutral bars as much as 200% above the NEC minimum requirements.
- c. Where indicated on the contract documents, provide insulated/isolated ground bus bars.
- d. Provide pad locking hardware on circuit breakers for small pieces of equipment which are hardwired without a local disconnecting means.
- e. Single, two, or three pole molded case circuit breakers indicated for shunt trip shall be UL listed, 60 Hz, factory installed, and have a 120 volt AC coil in addition to the requirements indicated hereinbefore. Trip-coil shall de-energize when breaker opens. Shunt trip breakers shall take an extra pole position within panelboards and may be either left or right mounted. Contractor shall provide the 120 volt circuit to power the shunt trip circuit. The shunt trip circuit activation device shall be a momentary close contact type. Contractor shall coordinate all accessories required for a complete and functional shunt trip circuit.
- f. Contractor shall provide branch circuit wiring, conduit, and overcurrent protection meeting submitted and approved equipment's respective nameplate data (maximum overcurrent protection (MOP) and minimum circuit ampacity (MCA)).

## 2.4 COORDINATION PANELBOARDS

- A. Contractor shall provide fusible coordination panelboards for Emergency Systems, Legally Required Standby Systems, Critical Operations Power Systems as defined by NFPA 70 Articles 700, 701, and 708, and as indicated on the drawings. Panelboards shall be Cooper Bussmann Quik-Spec Coordination Panelboards (Type QSCP) or Engineer approved equivalent.
- B. Coordination panelboard enclosures, bussing, neutrals, and interrupt capacity requirements shall meet or exceed those of panelboards as described in Section 2.3.
- C. Panelboard shall be equipped with a six-space spare fuse compartment for storing replacement branch circuit fuses. Spare fuse compartment shall be located behind locking panel door. Furnish six spare fuses, a minimum of one fuse of each rating and type of fuse installed within each panelboard.
- D. Permanently installed lockout means shall be provided on the main disconnect for lockout tagout procedures. Main disconnect shall be quick-make, quick-break type.
- E. Branch Fused Disconnects
  - 1. Device shall have visible circuit ON/OFF indication with colored and international symbol markings.

2. Device shall provide open fuse indication via permanently installed neon indicating light.
3. Device shall be UL Listed 600VAC/200kA voltage/short-circuit current rating, load-break disconnect with amp ratings and number of poles as indicated on the panelboard schedule.
4. Fuse and disconnect assembly shall be a finger-safe component with trim installed.
5. Fuse and disconnect shall be mechanically interlocked so as not to allow fuse removal while fuse terminals are energized.
6. No special tools shall be required for fuse removal.
7. Devices shall have bolt-on style bus connectors.
8. Device housing shall be clearly marked with device amperage.
9. Permanently installed lockout means shall be provided on the device for lockout tagout procedures. Permanently installed means for locking device in the ON position shall also be provided.
10. Device shall provide fuse amp rating rejection at the following ampacities to ensure continued circuit protection at the specified circuit rating: 15A, 20A, 30A, 40A, 50A, 60A, 70A, 90A & 100A.

F. Main & Branch Overcurrent Protection

1. Coordination panelboard overcurrent protective devices shall be selectively coordinated with all supply side (fed from both the normal and emergency source) fuses sized at a minimum amp ratio of 2:1.
2. Branch circuit overcurrent protection shall be 600VAC UL Listed minimum 300kA interrupt rating finger-safe fuse with Class J performance characteristics.
3. Main overcurrent protective devices shall be 600VAC UL Listed minimum 300kA interrupt rating Class J time-delay fuses or Class J performance fuses.
4. Where panelboard main fuses are installed, fuses in panelboard branch circuits shall selectively coordinate with main fuses for all overcurrents up to 200kA. Panelboards with main fuses shall be fed with copper feeders only.

### PART 3 - EXECUTION

#### 3.1 SURFACE-MOUNTED PANELS

- A. All surface-mounted panels shall be mounted on 12 gauge formed steel channel having a

cross-section dimension of at least 1-1/2 inches by 1-1/2 inches. The channel and fittings shall have Galv-Krom or hot-dipped galvanized finish. Channels shall be installed vertically and/or horizontally.

### 3.2 RECESSED/FLUSH-MOUNTED PANELS

- A. All recessed- or flush-mounted panels shall be coordinate by the Contractor to ensure the associated wall is of sufficient inside clear depth to accommodate the panelboard cabinet. Coordinate with other Divisions to ensure work of other trades such as wall framing, piping, ductwork, structural members, etc. will not be in conflict with the panel. Install suitable panel cover flush with finished wall surface without gaps.

### 3.3 COORDINATION

- A. Coordinate conduit rough-in for panelboards.

### 3.4 CONNECTIONS

- A. Connect conduit, wireways, and wiring to panelboards.

### 3.5 CLEANING

- A. Vacuum clean all dirt and debris from the inside and outside of the panelboards.

### 3.6 CIRCUIT DIRECTORY CARDS

- A. Type-in the panelboard's circuit directory card clearly identifying the use of each circuit and place behind clear plastic on the inside of the panelboard door depicting each pole position in a two-column fashion. The card shall be removable at the completion of the project.
- B. Contractor shall provide updated typed panelboard's circuit directory cards reflecting all updates and revisions which have occurred during the course of construction. Hand-written notes on the panelboard's circuit directory cards will not be accepted.

### 3.7 CLEARANCE

- A. Contractor shall install panelboards with proper NEC clearances. No piping, ducts, or equipment foreign to the electrical equipment or architectural appurtenances shall be permitted to be installed, enter or pass through such required clearance spaces.

END OF SECTION 26 24 16



## SECTION 26 27 26 - WIRING DEVICES

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Provide the wiring devices as shown on the contract documents and as specified herein.

## 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems

## 1.4 REFERENCE STANDARDS

- A. All wiring devices shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. NFPA 70 National Electrical Code
  - 2. Underwriters Laboratories
  - 3. Americans with Disabilities Act (ADA)

## 1.5 SUBMITTALS

- A. Submit manufacturers' literature, illustrations, specifications, and engineering data for each type and size of device with the appropriate cover plate.

## PART 2 - PRODUCTS

## 2.1 ACCEPTABLE MANUFACTURERS

- A. If it complies with these Specifications, equipment manufactured by one of the following manufacturers will be acceptable:
  - 1. Hubbell, Pass & Seymour, General Electric, Leviton, Lutron

## 2.2 LINE VOLTAGE FLUSH SWITCHES

- A. Furnish and install commercial specification grade line voltage flush toggle switches where indicated on the Drawings. Switches shall have oversized silver alloy contacts, brass terminal screws for # 10 or # 12 copper wire, molded phenolic or urea housing and

shall be UL listed. Switches shall be as follows or Engineer approved equivalent:

1. Load of 20 amps or less, single pole, 120/277 volts: Pass & Seymour # CS20AC1-GRY or as specified by the Architect. Contractor shall confirm selection with the Architect.
  2. Load of 20 amps or less, three way, 120/277 volts: Pass & Seymour # CS20AC3-GRY or as specified by the Architect. Contractor shall confirm selection with the Architect.
  3. Load of 20 amps or less, with pilot light, 120/277 volts: Pass & Seymour # PS20AC1-CPL or as specified by the Architect. Contractor shall confirm selection with the Architect.
  4. Load of 20 amps or less, located outside, 120/277 volts: Switch as noted above with Hubbell # HBL1795 cover plate or as specified by the Architect. Contractor shall confirm selection with the Architect.
- B. Where more than one switch occurs in the same location, they shall be set in gangs under one cover plate. Switches shall be installed in multiple gang boxes in a uniform position so that the same direction will open and close the circuits throughout the project.
- C. Switch color shall be gray unless otherwise indicated on the drawings or as specified by Architect. Contractor shall confirm selection with the Architect.

## 2.3 RECEPTACLES

- A. Furnish and install commercial specification grade plug-in receptacles of the type and location as indicated on the Drawings. Receptacles shall have large brass grounding contacts, triple wipe bronze hot and neutral contacts, back wiring screws capable of accepting #10 and #12 copper wire, high impact lexan or urea body and shall be UL listed. Receptacles shall be as follows or Engineer approved equivalent.
1. 15 amps, 120 volts, duplex: Pass & Seymour # CR15-GRY or as specified by the Architect. Contractor shall confirm selection with the Architect.
  2. 15 amps, 120 volts, single: Pass & Seymour # 5261-GRY or as specified by the Architect. Contractor shall confirm selection with the Architect.
  3. 20 amps or less, with isolated ground, 120 volts, duplex: Pass & Seymour # IG 5362-GRY or as specified by the Architect. Contractor shall confirm selection with the Architect.
  4. 20 amps, 120 volts, duplex: Pass & Seymour # CR20-GRY or as specified by the Architect. Contractor shall confirm selection with the Architect.
  5. 20 amps, 120 volts, duplex, weatherproof: Pass & Seymour # WR5362-GRY with weatherproof "While in Use" cover plate or as specified by the Architect. Contractor shall confirm selection with the Architect.

6. 20 amps, 120 volts, duplex with GFCI: Pass & Seymour # 2095-GRY or as specified by the Architect. Contractor shall confirm selection with the Architect.
  7. 20 amps, 120 volts, duplex with SPD: Pass & Seymour # CRB5362 or as specified by the Architect. Contractor shall confirm selection with the Architect.
  8. Special outlet NEMA numbers shall be as noted on the Drawings.
- B. Where more than one receptacle occurs in the same location, they shall be set in gangs under one cover plate installed in multiple gang boxes in a uniform position.
- C. Receptacle color shall be gray unless otherwise indicated on the drawings or as specified by Architect. Contractor shall confirm selection with the Architect.

## 2.4 COVER PLATES

- A. Cover plates shall be as follows for both receptacles and switches:
1. Plates shall be Type 302 brushed stainless steel unless otherwise indicated on the drawings or as directed by Architect to match device it covers. Contractor shall confirm selection with the Architect.
  2. Provide multiple gang cover plate whenever more than one device is indicated together on a wall.
  3. Plates for exposed or surface mounted boxes shall be of the galvanized type for interior use and cast metal type with gaskets for moist locations and exterior use.
  4. Telephone cover plates shall be supplied and installed by telephone installer.
  5. Back of house receptacle outlets connected with emergency power shall have red nylon cover plates.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Both switch and receptacle screw terminals shall be wrapped with at least one wrap of electrical tape before device is installed in outlet box. Vacuum clean all switch and receptacle outlets prior to and after installation.
- B. The highest operable part of electrical and communication outlets shall be placed within the reach ranges as required in The Americans with Disabilities Act (ADA). These requirements do not apply where the use of special equipment dictates otherwise or where electrical and communication outlets are not normally intended for use by building occupants.
- C. Receptacles and switches shall be grounded through the use of grounding screws. Grounding through the use of self grounding receptacles and switches is not acceptable.

- D. Provide weatherproof devices (junction boxes and cover plates) within elevator hoistways and pits. This shall include but not be limited to light switches, lights, and outlets.

### 3.2 SWITCH MOUNTING

- A. Switches shall be mounted vertically. Notify Architect of discrepancies before roughing-in outlet and obtain a new location as necessary. Mounting height shall be in accordance with Section 26 05 33 unless otherwise noted on the contract documents.

### 3.3 RECEPTACLE MOUNTING

- A. Receptacles shall be mounted vertically, unless noted otherwise, and properly grounded per the N.E.C. Notify the Owner's Representative of any discrepancies before roughing-in outlet and obtain a new location as necessary. Mounting height shall be in accordance with Section 26 05 33 unless otherwise noted on the contract documents. Receptacles shall be wired using screw terminals. Quick connect or spring loaded terminals shall not be acceptable.
- B. Receptacles shall be mounted with the grounding pole on top.

END OF SECTION 26 27 26

## SECTION 26 28 00 – LOW-VOLTAGE CIRCUIT PROTECTIVE DEVICES

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Provide manufacturer's standard, UL listed, molded-case circuit breakers as shown on the drawings and as specified herein.
- B. Provide UL listed fuses as shown on the drawings and as specified herein.
- C. Provide main switchboard overcurrent protective devices.
- D. Provide motor control center branch circuit protective devices.
- E. Provide disconnect switches as shown on the drawings and as specified herein.

## 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- C. Section 26 05 53 - Identification for Electrical Systems
- D. Section 26 05 93 - Testing
- E. Section 26 24 16 - Panelboards

## 1.4 REFERENCED STANDARDS

- A. All protective devices shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. NFPA 70 - "National Electrical Code" (NEC)
  - 2. UL 489 - "Molded-Case Circuit Breakers and Circuit Breaker Enclosures"
  - 3. UL 977 - "Fused Power Circuit Devices"
  - 4. UL 198D - "High Interrupting-Capacity Class K Fuses"
  - 5. ANSI C97.1 - Low-Voltage Cartridge Fuses.
  - 6. NEMA AB-1 - "Molded-Case Circuit Breakers"

7. UL 943 – GFCI
8. NFPA 70E
9. UL 98 Enclosed Switches
10. NEMA Enclosed Switch Standard KS1

## 1.5 SUBMITTALS

- A. Submit manufacturers' literature, illustrations, engineering data, and specifications for each type and size of device specific to this project. Include a listing of all fuse locations cross referenced with fuse characteristics (type, size, manufacturer, etc.).
- B. Submit manufacturer's literature, illustrations, engineering data and specifications for each type and size of disconnect switch specific to this project. A comprehensive list of equipment with each piece of equipment identified by contract document designation shall be submitted with cross reference to type of disconnect switch being supplied for it. Include enclosure NEMA type, fused, non-fused, rejection fuse clips, number of poles, amperage, etc.

## PART 2 - PRODUCTS

### 2.1 MOLDED-CASE CIRCUIT BREAKERS IN PANELBOARDS

- A. The breakers shall be operated by a toggle-type handle and shall have a quick-make, quick-break, over-center switching mechanism that is mechanically trip-free from the handle so that the contacts cannot be held closed against short circuits and abnormal currents. Tripping due to overload or short circuit shall be clearly indicated by the handle automatically assuming a position midway between the manual ON and OFF positions. All latch surfaces shall be ground and polished. Poles shall be so constructed that they can open, close and trip simultaneously.
- B. Breakers shall be completely enclosed in a molded case with the ampere ratings clearly visible. Contacts shall be non-welding silver alloy. Breakers shall be UL listed for use with 60°, 75°, and 90°C insulated wire.
- C. Circuit breaker ratings, modifications, etc., shall be as indicated on the drawings. Molded-case circuit breakers shall be as follows:
  1. Thermal magnetic type that provides inverse time-delay overload and instantaneous short circuit protection by means of a thermal magnetic element.
  2. Ambient compensated standard that provides inverse time-delay overload and instantaneous short circuit protection by means of a thermal magnetic element. Compensation shall allow the breaker to carry rated current between 25°C and 50°C with tripping characteristics that are approximately the same throughout this temperature range.
  3. Multi-pole breakers shall be of the common trip type having a single operating handle. Multi-pole 240-volt breakers smaller than fifty amperes may consist of

factory connected single pole breakers with a common trip handle.

4. All circuit breakers shall be full size and bolt-on.
  5. The minimum interrupting rating of 120/208 volt breakers shall be 10,000 amperes RMS symmetrical. The minimum interrupting rating of 277/480 volt breakers shall be 14,000 amperes RMS symmetrical. Refer to manufacturer's short circuit and fault current coordination study for exact interrupting rating.
- D. Single, two, or three pole molded case circuit breakers indicated for shunt trip shall be UL listed, 60 HZ, factory installed, and have a 120 volt AC coil in addition to the requirements indicated hereinbefore. Trip-coil shall de-energize when breaker opens. Shunt trip breakers shall take an extra pole position within panelboards and may be either left or right mounted. Contractor shall provide the 120 volt circuit to power the shunt trip circuit. The shunt trip circuit activation device shall be a momentary close contact type. Contractor shall coordinate all accessories required for a complete and functional shunt trip circuit.
- E. Single pole, 120 volt and 277 volt rated branch circuit breakers intended to switch fluorescent and high intensity discharge lighting loads shall be UL listed and marked for appropriate "SWD" or "HID" duty as required by adopted codes.

## 2.2 MAIN SERVICE OVERCURRENT PROTECTIVE DEVICES

- A. Main and Feeder Overcurrent Devices
1. Devices larger than 1200 amps shall be Siemens Type WL power insulated case circuit breaker or equivalent with electronic, micro processor based trip unit. Trip functions shall include adjustments for long time pickup and delay, short time pickup and delay, instantaneous, ground fault pickup and delay, zone selective interlocking for short time and ground fault on mains, and shall have an integral test function to test the trip unit electronics. Fault indication shall be provided on the trip unit for overload, short time, short circuit and ground fault trip conditions. Devices shall be UL listed in accordance with applicable Underwriters' Laboratories, Inc. standards and shall bear the listing mark.
  2. All circuit breakers must carry a UL 489 listing, be rated for 100% continuous duty, approved for reverse connection and shall be stationary mounted, suitable for manual operation. Each insulated case circuit breaker must carry an individual serial number with factory maintained production and test records.
  3. The breaker operating mechanism shall be a true two-step stored energy mechanism that shall provide a five-cycle maximum closing time. Separate indicators shall be provided to show charged/discharged status of the mechanism and open/closed status of the breaker's contacts. The breaker mechanism shall enable to be discharged without closing the main contacts. The manual charging handle shall be interlocked with the manual close button to prevent simultaneous operation.

4. Circuit protective devices equal to or greater than 1,000A and operating at 150 volts to ground or higher shall be provided with ground fault protection using a ground fault relay and current transformers as required for tripping under any ground fault condition. The ground fault shall be integral to the trip unit and configured to sense residual. Solid state relays shall be adjustable from 100 to 1,200 amperes and from instantaneous to one second time delay by means of lockable, direct indicating knobs on the front of the relay. Monitor panel shall be mounted on the front panel with a light to indicate when a ground fault function has occurred. It shall also contain a reset pushbutton, a push to test pushbutton and a control power "on" pilot light. Ground fault setting shall be set at minimum setting for both current and time during construction. The switchboard manufacturer shall include in the Shop Drawing data for the switchboard, the minimum setting of the devices and the recommended setting for normal building operation.
5. Feeder Devices 1,200A and less shall be molded case circuit breakers of quick-make, quick-break, trip-free solid state type with frame, trip and voltage ratings as indicated on the drawings. The switchboard shall have space or fully equipped provisions for future units as shown on the drawings.

## 2.3 FUSES

- A. Fuses shall be listed and meet UL and/or NEMA standards for Class K5, J, R, and L fuses.
- B. Fuses shall be dual-element, high interrupting capacity with current limiting effect, 200,000 ampere RMS symmetrical at rated voltage where possible to coordinate with the series rating of the electrical equipment. Single element devices will only be used where series rating conflicts arise due to UL tested combinations. Bussmann LPS-RK1 and Littelfuse LLS-RK1 are preferred where proper coordination is possible.
- C. Unless otherwise indicated on drawings, Class R or J time-delay fuses shall be used for individual 480 volt motor circuit protection, for motor control centers and motor starter panels protection. Switches shall be provided with proper mounting clips.
- D. Fuse voltage rating shall be 250 volt for 120/208 volt system and 480 or 600 volts for 277/480 volt system.
- E. Provide one complete set of fuses for all switches requiring fuses, including switchboards, distribution panels, bus risers, etc. Provide one set of three fuses for each type of fuse installed on the job to be stored in the original boxes in a cabinet in the main electrical room. Cabinet shall be furnished and installed by Contractor. Contractor shall replenish any stored fuses used during construction. One complete spare set of fuses with respective pullers shall be provided to the Owner at completion of project.
- F. If it complies with these Specifications, fuses shall be acceptable as manufactured by Bussmann, Mersen/Ferraz Shawmut, or Littelfuse. Refer to specifications for specific manufacturers for certain applications.

## 2.6 DISCONNECT SWITCHES



- A. If it complies with these Specifications, disconnect switches manufactured by one of the following manufacturers will be acceptable:
  - 1. Siemens, General Electric, Eaton Cutler-Hammer, Square D.
- B. Disconnect switches indicated and/or specified for 480 volt circuits shall be 600-volt horsepower-rated, direct drive, quick-make, quick-break type switches with spring-reinforced wire grips and self-aligning switch contacts. Switches shall be enclosed in a heavy sheet metal enclosure with hinged interlocking cover which shall prevent the cover from being opened when switch is "on". Provide rejection-type fuse clips for cartridge fuses in switches as indicated and accommodation for R fuses. Switches shall be NEMA type HD. Switches exposed to the weather within parking garages or within loading docks shall have NEMA Type 3R watertight enclosure and NEMA 4X grounded stainless steel enclosure for locations exposed to weather which are on the exterior of the building, on the roof, or within architectural exhaust and intake plenums unless noted otherwise on the Drawings.
- C. Fused disconnect switches shall be substituted for non-fused switches where required by manufacturer or local inspecting authority and/or fuse protection is indicated on motor nameplate. Refer to fuse requirements specified herein for additional requirements. Contractor shall provide fuses meeting equipment nameplate requirements.
- D. Disconnect switches for 208-volt circuits shall be similar except that 250-volt NEMA type HD with rejection type fuse clips for R fuses shall be acceptable.
- E. All switches shall have provision for padlocking.
- F. Provide extra large legible on/off label.
- G. For all disconnect switches located downstream from variable frequency controllers (VFC), reference section 23 05 14, provide auxiliary contacts and control wiring that will de-energize VFC prior to disconnection of power to equipment served by VFC. Coordinate requirements with VFC manufacturer.

## PART 3 - EXECUTION

### 3.1 GENERAL

- A. Install circuit breakers securely in panels as indicated on the contract drawings. Breakers with adjustable magnetic trip shall be set at the highest set-point per the manufacturer's recommendation in coordination with the fault current coordination study except where indicated otherwise on the drawings.
- B. Circuit breakers requiring current limiters shall be provided complete with removable current limiters.
- C. Provide fuses in all required devices requiring fuses as required by the drawings, local inspecting authorities, and the National Electrical Code.

- D. Mount all switches 60A and larger on 12 gauge formed steel channels having a cross section dimension of at least 1-1/2 inches x 1-1/2 inches. The channel and fittings shall have galvrom or hot-dipped galvanized finish to resist rust formation. Install channels vertically. Channels shall be Kindorf or equal.
- E. Vacuum clean all dirt and debris from the inside and outside of disconnect switches.
- F. All circuit protective devices shall be readily accessible and shall be installed so that the center of the grip of the operating handle of the switch or circuit breaker, when in its highest position, is not more than six foot seven inches above the floor except as otherwise permitted by NFPA 70.

### 3.2 TESTING

- A. The service entrance protective devices shall be factory tested at the manufacturer's factory prior to shipment as specified herein.
  - 1. The manufacturer shall provide a ground fault protection system test for circuit testing and verification of the tripping of the ground fault relays at the factory location. The manufacturer shall pass predetermined values of current through the relay sensors and measure the relay tripping time for each phase and the neutral sensor (if one is required). The measured time-current relationships shall be compared to the trip-characteristic curves for each relay. If the relay trips outside the range of values indicated on the curve the relays shall be replaced or recalibrated. This test shall include a polarity verification of the interconnection of the ground sensor circuits.
  - 2. Additional auxiliary, pilot, control relays, electrically operated breakers, shunt-trip operated breakers, switches etc., shall have the proper voltages applied to their circuits and satisfactory operation demonstrated.
  - 3. Four (4) copies of all test results certified by the switchboard manufacturer shall be submitted by the Contractor to the Engineer for review. See Section 26 00 10 for requirements.
  - 4. Upon completion of the factory ground fault protection system tests the current and time adjustments on each relay will be set on their minimum values.
- B. After construction work is complete and prior to energizing of the switchboard, the ground fault protection system shall be field tested and set to the manufacturer's recommended setting for both current and time by one of the following companies: Siemens, General Electric, Square D or Cutler-Hammer.
  - 1. The test procedure shall be similar to that specified for the factory test. At a minimum, four values of current shall be primary injected with graphed results. The primary current injection shall confirm that the current transformers, associated wiring, polarity, and trip unit features are installed and operating correctly.
  - 2. The Contractor shall notify the Engineer in writing at least two weeks prior to the day of the field test. The Engineer may witness the field test if he so desires.

3. Four (4) copies of all field test results certified by the testing company listed hereinbefore shall be submitted by the Contractor to the Engineer for review. See Section 26 00 10 for requirements. Test results shall include overcurrent device curve, primary injected current values, test results, and other items indicated in Section 26 05 93.

### 3.3 SHORT CIRCUIT AND PROTECTIVE DEVICE COORDINATION STUDY

- A. Contractor shall provide a certified short circuit and protective device coordination study to include all electrical equipment to ensure the UL listing of all new electrical equipment is maintained. This study and the results of this study shall be provided to the contractor and engineer prior to purchasing and installing any new electrical equipment on this project. All necessary modifications to the new electrical equipment in order to maintain the UL listing of the equipment as a result of this study shall be provided by the contractor and the costs associated with these modifications shall be included in the contractors bid. This study shall include all recommendations regarding calibration, application, duty, setting, and coordination of protective devices. This study shall also include verifying and adjusting all new breaker settings, readjusting breaker settings as required, and any additional relays, controls, wires, conduit, termination blocks, transformers, relay replacements, etc., required for proper coordination. The contractor shall submit tables, charts, time current curves, etc. for the equipment and modifications to the distribution system. Specific attention is brought to automatic transfer switches being UL listed with specific manufacturer's coordinated upstream circuit breakers. Contractor shall confirm selective coordination of Emergency Systems, Legally Required Standby Systems, and Critical Operations Power Systems as defined by NEC Articles 700, 701, and 708 is achieved. Unless otherwise directed by the local Authority Having Jurisdiction, these systems shall be selectively coordinated to 0.1 second.

### 3.4 ARC FLASH STUDY

- A. In addition to the short circuit and coordination study, provide an arc flash study for all the electrical equipment. Study shall include but not be limited to the requirements of OSHA, NFPA 70, NFPA 70E, and IEEE 1584. Where multiple power sources exist, the system distribution that delivers the highest level of arch flash incident energy shall be used. Include motor contributions within the calculations. Arc flash submittal calculations shall include but not be limited to identification, location, voltage, arcing fault magnitude, clearing time, duration, boundary, working distance, incident energy, and hazard risk category. Provide arc flash warning labels for the electrical equipment. Labels shall be roughly 3.5" by 5" thermal transfer type labels of high adhesion polyester with machine printed information. Label information shall include but not be limited to location, voltage, flash boundary, hazard risk category, incident energy, and working distance. The label shall be located so as to be clearly visible to qualified persons before examination, adjustment, servicing, or maintenance of the equipment.

### 3.5 EQUIPMENT NAMEPLATE DATA

- A. Contractor shall provide overcurrent protection for equipment that does not exceed respective nameplate maximum overcurrent protection (MOP). Contractor shall provide branch circuit wiring and conduit for equipment that will be sufficient to meet the respective nameplate minimum circuit ampacity (MCA).

END OF SECTION 26 28 00

## SECTION 26 50 00 - LIGHTING

## PART 1 - GENERAL

## 1.1 GENERAL REQUIREMENTS

- A. The work required under this Section shall conform to the requirements of "Division 01, General Requirements," "Conditions of the Contract" and "Supplementary Conditions." Specific attention is called to the "Division 26 General Requirements" located in Section 26 00 10.

## 1.2 WORK INCLUDED IN THIS SECTION

- A. Provide the lighting and accessories as shown on the contract documents and as specified herein. The specifications in this section shall apply to the light fixtures specified by the engineer and the fixtures specified by the lighting consultant. Refer to the drawings for additional information.

## 1.3 WORK INCLUDED IN OTHER SECTIONS

- A. Section 26 05 19 - Low-Voltage Electrical Power Conductors and Cables
- B. Section 26 05 33 - Raceway and Boxes for Electrical Systems
- C. Section 26 05 93 - Testing

## 1.4 REFERENCE STANDARDS

- A. Lighting fixtures shall be designed, manufactured, tested and installed in compliance with the following standards:
  - 1. NFPA 70 National Electrical Code
  - 2. Underwriters' Laboratories (UL)
  - 3. Illuminating Engineering Society (IES)
  - 4. ANSI C62 and C82
  - 5. FCC Part 18, Subpart C
  - 6. ASHRAE/IESNA 90.1
  - 7. FDA Food Code
  - 8. International Energy Conservation Code (IECC)
  - 9. NEMA SSL-1

## 1.5 SUBMITTALS

- A. Submit manufacturers' literature, illustrations, voltage, ballast specifications, and lamp characteristics for each light fixture type specific to this project.
- B. Substitute fixtures shall be submitted with current photometric certified test data from an independent testing laboratory of the substitute fixture and the specified fixture.
- C. For exterior surface parking lighting and parking garage lighting, manufacturer shall submit point to point foot candle calculations, based on maintained factor. All calculations shall conform to IES recommended values and design criteria.

## PART 2 - PRODUCTS

### 2.1 FIXTURES AND LAMPS

- A. Fixtures shall be provided as specified herein and as indicated on the drawings. Fixtures shall be complete with all required lamps, sockets, wiring, glassware, reflectors, hangers, fittings, plaster frames, etc., necessary for a complete installation.
  - 1. All high intensity discharge (HID) fixtures shall have 4KV-pulse-rated, mogul base sockets. Core and coil ballasts shall be designed with class H (180 degrees C) or higher insulation system and vacuum impregnated with a 100% solid based resin. Starter combinations shall be designed to provide reliable lamp starting down to -30 degrees C minimum for metal halide, high pressure sodium, and mercury at minimum rated line voltage.
  - 2. All fixtures shall be cleaned and have all lamps at the time of final acceptance of the building. All burned-out lamps shall be replaced at the time of final acceptance of building.
  - 3. All fixtures specified herein scheduled and/or detailed on the drawings, shall conform to the standards and bear the label of the Underwriters Laboratories, Inc.
  - 4. Prior to the application of any finish, all metal parts of all fixtures shall be protected by a rust inhibiting process approved by the Architect. The rust-inhibiting process shall be chemical. No type of sprayed, painted, or dipped primer may be used as the basic rust inhibitor. Any fixtures and/or parts of any fixtures which shall have begun to show signs of rusting or corroding at the time of completion of the job shall be removed and replaced by properly protected metal parts, subject to the approval of the Architect, and this shall be done before a final certificate of acceptance will be issued.
  - 5. Where required, fixtures shall be furnished complete with internal wiring and ballasts. All joints and splices within the fixture housing shall be made as specified in Section 26 05 19. Substitute material will not be acceptable.
  - 6. All fixtures provided for this project shall be designed and rated by the fixture manufacturer for the intended application and for the location installed. All fixtures provided for this project shall be UL listed for the intended application

and for the location installed. All fixtures exposed to outdoor weather conditions shall be suitable for outdoor weather conditions. All fixtures exposed to outside ambient temperatures shall be designed and rated for operation throughout the entire range of temperatures between the minimum and maximum outside ambient temperatures for this project. All fixtures exposed to damp locations, including but not limited to parking structure areas, shall be of damp rated construction. All fixtures shall be in accordance with the requirements of the Local Code Authority and the National Electrical Code. The requirements of this paragraph shall be in addition to all the other requirements of this specification. The requirements of the specification shall be in addition to the requirements indicated in the lighting fixture schedule. All fixtures shall meet these requirements whether specifically indicated in the lighting fixture schedule or not. It shall be the responsibility of the fixture manufacturer to provide all necessary accessories and modifications to the fixtures specified to meet these requirements. Catalog numbers of fixtures in the fixture schedule are intended to establish manufacturer, type, quality, aesthetic appearance, and lighting characteristics of the fixtures and do not necessarily indicate all the requirements of the specifications.

- B. Provide the proper fixture type for the type of ceiling or wall construction in which the fixture is to be installed. Regardless of fixture numbers given in the fixture schedule, the fixtures supplied shall have the proper trim, frames, mounting devices and configuration and accessories necessary to be properly installed in the building construction. Catalog numbers of fixtures in the fixture schedule are to establish a type of fixture and not to determine a method of mounting.
- C. The ballasts for all fluorescent and high intensity discharge fixtures shall be Class "P" energy-saving CBM approved, thermally protected. If it complies with these Specifications, ballasts manufactured by one of the following manufacturers will be acceptable: General Electric, Advance, Universal, Osram/Motorola, Thomas, or EBT.
  - 1. Fluorescent ballasts shall be high-frequency (above 20 kHz) electronic, energy-saving, high-power factor (95% minimum), "A" sound-rated, programmed start, universal voltage, and Type "P" automatic-reset type. Ballasts shall generate less than 15% total harmonic distortion with a lamp current crest factor less than 1.7 and a ballast factor of .87 or greater. Ballasts shall operate as a parallel circuit, sustain variations of +/- 10% of voltage and frequency with no damage to the ballasts, tolerate operation in ambient temperatures up to 105 degrees F without damage, and operate with no visible flicker (less than 3% flicker index). Compact fluorescent ballasts shall be similar to above with lamp shutdown circuitry for end of lamp life protection, plenum rated, and instant on.
  - 2. Ballasts shall be compatible for lamp type specified and shall be provided in quantity per fixture to perform the switching requirements indicated on the drawings.
  - 3. All ballasts located in fixtures exposed to freezing temperatures shall be rated for zero-degree operation. This shall include but not be limited to parking garages,

- truck docks, site lighting and roof mounted fixtures.
4. All lighting ballasts shall have a two year manufacturer's warranty for all parts and labor.
  5. Where dimming is specified, dimming ballasts shall meet the above ballast requirements in addition to proper dimming characteristics for the specific lamp and fixture type.
  6. Power input to a 277-volt fluorescent ballast for two 32-watt F32T8 lamps shall not exceed 58 watts when tested per ANSI C82.2.
  7. Ballasts for 3-tube fluorescent fixtures shall power three 32-watt F32T8 lamps. Power input shall not exceed 86 watts when tested per ANSI C82.2.
  8. Ballasts for fixtures located in remote or difficult to access locations shall have separate ballasts remotely mounted from fixture. Remote ballasts shall be mounted in fully accessible locations. Light fixtures mounted outside on the skin of the building shall have remote ballasts mounted nearby in accessible ceiling plenum area or other accessible area. All ballasts located within environmental air plenums shall be rated for such a location.
- D. All fluorescent lamps shall be energy-saving 32-watt F32T8 3500K unless indicated otherwise in the lighting fixture schedule. Fluorescent type (tube and compact) lamp color rendering index (CRI) shall be a minimum of 82 unless otherwise noted by the Lighting Consultant.
- E. All HID lamps shall be mogul-base with coated glass envelopes, except where noted otherwise on the contract drawings. For HID light fixtures, which are indicated as life safety lights, provide emergency quartz lamp with relay type system to turn on and off when there is a power interruption.
- F. New and existing indoor (non-dwelling unit) fluorescent light fixtures utilizing double ended lamps and ballasts within the area of work shall include required NEC ballast disconnect internal to fixture and be accessible to qualified persons. Disconnect shall be UL Listed with two mating finger safe halves disconnecting simultaneously all ballast supply conductors including the ground.
9. Light fixtures with emergency ballasts shall not include a disconnecting means.
- G. Provide LED lighting fixtures as indicated. Provide LED lighting fixtures complete with lamps of number, type, and wattage indicated. Details, shapes, and dimensions are indicative of the general type desired, but are not intended to restrict selection to LED lighting fixtures of a particular manufacturer. LED lighting fixtures of similar designs and of equal finish and quality will be acceptable as approved.
1. Lamp maximum wattage shall be as indicated on the Drawings. LED arrays shall have an average rated life of 50,000 hours (minimum) as confirmed by standard industry testing life span data which complies with IESNA LM-80.



LED arrays shall have a color temperature of 3500K and a minimum color rendering index (CRI) of 80.

- a. Confirm color temperature with the Architect, Interior Designer, or Lighting Consultant. Where a discrepancy exists for color temperature, the engineering specifications shall take the least precedence.
2. Drivers for LED lighting fixtures shall be high efficiency, full range dimming from 0-10V control signal (or as otherwise specified), voltage as indicated. Drivers shall be individually addressable and shall include a lumen management system to ensure constant light output over the life of the fixture.

## 2.2 LIGHTING CONTROLS

### A. Dimmers and Dimming Systems

1. Refer to the electrical drawings for dimming system requirements.
2. Refer to specification Section 26 27 26 and the electrical drawings for wall box dimmer requirements.

### B. Lighting Contactors

1. Lighting contactors shall be similar or equal to ASCO #917 Series, NEMA 1 enclosure.
2. Refer to specification Section 25 00 90 for additional requirements.

## PART 3 - EXECUTION

### 3.1 INSTALLATION

- A. Recessed lay-in type lighting fixtures shall be installed in the lay-in type ceiling in such a manner that the lens or louver housing may be easily opened and so that the fixtures may be removed and relocated without forcing the fixtures or changing the grid system tie wires. The electrical subcontractor shall coordinate with the ceiling subcontractor before the ceiling grid is installed to assure a mutually satisfactory installation of ceiling and light fixtures, which will permit the fixtures to be relocated at a future date.
- B. with manufacturer's recommendations and the Local Code Authority seismic requirements and wind loading.

### 3.2 CLEANING

- A. All fixtures shall be cleaned of dirt and debris inside and outside and left in a clean condition at the end of the construction work.

### 3.3 COORDINATION

- A. The Contractors shall coordinate the control of all light fixtures with the lighting controls indicated in the Automatic Temperature Control System specification section.

### 3.4 LIGHT POLES

- A. Light poles shall have a hand hole near the bottom of the pole with a secure grommated cover for access. A ground lug shall be provided with access from hand hole. Provide concrete bases for specific light fixtures located on the top level of the parking structure as indicated on the drawings per the manufacturer's recommendations. Concrete bases shall meet the respective region's wind loading and seismic requirements. Refer to the structural engineer's documents for additional requirements.
- B. Unless otherwise indicated, all pole mounted light fixtures shall be full cut-off type light fixtures.

### 3.5 UNDERGROUND AND GRADE MOUNTED LIGHT FIXTURES

- A. For exterior mounted light fixtures, provide watertight fittings, seals, connectors, junction boxes, terminations, concrete collars, etc for a complete and operational system. Provide all accessories required per manufacturer's recommendations for each light fixture installation/system. Provide appropriate backfill material for proper water drainage away from the light fixtures; refer to the contract drawings and manufacturer's recommendations for additional requirements and details.

END OF SECTION 26 50 00

## 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. Temporary erosion and sedimentation control.

## 1.2 PREINSTALLATION MEETINGS

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

## 1.3 MATERIAL OWNERSHIP

- A. Except for 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.

## 1.4 FIELD CONDITIONS

- A. Traffic: Minimize interference with adjoining roads, streets, walks, and other adjacent occupied or used facilities during site-clearing operations.
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 trafficways if required by Owner or authorities having jurisdiction.
- B. Salvageable Improvements: Carefully remove items indicated to be salvaged and store on Owner's premises where indicated.
- C. Utility Locator Service: Notify utility locator service for area where Project is located before site clearing.
- D. Do not commence site clearing operations until temporary erosion and sedimentation control measures are in place.

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PART 2 - PRODUCTS

## 2.1 MATERIALS

- A. Satisfactory Soil Material: Requirements for satisfactory soil material are specified in Section 31 20 00 "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. Verify that trees, shrubs, and other vegetation to remain or to be relocated have been flagged and that protection zones have been identified and enclosed."
- 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 TREE AND PLANT PROTECTION

- A. Protect trees and plants indicated to remaining on-site on the Drawings.
- B. Repair or replace trees, shrubs, and other vegetation indicated to remain or be relocated that are damaged by construction operations.

## 3.3 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 Engineer not less than two days in advance of proposed utility interruptions.
  - 2. Do not proceed with utility interruptions without Engineer's written permission.

### 3.4 CLEARING AND GRUBBING

- A. Remove obstructions, trees, shrubs, and other vegetation to permit installation of new construction.
  - 1. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.
  - 2. Use only hand methods or air spade 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, and compact each layer to a density equal to adjacent original ground.

### 3.5 TOPSOIL STRIPPING

- A. Remove sod and grass before stripping topsoil.
- B. Strip topsoil to depth of 6 inches 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 or other materials. Grade and shape stockpiles to drain surface water. Cover to prevent windblown dust and erosion by water.

### 3.6 SITE IMPROVEMENTS

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

### 3.7 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 nonrecyclable 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 31 10 00

## SECTION 31 10 20 – EROSION AND SEDIMENT CONTROL

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Requirements for temporary erosion and sedimentation control.

## 1.2 PREINSTALLATION MEETINGS

- A. Preinstallation Conference: Conduct conference at Project site. The Contractor shall present a general overview of erosion and sediment control measures will be implemented of the project.

## 1.3 CONTRACTOR PERSONNEL

- A. The Contractor shall assign a Certified Employee to the project site in the capacity of the Responsible land Disturber (RLD).

## 1.4 STANDARDS AND SPECIFICATIONS

- A. Temporary erosion and sediment control measures shall be constructed in conformance with the latest Virginia Erosion and Sediment Control Handbook (VESCH), published by the Virginia Department of Conservation and the Fairfax County Public Facilities Manual (PFM).
- B. The installation and maintenance of temporary erosion and sediment control devices shall be in accordance with the Stormwater Pollution Prevention Plan (SWPPP) required by the Virginia Department of Environmental Quality, which shall be prepared and submitted by the Contractor.

## 1.5 CONSTRUCTION OPERATION

- A. Storage of construction vehicles, trucks, and equipment is limited to the fenced construction staging area as shown on the Contract Drawings. Parking areas shall not be used for construction staging.

## PART 2 - PRODUCTS

## 2.1 STABILIZATION MATERIALS

- A. Seed, mulch, fertilizer, soil conditioner and other materials for seeding and soil stabilization shall meet the requirements of the VESCH, latest edition.

## 2.2 GEOTEXTILE (FILTER CLOTH)

- A. Geotextiles shall conform to the standards and specifications of the Contract Drawings and shall meet the requirements of the VESCH, latest edition.

## 2.3 STONE

- A. Stone 2 to 3 inches in size shall conform to AASHTO M43, No. 2.
- B. Stone 3/4 –inch to 12-inch shall conform to AASHTO M43, No.4.
- C. VDOT No. 1 Coarse Aggregate, Section 203.
- D. VDO No. 57 Coarse Aggregate, Section 203.

## 2.4 SILT FENCE

- A. Silt fence shall be installed in the locations reflected on the Contract Drawings.
- B. VESCH Standard 3.05.

# PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Protect and maintain benchmarks and survey control points from disturbance during construction.
- B. Install the Phase 1 Erosion and Sediment Controls as shown on the Contract Drawings. All measures shall be inspected and approved by the Engineer and the local jurisdiction prior to beginning any land disturbance. The Contractor shall ensure all runoff from the disturbed area is directed to the erosion and sediment control measures.
- C. Verify that flows of water redirected from construction areas or generated by construction activity do not enter or cross protection zones.
- D. Inspect, maintain, and repair erosion- and sedimentation-control measures during construction until permanent vegetation has been established.
- E. The Contractor shall not remove any erosion and sediment control measure without the approval of the Engineer and the local jurisdiction.

## 3.2 TEMPORARY EROSION AND SEDIMENTATION CONTROL SEQUENCE OF CONSTRUCTION

- A. The Contractor shall implement the Erosion and Sediment Control Plan (E&S Plan) and sequence of construction as approved by the local jurisdiction. Minor adjustments to the

sediment control measures may be made in the field with the prior approval of the Engineer and the local jurisdiction.

- B. Major revisions, deletions, or substitutions to the E&S Plan will require a formal review and approval by the Engineer and the local jurisdiction prior to implementing the change. Changes to the approved E&S Plan shall be submitted to the Engineer in writing at least five (5) days prior to implementing the change.
- C. The Contractor shall apply for and obtain the Virginia Pollutant Discharge Elimination System (VPDES) Construction Permit.

### 3.3 RESPONSIBLE LAND DISTURBER

- A. At least 10 days prior to applying to the permit, the name and credentials of the Responsible Land Disturber (RLD) shall be submitted to the Engineer for approval. Any substitutes for the RLD will be subject to the approval of the Engineer. The substitution shall be timed to ensure that a RLD is assigned to the project at all times. VRE reserves the right to request a reassignment of the RLD duties for another individual for any reason.
- B. The RLD shall be thoroughly experienced in all aspects of construction and have satisfactorily completed the Erosion and Sediment Control Training Program either conducted or authorized by the Commonwealth of Virginia pursuant to the appropriate legislation. The RLD shall have the primary responsibility and authority for the implementation of the approved erosion and sediment control plans, schedules and methods of operation for both onsite and offsite activities.
- C. The RLD's duties shall include":
  - 1. Inspect all erosion and sediment controls on a daily basis to ensure that all controls are in place at all times and to develop a list of activities and schedules to ensure conformance with the Contract Documents.
  - 2. Maintain a daily log of these inspections, including actions taken and submit a written report to the Engineer at the end of the week.
  - 3. Conduct after storm inspections with the Engineer both during and beyond normal working hours/days and submit a written report.
  - 4. Be assigned the authority by the Contractor to mobilize crews to make immediate repairs to the controls during working and nonworking hours.
  - 5. When requested, accompany the Engineer on Quality Assurance Inspections and inspections made by the regulating agencies.
  - 6. Coordinate with the Engineer to ensure all the corrections are made immediately and that the project is in compliance with the approved plans.



### 3.4 SCHEDULE

- A. Within the 14 days after the Notice of Award, the Contractor shall submit to the Engineer an Erosion and Sediment Control Schedule to implement the E&S Plan. The schedule shall indicate the sequence of construction, implementation and maintenance of controls, temporary and permanent stabilization, and various stages of soil disturbance. After the schedule is approved by the local jurisdiction, it will be forwarded to the Engineer for his concurrence.
- B. The schedule shall include:
  - 1. Clearing and grubbing of areas necessary for installation of perimeter controls specified in the Contract Documents.
  - 2. Construction of perimeter controls specified in the Contract Documents.
  - 3. Excavation and backfilling.
- C. No work shall be started, onsite or offsite until the Erosion and Sediment Control schedule and methods of operation have been accepted by the local jurisdiction.

### 3.5 MEETINGS

- A. At least seven working days prior to the start of work, the Contractor shall initiate and conduct an Erosion and Sediment Control Field Meeting. The meeting shall be attended by the RLD, and representatives of the local jurisdictions and VRE. Grind down stumps and remove roots larger than 3 inches in diameter, obstructions, and debris to a depth of 18 inches below exposed subgrade.

### 3.6 INITIAL CONTROLS

- A. All perimeter controls such as silt fence, earth dikes/swales, check dams, traps, basins, etc., shall be installed prior to the clearing and grubbing operation. Remove sod and grass before stripping topsoil.
- B. If the Engineer determines that the clearing area has been disturbed and a potential for sediment runoff or erosion exists, the Engineer will direct the Contractor to install the controls at that time.

### 3.7 STABILIZATION REQUIREMENTS

- A. Areas flatter than 3:1 and stockpile areas shall be permanently or temporarily stabilized as soon as possible, but not later than fourteen days after grubbing and grading activities have ceased in the area. Trap embankments and slopes, earth dikes, temporary swales, perimeter dike/swales, ditches, and slopes 3:1 or steeper shall be permanently or temporarily stabilized as soon as possible, but not later than seven days after grubbing and grading activities have ceased in the area. Slope 2:1 and steeper shall be stabilized with slope stabilization MAT. The seven and fourteen day requirements mean that the stabilization operation is complete within the applicable seven or fourteen day time frame.

- B. When permanently stabilized areas are disturbed by the Contractor's grading operation or other activities not specifically approved by the Engineer, the restabilization will be at no additional cost to VRE. Stabilization requirements may be reduced to less than seven days for sensitive areas and can be required at any point in time by the local jurisdiction. Maintenance shall be performed as necessary to ensure continued stabilization.
- C. All slopes shall be tracked within five days of establishment with cleated type equipment operating perpendicular to the slope.

### 3.8 MAINTENANCE

- A. All erosion and sediment control devices shall be maintained during the construction season, the winter months, and other times when the project is shut down. Access shall be maintained to all erosion and sediment controls until the controls are removed. Lack of maintenance by the Contractor will be considered as noncompliance with the E&S Plan.
- B. Controls shall be inspected immediately following storm events. The Contractor shall repair controls when damaged and clean out controls as necessary as the first order of business after a storm event.
- C. Any pumping activity, including dewatering sediment traps and basins, shall be directed through a dewatering device approved by the Engineer.
- D. The Contractor shall remove accumulated sediment from sediment controls or other areas during routine maintenance of sediment controls, or as directed by the Engineer. Silt fence, super silt fence, stone outlet structures, stone check dams, sediment control logs, and straw bales shall have sediment removed when it reaches 50 percent of the height of the control device.
- E. Sediment removed from control devices shall be placed in an approved waste site either on or off the project. Material stored on-site may be reused once it has dried and it conforms to project requirements for embankment.

### 3.9 WASTE AREAS

- A. Off-site waste areas on State or Federal property require state and local approvals. All waste areas and stockpile areas shall be protected by erosion and sediment control measures and stabilized within the seven or fourteen day stabilization requirement. All waste areas shall be on approved sites.

### 3.10 INSPECTIONS

- A. The local jurisdiction may conduct frequent field inspections relative to erosion and sediment control compliance. If they determine that noncompliance with erosion and sediment control provisions are found, their representative will immediately notify the Engineer relative to corrective action. This corrective action may require a shutdown of construction activities until the noncompliance is satisfactorily corrected, and no claims against the project will be considered due to a shutdown of the grading operations or the entire project.

## 3.11 REMOVAL OF CONTROLS

- A. No erosion and sediment control measures shall be removed until all previously disturbed areas are vegetated and the removal has been approved by the Engineer and local jurisdictions. The sediment controls shall be backfilled, graded, and stabilized as specified in the Contract Documents.
- B. All control devices shall be removed, except where an attempt to remove a particular control may severely disturb an area that has been stabilized. When a sediment trap or stone outlet structure is placed at the bottom of a fill greater than 8 feet, the controls may be left in place as determined by the Engineer. Sediment traps left in place shall be stabilized by placing erosion control matting over a permanent seed mix.

## 3.12 SILT FENCE

- A. The geotextile shall be trenched a minimum of 8 inches into the ground and extend a minimum of 22 inches above ground. Silt fence shall be removed and reset when and as directed by the Engineer. All of the requirements for the original placement of the silt fence shall be strictly adhered to when the fence is reset.

## 3.13 STABILIZED CONSTRUCTION ENTRANCE

- A. Stabilized construction entrances shall be located as specified in the Contract Documents or as directed by the Engineer. Rehabilitation of stabilized construction entrance shall consist of periodic top dressing with additional VDOT No. 1 aggregate, replacement of pipe, or other repairs to the entrance and sediment trapping devices as needed or as directed by the Engineer.

END OF SECTION 31 10 20

## SECTION 31 20 00 - EARTH MOVING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Excavating and filling for rough grading the Site.
2. Preparing subgrades for walks, turf and grasses.
3. Excavating and backfilling for platform structures.
4. Subbase course for concrete walks.

## 1.2 DEFINITIONS

## A. Backfill: Soil 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.

## B. Base Course: Aggregate layer placed between the subbase course and hot-mix asphalt paving.

## C. Bedding Course: Aggregate layer placed over the excavated subgrade in a trench before laying pipe.

## D. Borrow Soil: Satisfactory soil imported from off-site for use as fill or backfill.

## E. Drainage Course: Aggregate layer supporting the slab-on-grade that also minimizes upward capillary flow of pore water.

## F. Excavation: Removal of material encountered above subgrade elevations and to lines and dimensions indicated.

1. Authorized Additional Excavation: Excavation below subgrade elevations or beyond indicated lines and dimensions as directed by Architect. 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 Architect. Unauthorized excavation, as well as remedial work directed by Architect, shall be without additional compensation.

## G. Fill: Soil materials used to raise existing grades.

## H. 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.

- I. Subbase Course: Aggregate layer placed between the subgrade and base course for 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.
- J. 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.
- K. Utilities: On-site underground pipes, conduits, ducts, and cables as well as underground services within buildings.

### 1.3 PREINSTALLATION MEETINGS

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

### 1.4 INFORMATIONAL SUBMITTALS

- A. Material test reports.

### 1.5 FIELD CONDITIONS

- A. Utility Locator Service: Notify utility locator service for area where Project is located before beginning earth-moving operations.

## PART 2 - PRODUCTS

### 2.1 SOIL MATERIALS

- A. General: Provide borrow soil materials when sufficient satisfactory soil materials are not available from excavations.
- B. Satisfactory Soils: Soil Classification Groups CL, ML, SC, SM, SP, SW, GC, GM, GP, and GW according to ASTM D 2487, or a combination of these groups; free of rock or gravel larger than 3 inches in any dimension, debris, waste, frozen materials, vegetation, and other deleterious matter may be reused as engineered fill and shall meet the following requirements:
  - 1. Liquid Limit (LL) < 40.
  - 2. Plasticity Index (PI) < 25.
  - 3. Maximum Dry Density > 105
- C. Unsatisfactory Soils: Soil Classification Groups OL, CH, MH, OH, and PT according to ASTM D 2487, or a combination of these groups.
  - 1. Unsatisfactory soils also include satisfactory soils not maintained within 2 percent of optimum moisture content at time of compaction.
- D. Base Course: VDOT Standard 21A Stone

- E. Engineered Fill: Naturally or artificially graded mixture of natural or crushed gravel, crushed stone, and natural or crushed sand; ASTM D 2940/D 2940M; with at least 90 percent passing a 1-1/2-inch sieve and not more than 12 percent passing a No. 200 sieve.

## PART 3 - EXECUTION

### 3.1 PREPARATION

- A. Subgrades that support controlled structural fill or structures shall be prepared as noted in Section 1.2.3 of the American Railway Engineering MaintenanceProtect structures, utilities, sidewalks, pavements, and other facilities from damage caused by settlement, lateral movement, undermining, washout, and other hazards created by earth-moving operations.
- B. Protect and maintain erosion and sedimentation controls during earth-moving operations.
- C. Protect subgrades and foundation soils from freezing temperatures and frost. Remove temporary protection before placing subsequent materials.

### 3.2 EXCAVATION, GENERAL

- A. Unclassified Excavation: Excavate to subgrade elevations regardless of the character of surface and subsurface conditions encountered. Unclassified excavated materials may include rock, soil materials, and obstructions. No changes in the Contract Sum or the Contract Time will be authorized for rock excavation or removal of obstructions.
  - 1. If excavated materials intended for fill and backfill include unsatisfactory soil materials and rock, replace with satisfactory soil materials.

### 3.3 EXCAVATION FOR STRUCTURES

- A. Excavate to indicated elevations and dimensions within a tolerance of plus or minus 1 inch. If applicable, extend excavations a sufficient distance from structures for placing and removing concrete formwork, for installing services and other construction, and for inspections.
  - 1. Excavations for Footings and Foundations: Do not disturb bottom of excavation. Excavate by hand to final grade just before placing concrete reinforcement. Trim bottoms to required lines and grades to leave solid base to receive other work.
- B. Excavations at Edges of Tree- and Plant-Protection Zones:
  - 1. Excavate by hand or with an air spade to indicated lines, cross sections, elevations, and subgrades. If excavating by hand, use narrow-tine spading forks to comb soil and expose roots. Do not break, tear, or chop exposed roots. Do not use mechanical equipment that rips, tears, or pulls roots.

### 3.4 EXCAVATION FOR WALKS AND PAVEMENTS

- A. Excavate surfaces under walks and pavements to indicated lines, cross sections, elevations, and subgrades.

### 3.5 SUBGRADE INSPECTION

- A. Unsuitable existing fill, wet soils, soft or loose natural soils, organic materials, and rubble shall be stripped to approved subgrades as determined by the Engineer.
- B. All subgrades shall be proofrolled with a minimum 20 ton, loaded dump truck or suitable rubber tire construction equipment approved by the geotechnical engineer, prior to the placement of fill to identify soft pockets and areas of excess yielding. Do not proof-roll wet or saturated subgrades.
- C. Soils that exhibit excessive pumping or rutting under the weight of construction equipment shall be undercut and replaced with controlled structural fill as determined by the Engineer.
- D. Reconstruct subgrades damaged by freezing temperatures, frost, rain, accumulated water, or construction activities, as directed by Engineer, without additional compensation.

### 3.6 UNAUTHORIZED EXCAVATION

- A. Fill unauthorized excavation under foundations or wall footings by extending bottom elevation of concrete foundation or footing to excavation bottom, without altering top elevation. Lean concrete fill, with 28-day compressive strength of 2500 psi may be used when approved by the Engineer.
  - 1. Fill unauthorized excavations under other construction, pipe, or conduit as directed by Engineer.

### 3.7 STORAGE OF SOIL MATERIALS

- A. Stockpile borrow soil materials and excavated satisfactory soil materials without intermixing. Place, grade, and shape stockpiles to drain surface water. Cover to prevent windblown dust.
  - 1. Stockpile soil materials away from edge of excavations. Do not store within drip line of remaining trees.

### 3.8 BORROW

- A. Two direct shear tests shall be performed on the soil obtained from borrow source to meet the following shear strength requirements:
  - 1. Friction angle = 30 degrees
  - 2. Cohesion = 50 psf

## 3.9 SOIL FILL

- A. Plow, scarify, bench, or break up sloped surfaces steeper than 1 vertical to 4 horizontal so fill material will bond with existing material.
- B. Place and compact fill material in layers to required elevations as follows:
  - 1. Under grass and planted areas, use satisfactory soil material.
  - 2. Under walks and pavements, use satisfactory soil material.
  - 3. Under steps and ramps, use engineered fill.

## 3.10 SOIL MOISTURE CONTROL

- A. Uniformly moisten or aerate subgrade and each subsequent fill or backfill soil layer before compaction to within 2 percent of optimum moisture content.
  - 1. Do not place backfill or fill soil material on surfaces that are muddy, frozen, or contain frost or ice.
  - 2. Remove and replace, or scarify and air dry, otherwise satisfactory soil material that exceeds optimum moisture content by 2 percent and is too wet to compact to specified dry unit weight.

## 3.11 COMPACTION OF SOIL BACKFILLS AND FILLS

- A. Place backfill and fill soil materials in layers not more than 8 inches in loose depth for material compacted by heavy compaction equipment and not more than 4 inches in loose depth for material compacted by hand-operated tampers.
- B. Place backfill and fill soil materials evenly on all sides of structures to required elevations and uniformly along the full length of each structure.
- C. Compaction equipment that is compatible with the soil type used for the fill shall be selected.
- D. Compaction equipment used adjacent to walls below grade shall be selected to not impose undesirable surcharge on walls.
- E. Compact soil materials to not less than the following percentages of maximum dry unit weight according to ASTM D 1557 (Modified Proctor):
  - 1. Fill shall be compacted at +/- 2 percent of the optimum moisture content, to at least 95 percent of the maximum dry density.
  - 2. Fill placed along slopes steeper than 5H:1V shall be benched into the existing slope. Benches shall consist of minimum 8 feet wide level cut, and at least one such bench shall be used for each 3 feet of vertical rise of fill placed.
- F. All areas receiving fill shall be graded to facilitate positive drainage of any water associated with precipitation and surface runoff.



## 3.12 UTILITY EXCAVATION BACKFILL

- A. Crushed stone with a maximum 2-inch aggregate size with no more than 5 percent passing the No. 200 sieve shall be used to backfill the pipe trench to the spring line of the pipe.
- B. Hand operated compaction equipment shall be used until the backfill has reached a level 1 foot above the top of the pipe to prevent damaging the pipe.
- C. Backfill material within 2 feet of the top of pipe shall not contain rock fragments or gravel greater than 1-inch in diameter.
- D. All backfilled pipes laid either perpendicular or parallel to the tracks must be designed so that the backfill material is positively drained.

## 3.13 GRADING

- A. General: Uniformly grade areas to a smooth surface, free of irregular surface changes. Comply with compaction requirements and grade to cross sections, lines, and elevations indicated.
- B. Site Rough Grading: Slope grades to direct water away from buildings and to prevent ponding. Finish subgrades to elevations required to achieve indicated finish elevations, within the following subgrade tolerances:
  - 1. Turf or Unpaved Areas: Plus or minus 1 inch.
  - 2. Walks: Plus or minus 1 inch.

## 3.14 SUBBASE AND BASE COURSES UNDER PAVEMENTS AND WALKS

- A. Place subbase course on subgrades free of mud, frost, snow, or ice.
- B. On prepared subgrade, place subbase course under pavements and walks as follows:
  - 1. Shape subbase course to required crown elevations and cross-slope grades.
  - 2. Place subbase course that exceeds 6 inches in compacted thickness in layers of equal thickness, with no compacted layer more than 6 inches thick or less than 3 inches thick.
  - 3. Compact subbase course at optimum moisture content to required grades, lines, cross sections, and thickness to not less than 95 percent of theoretical maximum density as determined by ASTM Specification D-698 standard proctor method, within + or – 2% of optimum moisture with the upper 1.0 foot compacted to 100% of the maximum density per ASTM-698.

## 3.15 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified special inspector to perform the following special inspections:
  - 1. Excavation for drilled piers.

- B. Testing Agency: Contractor will engage a qualified geotechnical engineering testing agency to perform tests and inspections.
- C. 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.
- A. Testing agency will test compaction of soils in place according to ASTM D 1556, ASTM D 2167, ASTM D 2937, and ASTM D 6938, as applicable. Tests will be performed at the following locations and frequencies:
  - 1. Pavement and Building Slab Areas: At subgrade and at each compacted fill and backfill layer, at least one test for every 500 square-feet or less of paved area or building slab but in no case fewer than three tests.
  - 2. 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.
- B. 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 Architect.
- C. 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.

### 3.16 PROTECTION

- A. Existing roadways, tracks, utilities and parking lot pavements shall be protected from damage during excavation and construction activities. Maintain a continuous clearance envelope a minimum of 30 feet from the centerline of all active tracks unless instructed otherwise and accompanied by designated watchmen. A railroad flagman will not be provided for this work.
- B. Protecting Graded Areas: Protect newly graded areas from traffic, freezing, and erosion. Keep free of trash and debris.
- C. Repair and reestablish grades to specified tolerances where completed or partially completed surfaces become eroded, rutted, settled, or where they lose compaction due to subsequent construction operations or weather conditions. Damage to adjacent facilities will be repaired at no additional cost to the Owner. Pavements damaged by construction traffic shall be restored to at least the preconstruction condition.
- D. Where settling occurs before Project correction period elapses, remove finished surfacing, backfill with additional soil material, compact, and reconstruct surfacing.
  - 1. Restore appearance, quality, and condition of finished surfacing to match adjacent work, and eliminate evidence of restoration to greatest extent possible.

3.17 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Remove surplus satisfactory soil and waste materials, including unsatisfactory soil, trash, and debris, and legally dispose of them off Owner's property.

END OF SECTION 312000

## SECTION 312319 - DEWATERING

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. Section includes construction dewatering.

## 1.2 FIELD CONDITIONS

- A. 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. Dewatering Performance: Design, furnish, install, test, operate, monitor, and maintain dewatering system of sufficient scope, size, and capacity to control hydrostatic pressures and to lower, control, remove, and dispose of ground water and permit excavation and construction to proceed on dry, stable subgrades.

## PART 3 - EXECUTION

## 3.1 PREPARATION

- A. Provide temporary grading to facilitate dewatering and control of surface water.
- B. Protect and maintain temporary erosion and sedimentation controls during dewatering operations.

## 3.2 INSTALLATION

- A. Install dewatering system utilizing wells, well points, or similar methods complete with pump equipment, standby power and pumps, filter material gradation, valves, appurtenances, water disposal, and surface-water controls.
  - 1. Space well points or wells at intervals required to provide sufficient dewatering.
  - 2. Use filters or other means to prevent pumping of fine sands or silts from the subsurface.
- B. Place dewatering system into operation to lower water to specified levels before excavating below ground-water level.

- 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.

### 3.3 OPERATION

- A. Operate system continuously until drains, sewers, and structures have been constructed and fill materials have been placed or until dewatering is no longer required.
- B. Operate system to lower and control ground water to permit excavation, construction of structures, and placement of fill materials on dry subgrades. Drain water-bearing strata above and below bottom of foundations, drains, sewers, and other excavations.
  - 1. Do not permit open-sump pumping that leads to loss of fines, soil piping, subgrade softening, and slope instability.
  - 2. Reduce hydrostatic head in water-bearing strata below subgrade elevations of foundations, drains, sewers, and other excavations.
  - 3. Maintain piezometric water level a minimum of 24 inches below bottom of excavation.
- C. Remove dewatering system from Project site on completion of dewatering. Plug or fill well holes with sand or cut off and cap wells a minimum of 36 inches below overlying construction.

### 3.4 FIELD QUALITY CONTROL

- A. Survey-Work Benchmarks: Resurvey benchmarks regularly during dewatering and maintain an accurate log of surveyed elevations for comparison with original elevations. Promptly notify Architect if changes in elevations occur or if cracks, sags, or other damage is evident in adjacent construction.

END OF SECTION 312319

## SECTION 31 33 00 – CONCRETE REPAIR

## PART 1 - GENERAL

## 1.1 SUMMARY

- A. This Section includes specifications for concrete stair, ramp and platform repair, as indicated on the contract documents.
- B. The work shall consist of:
  - 1. Preparation of all surfaces to receive patching compound.
  - 2. Mixing and transportation of patching compound.
  - 3. Repairs to delaminated and scaled area of existing concrete.
  - 4. Priming of repair area and placement of patching compound.
  - 5. Finishing and curing of patches.
  - 6. Repair of cracks.

## 1.2 PREINSTALLATION MEETINGS

- A. Pre-installation Conference: Conduct conference at Project site and visit the site and work scope.
- B. The contractor is responsible to visit the site, list all repair needed elements in existing stair, ramp and platform and provide remedies as listed in this specification.

## 1.3 ACTION SUBMITTALS

- A. In accordance with Section 01 33 00 “Submittal Procedures”, submit the following:
  - 1. Shop Drawings: Show layout and types of concrete damages on the stair, ramp and platform – with detail repair methods and material use.
  - 2. Product Data: Submit manufacturer's technical data for each product indicated including recommendations for their application and use. Include test reports and certifications substantiating that products comply with requirements.
  - 3. Written certificates from the patching materials manufacturer should be submitted stating that all installers of the patching material have successfully completed a training workshop for installation of the patching material, or have met alternative workmanship qualifications acceptable to the manufacturer.
  - 4. Samples of all specified materials and Material Safety Data Sheets (MSDS) as appropriate

## 1.4 QUALITY ASSURANCE

- A. Source of Materials: Obtain materials for patching, coating, sealing and crack repair from a single sources manufacturer to ensure match quality, color, texture and detailing.

## 1.5 DELIVERY, STORAGE AND HANDLING

- A. Deliver materials to site in manufacturer's original unopened containers and packaging, bearing labels as to type and names of products and manufacturers
- B. Protect grout, mortar and other materials from deterioration by moisture and temperature. Store in a dry location or in waterproof containers. Keep containers tightly closed and away from open flames. Protect liquid components from freezing. Comply with manufacturer's recommendations for minimum and maximum temperature requirements for storage.
- C. Comply with the manufacturer's written specifications and recommendations for mixing, application, and curing of grouts and patching materials

## 1.6 PROTECTION / SITE CONDITIONS

- A. Protect persons, vehicles, building site and surrounding buildings from injury resulting from concrete restoration work.
- B. Clean concrete surfaces only when air temperatures are above 40 degrees F (4 deg. C) and will remain so until concrete has dried out, but for not less than 7 days after completion of cleaning.
- C. Do not perform any patching unless air temperatures are between 40 degrees Fahrenheit (10 deg. C) and 86 degrees Fahrenheit (30 deg. C) and will remain so for at least 48 hours after completion of work.
- D. Do not perform any patching work if precipitation is expected. In case of unexpected precipitation, work shall cease and all uncured material shall be adequately protected with an impermeable polyethylene sheet.
- E. If either the ambient or subsurface temperature is expected to fall between 35F (2C) and 40F (4C) during curing and ultimate drying of the patching compound, then the cold weather precautions outlined in item 7, below, of this section of the specification shall be followed.
- F. If ambient or surface temperature is expected to rise above 86F (30C) during application and curing of the patching compound, then the hot weather precautions outlined in item 8 of this section of the specifications shall be followed.
- G. Cold Weather Precautions:
  - 1. Curing times shall be extended to compensate for lower temperature cure.
  - 2. Do not proceed if temperatures will drop below freezing before patching compound has reached final set. Any material disrupted by early freezing must be removed and replaced under appropriate controls or conditions.
  - 3. If auxiliary heating will be used to protect freshly placed materials from freezing, equipment must not directly vent exhaust gases onto the repair materials or into repair enclosure air. This may cause carbonation and low strength. Use moderate temperatures and heated air or radiant heat.
- H. Hot Weather Precautions:
  - 1. All materials shall be kept cool, stored out of direct sun.

2. Precooling of subsurface shall be carried out by continuous wetting at least one hour before placing patching compounds. This shall be done by covering or draping the entire repair area with burlap and by continuously keeping the burlap wet. The burlap shall be removed just prior to the patching of each area, as work proceeds.
  3. In hot, dry, windy weather, repair areas shall be covered or draped with burlap for a minimum of 3 hours after patch placement, to avoid rapid drying of the patches. Maximum wet cure time shall not exceed 24 hours.
- I. Cover partially completed work when work is not in progress.

#### 1.7 SEQUENCING / SCHEDULING:

- A. Perform concrete restoration work in the following sequence:
1. Remove paint, stains and plant material from all surfaces.
  2. Remove existing unsound materials from areas indicated to be restored.
  3. Pressure wash building and repair surfaces as indicated.
  4. Patch and repair existing concrete structures as indicated
  5. Provide special coating over indicated sections.

### PART 2 - PRODUCTS

#### 2.1 MATERIALS

- A. Acrylic latex primer/bonding agent shall be SYSTEM 42, as manufactured by Edison Coatings, Inc., Plainville, CT, (800) 697-8055, or approved equal.
- B. Patching compound shall be a custom, 1-component, polymer-modified cementitious product, SYSTEM 44-Custom, as manufactured by Edison Coatings, Inc., (800) 697-8055, or approved equal.
1. Patching compound shall be an acrylic polymer modified blend of portland cement, specially graded aggregates and admixtures, designed for low shrinkage, low stress cure, and compatibility with existing host concrete.
  2. Prior to patching, sample cores of existing concrete shall be delivered by Contractor to manufacturer for testing and evaluation. Patching compound shall be customized by manufacturer, so that compressive strength does not exceed 4000 psi, or 500 psi above the existing concrete's compressive strength, whichever is higher, as measured by ASTM C-109. Manufacturer shall have a successful performance history for similar projects of no less than 10 years, and shall have been doing business as the same business entity for no less than 10 years.
  3. Patching compound shall develop a minimum 200 psi direct tensile adhesion with host substrate, when applied in accordance with these specifications.
  4. Tensile strength of patching compound shall be a minimum of 400 psi. Flexural modulus shall be  $1.1 \times 10^6$ . Material must be vapor permeable, with a minimum permeance of 8 perms at 1/2" depth as measured by ASTM E-96.
  5. Water used for cleaning, mixing and finishing shall be clean, potable, free from oil, acid, injurious amounts of vegetable matter, alkalies or other salts.
  6. No colorants, accelerators, bonding agents or other additives shall be added to the patching compound without express written direction of the manufacturer.



- C. Crack sealant for small cracks shall be a 100% solids, 2-component elastomeric epoxy with 110% elongation and minimum 1200 psi tensile strength as measured by ASTM D412. Sealant shall be Flexi-Seal 510 as manufactured by Edison Coatings, Inc. (800) 697-8055, or approved equal.
- D. Reinforcing steel primer/corrosion inhibitor shall be an alkaline, silica fume modified, latex modified cementitious coating, SYSTEM 49 CPBA, as manufactured by Edison Coatings, Inc., (800) 697-8055, or approved equal.
- E. The products specified herein shall be assumed to meet the performance criteria specified. If a proposed equal is submitted, thorough lab testing shall be required to establish equivalent performance levels. An independent testing laboratory shall be utilized as determined by the Architect, and shall be paid for by the submitting party.

### PART 3 - EXECUTION

#### 3.1 SURFACE PREPARATION

- A. Prior to patching, all surfaces must be prepared in accordance with this section of the specifications.
- B. Remove all unsound concrete, using lightweight demolition hammers, not to exceed 18 pounds in weight. All removals to be performed in accordance with ICRI Guideline #03730, which shall be a part of these specifications, with regard to removal geometry, exposing, undercutting and cleaning of embedded reinforcement, and conditioning of edges and surfaces. Following demolition, test surfaces for alkalinity/carbonation with a 1-2% solution of phenolphthaleine. Surfaces which do not indicate alkalinity (solution turns pink) shall require further demolition.
- C. Pressure wash all indicated surfaces using 3000-4000 psi water blast, as required to remove all dust and dirt. Abrasive shall be used in combination with water when cleaning repair cavities, as required to eliminate micro-cracked surface materials resulting from demolition. No water with concrete dust shall be allowed to remain on any surface following washing, and must be immediately removed, prior to drying and re-hardening.
- D. The result of this preparation shall render a surface clean, meaning having complete exposure of sound original material without any deposits of contaminants, foreign matter or loose material, which could affect the bond or long-term durability of the surface and the patching compound. Examine supporting frame and field conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

#### 3.2 CRACK REPAIR

- A. Patching compounds are not to be used to platform, ramp and stair working cracks or joints. Prior to crack repair, contractor shall engage the services of the crack sealant manufacturer's

technical representative to assist in the selection of the appropriate grades of crack sealants for each area.

- B. 2. Crack repair for small cracks less than 1/16" (62 mils, 1.5 mm) shall be performed following pressure washing and drying by gravity filling with elastomeric crack sealant. Cracks wider than than 1/16" shall be grooved out to a nominal 1/2" x 1/2" (3mm x 3mm), and filled with crack sealant.

### 3.3 PRIMING OF REINFORCING STEEL

- A. Any steel reinforcement exposed in the course of removing unsound materials shall be cleaned and prepared in accordance with the above specifications.
- B. Following cleaning and prior to patching, apply cementitious corrosion inhibitive primer and bonding agent to all steel surfaces in accordance with manufacturer's instructions. Care must be taken to create a continuous coating on the full surface, including the underside of the undercut reinforcement. Observe manufacturer's guidelines with regard to minimum and maximum timing "windows" for patching after application of prime repair Painting: Wire brush and clean rust spots, welds, and abraded areas on both surfaces of prime-painted deck immediately after installation, and apply repair paint.

### 3.4 CONCRETE PATCHING

- A. Following preparation, as specified above, contractor shall maintain work area in a clean condition, including materials, equipment and workers' footwear, to avoid tracking in of contaminants, dirt, dust, mud or other materials which may interfere with adhesion and durability of repairs.
- B. Prior to patching, all repair areas to be patched shall be kept continuously wet for at least 20 minutes prior to application of patching compound. Before placing patch, excess water shall be blown, vacuumed or otherwise removed from the surface, leaving the surface damp or saturated/surface dry.
- C. Within 4 hours of primer application, mix and place patching compound in accordance with manufacturer's instructions.
- D. Mix the precisely measured quantity of water specified by the manufacturer with full bags of patching compound only. Mix using slow speed drill (450 rpm maximum) with mud or paddle mixer. Motorized mortar mixers may be used for mixing larger quantities. Mix for precisely 4 minutes, using a mix timer. Mix to a uniform consistency, free of lumps or dry material. Do not whip air into the mix. Do not overmix.
- E. When placing the patching compound, care shall be taken to assure that all corners and gaps under reinforcing steel is completely filled and properly compacted to prevent formation of voids or un-bonded areas. "Work" the material into corners and gaps, using pressure on the trowel to assure good contact between patch and substrates.

- F. Patches deeper than 1" (25 mm) may be extended by coarse aggregate addition. 20 pounds of clean, washed, 3/8" pea stone suitable in composition and surface profile for use as a concrete aggregate, may be added to each 50 pound bag of patching compound.
- G. Do not re-temper material which has begun to set. Discard any unused material after 20 minutes. Do not excessively wet patch surfaces after placement or as an aid to trowelling. Limit surface water addition to light misting and do not wet or rework repeatedly.
- H. Observe the curing requirements for each day's working conditions, as specified herein. Do not extend wet curing beyond the maximum specified. Do not open to traffic or expose to weather until adequate strength has been reached, as affected by working and curing conditions.

END OF SECTION 31 33 00

## 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 INFORMATIONAL SUBMITTALS

- A. Contractor Calculations: For excavation support and protection system. Include analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
- B. Record Drawings: Identify locations and depths of capped utilities, abandoned-in-place support and protection systems, and other subsurface structural, electrical, or mechanical conditions.

## 1.3 FIELD CONDITIONS

- A. 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. Provide, design, install, monitor, and maintain excavation support and protection system capable of supporting excavation sidewalls and of resisting earth and hydrostatic pressures and superimposed and construction loads.
  - 1. Design excavation support and protection system, including preparation of shop drawings and comprehensive engineering analysis by a qualified professional engineer.

## PART 3 - EXECUTION

## 3.1 SOLDIER PILES AND LAGGING

- A. Install steel soldier piles before starting excavation. Extend soldier piles below excavation grade level to depths adequate to prevent lateral movement. Space soldier piles at regular intervals not to exceed allowable flexural strength of wood lagging. 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. Trim excavation as required to install lagging. Fill voids behind lagging with soil, and compact.
- C. Install wales horizontally at locations indicated on Drawings and secure to soldier piles.

### 3.2 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. Limit vertical offset of adjacent sheet piling to 60 inches. 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.

### 3.3 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.

### 3.4 BRACING

- A. Bracing: 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 Engineer.
  - 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.

### 3.5 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. Maintain an accurate log of surveyed elevations and positions for comparison with original elevations and positions. Promptly notify Engineer if changes in elevations or positions occur or if cracks, sags, or other damage is evident in adjacent construction.

## 3.6 REMOVAL AND REPAIRS

- A. Remove excavation support and protection systems when construction has progressed sufficiently to support excavation and earth and hydrostatic pressures. Remove in stages to avoid disturbing underlying soils and rock or damaging structures, pavements, facilities, and utilities.
  - 1. Remove excavation support and protection systems to a minimum depth of 48 inches below overlying construction and abandon remainder.
- B. Repair or replace, as approved by Engineer, adjacent work damaged or displaced by removing excavation support and protection systems.

END OF SECTION 31 50 00

## SECTION 31 63 29 - DRILLED CONCRETE PIERS AND SHAFTS

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Dry-installed drilled piers.

## 1.2 UNIT PRICES

- A. Drilled Shafts: Actual vertical length of shaft from the bottom of the cap beam to the bottom of the finished hole, as measured along the centerline of the hole. Actual length may vary, to coincide with elevations where satisfactory bearing strata are encountered.

1. Base bids on indicated overall length of drilled shafts.
2. Unit prices include labor, materials, tools, equipment, and providing access for drilling equipment, earthwork, installation and removal of temporary shoring, drilling, furnishing and installing casing, preparing the hole, cast-in-place concrete and reinforcing steel.

## 1.3 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. Design Mixtures: For each concrete mixture.
- C. Shop Drawings: For concrete reinforcement.

## 1.4 INFORMATIONAL SUBMITTALS

- A. Welding certificates.
- B. Material certificates.
- C. Material test reports.
- D. Field quality-control reports.

## 1.5 CLOSEOUT SUBMITTALS

- A. Record drawings.

## 1.6 QUALITY ASSURANCE

## A. Welding Qualifications: Qualify procedures and personnel according to the following:

1. AWS D1.1/D1.1M, "Structural Welding Code - Steel."
2. AWS D1.4/D1.4M, "Structural Welding Code - Reinforcing Steel."

## 1.7 FIELD CONDITIONS

## A. 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 is not responsible for interpretations or conclusions drawn from this data.

1. Make additional test borings and conduct other exploratory operations necessary for drilled piers.
2. The geotechnical report is included in this set of specifications.

## B. Survey Work: Engage a qualified land surveyor or professional engineer to perform surveys, layouts, and measurements for drilled piers. Before excavating, lay out each drilled pier to lines and levels required. Record actual measurements of each drilled pier's location, shaft diameter, bottom and top elevations, deviations from specified tolerances, and other specified data.

1. Record and maintain information pertinent to each drilled pier and indicate on record Drawings.

## PART 2 - PRODUCTS

## 2.1 PERFORMANCE REQUIREMENTS

## A. Drilled-Pier Standard: ACI 336.1 except as modified in this Section.

## 2.2 STEEL REINFORCEMENT

## A. Reinforcing Bars: ASTM A 615/A 615M, Grade 60, deformed.

## 2.3 CONCRETE MATERIALS

## A. Comply with Virginia Department of Transportation (VDOT) Road and Bridge Specifications, 2016, for the concrete materials. Concrete shall have a 28-day compressive strength of 4000 psi and shall comply with VDOT Class A4 concrete, General.



## 2.4 STEEL CASINGS

- A. Steel Pipe Casings: ASTM A 36/A 36M, Grade 36, carbon-steel plate, with joints full-penetration welded according to AWS D1.1/D1.1M.

## 2.5 CONCRETE MIXTURES AND MIXING

- A. Comply with VDOT Road and Bridge Specifications, 2016, for the concrete mixtures and mixing.

# PART 3 - EXECUTION

## 3.1 EXCAVATION

- A. Unclassified Excavation: Excavate to bearing elevations regardless of character of surface and subsurface conditions encountered.
- B. Excavate shafts for drilled piers to indicated elevations. Remove loose material from bottom of excavation. A Geotechnical Engineer shall be present on the site to evaluate the drilled shaft installation operations and bearing soils, to verify the subgrades are suitable for support of design bearing pressures and to ensure that subgrades are free of loose or disturbed material.
- C. Notify and allow testing and inspecting agency to test and inspect bottom of excavation. If unsuitable bearing stratum is encountered, make adjustments to drilled piers as determined by Engineer.
  - 1. Do not excavate shafts deeper than elevations indicated unless approved by Engineer.
  - 2. Payment for additional authorized excavation is according to Contract provisions for changes in the Work.
- D. End-Bearing Drilled Piers: Probe with auger to a depth 10 feet below bearing elevation of drilled pier. Determine whether voids, clay seams, or solution channels exist.
- E. After the shaft is advanced to suitable bearing material, the subgrade shall be hand cleaned or suitably mechanically cleaned prior to observation. Drilled shaft bases shall be leveled.
- F. Pumping of water at the bottom of the caisson may be required to control groundwater during construction. Concrete shall not be placed in standing water in excess of 2 inches in depth.
- G. Casings: Install watertight steel casings of sufficient length and thickness to prevent water seepage into shaft; to withstand compressive, displacement, and withdrawal stresses; and to maintain stability of shaft walls.
  - 1. Casings shall be maintained in plumb position during concrete placement.
  - 2. Casings shall not be removed. They shall be permanent.
  - 3. The minimum thickness of the casings shall be as shown on the contract documents.

- H. Tolerances: Construct drilled piers to remain within ACI 336.1 tolerances.

### 3.2 INSTALLATION

- A. Install steel casings of minimum wall thickness indicated and of diameter not less than diameter of drilled pier.
- B. Comply with recommendations in CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- C. Place concrete in continuous operation and without segregation immediately after inspection and approval of shaft by a qualified testing agency.
- D. Place concrete to fall vertically down the center of drilled pier without striking sides of shaft or steel reinforcement.
- E. Drilled shafts shall be concreted the same day they are drilled and shall not be concreted to intermediate depths due to insufficient amounts of concrete at the site.
- F. A minimum of 16 hours shall be allowed between concrete placement in one drilled shaft before drilling an adjacent drilled shaft.

### 3.3 FIELD QUALITY CONTROL

- A. Special Inspections: Owner will engage a qualified independent special inspector to perform the following special inspections:
  - 1. Drilled piers.
  - 2. Excavation.
  - 3. Concrete.
  - 4. Steel reinforcement welding, as applicable.
- B. Testing Agency: Engage a qualified testing agency to perform tests and inspections.
- C. Drilled-Pier Tests and Inspections: For each drilled pier, before concrete placement.
  - 1. Soil Testing: Bottom elevations, bearing capacities, and lengths of drilled piers indicated have been estimated from available soil data. Actual elevations and drilled-pier lengths and bearing capacities are determined by testing and inspecting agency. Final evaluations and approval of data are determined by Engineer.
- D. Concrete Tests and Inspections: ACI 301 (ACI 301M).

### 3.4 DISPOSAL OF SURPLUS AND WASTE MATERIALS

- A. Disposal: Remove surplus satisfactory soil and waste material, including unsatisfactory soil, trash, and debris, and legally dispose of it off Owner's property.

END OF SECTION 31 63 29

## SECTION 321313 - CONCRETE PAVING

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes Concrete Paving for the following:

1. Walks.

## 1.2 ACTION SUBMITTALS

- A. Product Data: For each type of product.
- B. 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.

## 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.
  1. Manufacturer certified according to NRMCA's "Certification of Ready Mixed Concrete Production Facilities" (Quality Control Manual - Section 3, "Plant Certification Checklist").

## PART 2 - PRODUCTS

## 2.1 CONCRETE, GENERAL

- A. VDOT Section 217

## 2.2 STEEL REINFORCEMENT

- A. Plain-Steel Welded-Wire Reinforcement: ASTM A 1064, fabricated from as-drawn steel wire into flat sheets.
- B. Deformed-Steel Welded-Wire Reinforcement: ASTM A 1064, flat sheet.
- C. Reinforcing Bars: ASTM A 615, Grade 60 deformed.

- D. Joint Dowel Bars: ASTM A 615 Grade 60 plain-steel bars. Cut bars true to length with ends square and free of burrs.
- 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.

## 2.3 CONCRETE MATERIALS

- A. VDOT Section 217

## 2.4 CURING MATERIALS

- A. VDOT Section 220

## 2.5 RELATED MATERIALS

- A. Joint Fillers: ASTM D 1751, asphalt-saturated cellulosic fiber in preformed strips.
- B. Slip-Resistive Aggregate Finish: Factory-graded, packaged, rustproof, nonglazing, abrasive aggregate of fused aluminum-oxide granules or crushed emery aggregate containing not less than 50 percent aluminum oxide and not less than 20 percent ferric oxide; unaffected by freezing, moisture, and cleaning materials.

# PART 3 - EXECUTION

## 3.1 EXAMINATION

- A. Examine exposed subgrades and subbase surfaces for compliance with requirements for dimensional, grading and elevation tolerances.
- B. Proof-roll prepared subbase surface below concrete paving to identify soft pockets and areas of excess yielding.
- C. Proceed with concrete pavement operations only after the nonconforming conditions have been corrected and subgrade is ready to receive pavement.

## 3.2 PREPARATION

- A. Remove loose material from compacted subbase surface immediately before placing concrete.

### 3.3 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.

### 3.4 STEEL REINFORCEMENT INSTALLATION

- A. Comply with CRSI's "Manual of Standard Practice" for fabricating, placing, and supporting reinforcement.
- B. Clean reinforcement of loose rust and mill scale, earth, ice, or other bond-reducing materials.
- C. Arrange, space and securely tie bars and bar supports to hold reinforcement in position during concrete placement. Maintain minimum cover to reinforcement.
- D. Install welded wire reinforcement in lengths as long as practicable. Lap adjoining pieces at least one full mesh, and lace splices with wire. Offset laps of adjoining widths to prevent continuous laps in either direction.

### 3.5 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.
- E. Edging: After initial floating, tool edges of paving and joints in concrete with an edging tool to a 1/4-inch radius. Repeat tooling of edges after applying surface finishes.

### 3.6 CONCRETE PLACEMENT

- A. Sidewalks: VDOT Section 504.

## 3.7 FLOAT FINISHING

- A. Slip-Resistive Aggregate Finish: Constructed in accordance with the requirements and procedures of VDOT standards.

## 3.8 CONCRETE PROTECTION AND CURING

- A. Comply with VDOT Section 316.04.

## 3.9 PAVING TOLERANCES

- A. Comply with tolerances in ACI 117 and as follows:
  - 1. Elevation: 3/4 inch.
  - 2. Thickness: Plus 3/8 inch, minus 1/4 inch.
  - 3. Surface: Gap below 10-feet- long; unlevelled straightedge not to exceed 1/2 inch.
  - 4. Joint Spacing: 3 inches.
  - 5. Contraction Joint Depth: Plus 1/4 inch, no minus.
  - 6. Joint Width: Plus 1/8 inch, no minus.

## 3.10 REPAIR 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 Architect.
- 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.

END OF SECTION 32 13 13

## SECTION 32 92 00 - TURF AND GRASSES

## PART 1 - GENERAL

## 1.1 SUMMARY

## A. Section Includes:

1. Seeding.

## 1.2 DEFINITIONS

- A. Planting Soil: Existing, on-site soil; imported soil; or manufactured soil that has been modified with soil amendments and perhaps fertilizers to produce a soil mixture best for plant growth.

## 1.3 PREINSTALLATION MEETINGS

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

## 1.4 INFORMATIONAL SUBMITTALS

- A. Certification of grass seed.
- B. Product certificates.

## 1.5 QUALITY ASSURANCE

- A. Installer Qualifications: A qualified landscape Installer whose work has resulted in successful turf establishment.
  1. Installer's Field Supervision: Require Installer to maintain an experienced full-time supervisor on Project site when work is in progress.

## 1.6 DELIVERY, STORAGE, AND HANDLING

- A. Seed and Other Packaged Materials: Deliver packaged materials in original, unopened containers showing weight, certified analysis, name and address of manufacturer, and indication of compliance with state and Federal laws, as applicable.



## PART 2 - PRODUCTS

## 2.1 SEED

- A. Grass Seed: Fresh, clean, dry, new-crop seed complying with AOSA's "Rules for Testing Seeds" for purity and germination tolerances.
- B. Seed Species:
  - 1. Quality: State-certified seed of grass species in accordance with the Virginia Erosion and Sediment Control Handbook listed below.
  - 2. Quality: Seed of grass species as listed below, with not less than 85 percent germination, not less than 95 percent pure seed, and not more than 0.5 percent weed seed:
  - 3. Proportioned by weight as follows:
    - a. Kentucky 31 or Turf-Type Tall Fescue: 95 – 100%.
    - b. Improved Perennial Grass: 0 – 5%.
    - c. Kentucky Bluegrass: 0 – 5%.

## 2.2 FERTILIZERS

- A. Commercial Fertilizer: Commercial-grade complete fertilizer of neutral character, consisting of fast- and slow-release nitrogen, 50 percent derived from natural organic sources of urea formaldehyde, phosphorous, and potassium in the following composition:
  - 1. Composition: 1 lb/1000 sq. ft. of actual nitrogen, 4 percent phosphorous, and 2 percent potassium, by weight.
- B. Slow-Release Fertilizer: Granular or pelleted fertilizer consisting of 50 percent water-insoluble nitrogen, phosphorus, and potassium in the following composition:
  - 1. Composition: 20 percent nitrogen, 10 percent phosphorous, and 10 percent potassium, by weight.

## 2.3 MULCHES

- A. Straw Mulch: Provide air-dry, clean, mildew- and seed-free, salt hay or threshed straw of wheat, rye, oats, or barley.
- B. Sphagnum Peat Mulch: Partially decomposed sphagnum peat moss, finely divided or of granular texture, and with a pH range of 3.4 to 4.8.
- C. Muck Peat Mulch: Partially decomposed moss peat, native peat, or reed-sedge peat, finely divided or of granular texture, with a pH range of 6 to 7.5, and having a water-absorbing capacity of 1100 to 2000 percent, and containing no sand.

- D. Compost Mulch: Well-composted, stable, and weed-free organic matter, pH range of 5.5 to 8; moisture content 35 to 55 percent by weight; 100 percent passing through 1-inch sieve; soluble salt content of 2 to 5 decisiemens/m; not exceeding 0.5 percent inert contaminants and free of substances toxic to plantings; and as follows:

## 2.4 PESTICIDES

- A. General: Pesticide, registered and approved by the EPA, acceptable to authorities having jurisdiction, and of type recommended by manufacturer for each specific problem and as required for Project conditions and application. Do not use restricted pesticides unless authorized in writing by authorities having jurisdiction.

## PART 3 - EXECUTION

### 3.1 TURF AREA PREPARATION

- A. General: Prepare planting area for soil placement and mix planting soil according to Section 329113 "Soil Preparation."
- B. Reduce elevation of planting soil to allow for soil thickness of sod.
- C. Moisten prepared area before planting if soil is dry. Water thoroughly and allow surface to dry before planting. Do not create muddy soil.
- D. Before planting, obtain Architect's acceptance of finish grading; restore planting areas if eroded or otherwise disturbed after finish grading.

### 3.2 SEEDING

- A. Sow seed with spreader or seeding machine. Do not broadcast or drop seed when wind velocity exceeds 5 mph.
  - 1. Evenly distribute seed by sowing equal quantities in two directions at right angles to each other.
  - 2. Do not use wet seed or seed that is moldy or otherwise damaged.
  - 3. Do not seed against existing trees. Limit extent of seed to outside edge of planting saucer.
- B. Sow seed at a total rate of 175 to 200 pounds per acre.
- C. Rake seed lightly into top 1/8 inch of soil, roll lightly, and water with fine spray.
- D. Protect seeded areas with slopes not exceeding 1:6 by spreading straw mulch. Spread uniformly at a minimum rate of 2 tons/acre to form a continuous blanket 1-1/2 inches in loose thickness over seeded areas.
  - 1. Anchor straw mulch by crimping into soil with suitable mechanical equipment.

- E. Protect seeded areas from hot, dry weather or drying winds by applying compost mulch within 24 hours after completing seeding operations. Soak areas, scatter mulch uniformly to a thickness of 3/16 inch, and roll surface smooth.

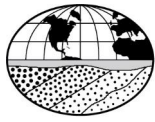
### 3.3 TURF MAINTENANCE

- A. General: Maintain and establish turf by watering, fertilizing, weeding, mowing, trimming, replanting, and performing other operations as required to establish healthy, viable turf. Roll, regrade, and replant bare or eroded areas and remulch to produce a uniformly smooth turf. Provide materials and installation the same as those used in the original installation.
- B. Mow turf as soon as top growth is tall enough to cut. Repeat mowing to maintain specified height without cutting more than one-third of grass height. Remove no more than one-third of grass-leaf growth in initial or subsequent mowings.

### 3.4 SATISFACTORY TURF


- A. Turf installations shall meet the following criteria as determined by Architect:
  - 1. Satisfactory Seeded Turf: At end of maintenance period, a healthy, uniform, close stand of grass has been established, free of weeds and surface irregularities, with coverage exceeding 90 percent over any 10 sq. ft. and bare spots not exceeding 5 by 5 inches.
- B. Use specified materials to reestablish turf that does not comply with requirements, and continue maintenance until turf is satisfactory.

END OF SECTION 32 92 00



## Memorandum

Date: February 22, 2018

To: Timothy C. Culleton, PE, Dewbei 

From: Sushant Upadhyaya, PhD, PE, PMP, Senior Associate

Subject: Geotechnical Specifications Virginia Railway Express –  
Rolling Road Platform Extension  
(GeoConcepts Project No. JD185036), Burke, Fairfax County, Virginia



The following geotechnical specifications for the Rolling Road Platform Extension are based on the Geotechnical Report Dated February 22, 2018 prepared by GeoConcepts Engineering Inc., A Terracon Company. Please refer to the aforementioned report for additional information regarding subsurface investigation procedures, soil laboratory test results, and engineering analysis, calculations and recommendations.

## Subgrade Preparation and Earthwork Operations

Subgrades that support controlled structural fill or structures shall be prepared as noted in Section 1.2.3 (American Railway Engineering Maintenance-of-Way Association, most recent) and as noted below:

1. Unsuitable existing fill, wet soils, soft or loose natural soils, organic materials, and rubble shall be stripped to approved subgrades as determined by the geotechnical engineer or his/her representative.
2. All subgrades shall be proofrolled with a minimum 20 ton, loaded dump truck or suitable rubber tire construction equipment approved by the geotechnical engineer, prior to the placement of new fill.
3. Soils that exhibit excessive pumping or rutting under the weight of construction equipment shall be undercut and replaced with controlled structural fill as determined by the geotechnical engineer or his/her representative.

## Controlled Structural Fill

1. Soils classified as CL, ML, SC, SM, SP, SW, GC, GM, GP or GW per ASTM D-2487 may be reused as engineered fill and shall meet the following requirements:
  - a) Liquid Limit (LL) <45
  - b) Plasticity Index (PI) <25
  - c) Maximum Dry Density >105 pcf
2. Fill shall be placed in horizontal, in lifts not exceeding 8-inches loose thickness. Fill shall be compacted at +/- 2 percent points of the optimum moisture content, to at least 95 percent of the maximum dry density per ASTM D-1557 (modified Proctor)
3. Fill placed along slopes steeper than 5H:1V shall be benched into the existing slope. Benches shall consist of minimum 8 feet wide level cut, and at least one such bench shall be used for each 3 feet of vertical rise of fill placed.

4. Two direct shear testing shall be performed on the soil obtained from borrow source to meet the following shear strength requirements:
  - a. Friction angle ( $\phi$ ) = 30 degrees
  - b. Cohesion (c) = 50 psf
5. Fill materials shall not be placed on frozen or frost-heaved soils, and/or soils that have been recently subjected to precipitation.
6. Borrow fill materials shall not contain frozen materials at the time of placement.
7. Compaction equipment that is compatible with the soil type used for fill shall be selected.
8. Compaction equipment used adjacent to walls below grade shall be selected to not impose undesirable surcharge on walls.
9. All areas receiving fill shall be graded to facilitate positive drainage of any water associated with precipitation and surface run-off.
10. After completion of compacted fill operations, construction of foundation elements shall begin immediately, or the finished subgrade shall be protected from exposure to inclement weather conditions.

## Utility Excavation Backfill

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1. Crushed stone with a maximum 2-inch aggregate size with no more than 5 percent passing the No. 200 sieve shall be used to backfill the pipe trench to the spring line of the pipe.
2. Hand operated compaction equipment shall be used until the backfill has reached a level 1 foot above the top of the pipe to prevent damaging the pipe.
3. Backfill material within 2 feet of the top of the pipe shall not contain rock fragments or gravel greater than 1-inch in diameter.
4. All backfilled pipes laid either perpendicular or parallel to the tracks must be designed so that the backfill material will be positively drained.

## Drilled Shaft Construction

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1. Prior to concrete placement, drilled shaft subgrades shall be observed by a representative of the geotechnical engineer in order to verify that subgrades are suitable for support of design bearing pressures, and to ensure that subgrades are free of loose or disturbed material.
2. Drilled shafts shall extend down to adequate bearing materials as described in the Geotechnical Engineering Report.
3. After the shaft is advanced to suitable bearing material, the subgrade shall be hand cleaned or suitably mechanically cleaned prior to observation. Drilled shaft bases shall be leveled.
4. A permanent steel casing shall have a yield stress of 36 psi and a minimum casing thickness of 1/4-inch.
5. Pumping of water at the bottom of the caisson may be required to control groundwater during construction. Concrete shall not be placed in standing water in excess of 2 inches in depth.
6. The concrete shall have a minimum slump of 5 inches.
7. Concrete may be placed using the free fall method, as long as the concrete does not strike the sides of the casing or any reinforcing steel. If concrete free falls and strikes obstructions, it may segregate and result in zones of low strength concrete.
8. Drilled shafts shall be concreted the same day they are drilled and shall not be concreted to intermediate depths due to insufficient amounts of concrete at the site.

9. A minimum of 16 hours shall be allowed between concrete placement in one drilled shaft before drilling an adjacent drilled shaft.
10. Drilled piers shall be constructed as straight piers at least 30 inches in diameter, to facilitate cleaning of the bottoms and to facilitate observations of end bearing materials.
11. Prior to concrete placement, drilled pier subgrades shall be observed by a representative of the geotechnical engineer or his/her representative in order to verify that subgrades are suitable for support of design bearing pressures, and to ensure that subgrades are free of loose or disturbed material.

## General

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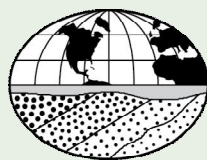
We have prepared this memorandum in accordance with generally accepted geotechnical engineering practices. No warranties, expressed or implied, are made as to the professional services included in this memorandum.

# Geotechnical Engineering Report

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## VRE Rolling Road Station Platform Extension Burke, Virginia

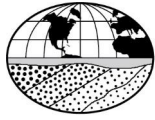
February 22, 2018



**GeoConcepts  
Engineering, Inc.**

A **Terracon** COMPANY

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# GeoConcepts Engineering, Inc.

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February 22, 2018

Timothy C. Culleton, PE  
Dewberry  
8401 Arlington Boulevard  
Fairfax, Virginia 22031

Subject: Geotechnical Engineering Report  
VRE Rolling Road Station Platform Extension  
Burke, Fairfax County, Virginia (GeoConcepts Project No. JD185036)

Dear Mr. Culleton:

GeoConcepts Engineering, Inc., (GeoConcepts) is pleased to present the following geotechnical engineering report prepared for VRE Rolling Road Station Platform Extension in Burke, Fairfax County, Virginia.

We appreciate the opportunity to serve as your geotechnical consultant on this project. Please do not hesitate to contact me if you have any questions or want to meet to discuss the findings and recommendations contained in the report.

Sincerely,

GEOCONCEPTS ENGINEERING, INC.

Fernanda Madrona, PE  
Project Manager  
[fmadrona@geoconcepts-eng.com](mailto:fmadrona@geoconcepts-eng.com)



# Table of Contents

1.0 Scope of Services .....	1
2.0 Site Description and Proposed Construction .....	1
3.0 Subsurface Conditions.....	2
3.1 Geology.....	2
3.2 Mapped Soil Units and Properties .....	2
3.3 Stratification .....	3
3.4 Groundwater.....	3
3.5 Soil Laboratory Test Results.....	3
3.5.1 Classification Test Results .....	4
3.5.2 Metal Corrosion Test Results .....	4
3.5.3 Concrete Attack Test Results.....	5
3.6 Seismic Site Classification .....	5
4.0 Engineering Analysis .....	5
4.1 Drilled Pier Foundations for the "Expanded Configuration" .....	5
4.2 Slope Stability .....	9
4.3 Earthwork.....	10
5.0 Considerations for the "Ultimate Configuration" .....	11
5.1 Design Concept 1: Pedestrian Bridge .....	11
5.2 Design Concept 2: Tunnel .....	12
6.0 General Limitations.....	12

Figure 1: Site Vicinity Map

Appendix A: Subsurface Investigation  
Appendix B: Soil Laboratory Test Results  
Appendix C: Engineering Calculations

## 1.0 Scope of Services

This geotechnical engineering report presents the results of the field investigation, soil laboratory testing, and engineering analysis of the geotechnical data. This report specifically addresses the following:

- An evaluation of subsurface conditions within the area of the proposed site development, including a seismic site classification per the International Building Code.
- Foundation recommendations for support of the proposed platform extension ("Expanded Configuration").
- Slope stability analysis of the proposed staircase, including recommendations to enhance stability, as applicable.
- Earthwork recommendations for construction of loadbearing fills, including an assessment of on-site soils to be excavated for re-use as fill.
- Preliminary assessment of the expected subsurface conditions for the "Ultimate Configuration" for future planning purposes.

Services not specifically identified in the contract for this project are not included in the scope of services.

## 2.0 Site Description and Proposed Construction

The project site is located at 9016 Burke Road in Burke, Fairfax County, Virginia. A site vicinity map is presented as Figure 1 at the end of this report, and an aerial image of the site is provided below. The site is currently developed with the VRE Rolling Road Station which consists of two train tracks and a 400-foot long platform with a partial canopy coverage. A parking lot is located on the south side of the train station. The elevation (EL) at the site ranges from approximately EL 294 to EL 300, sloping upwards towards the east.

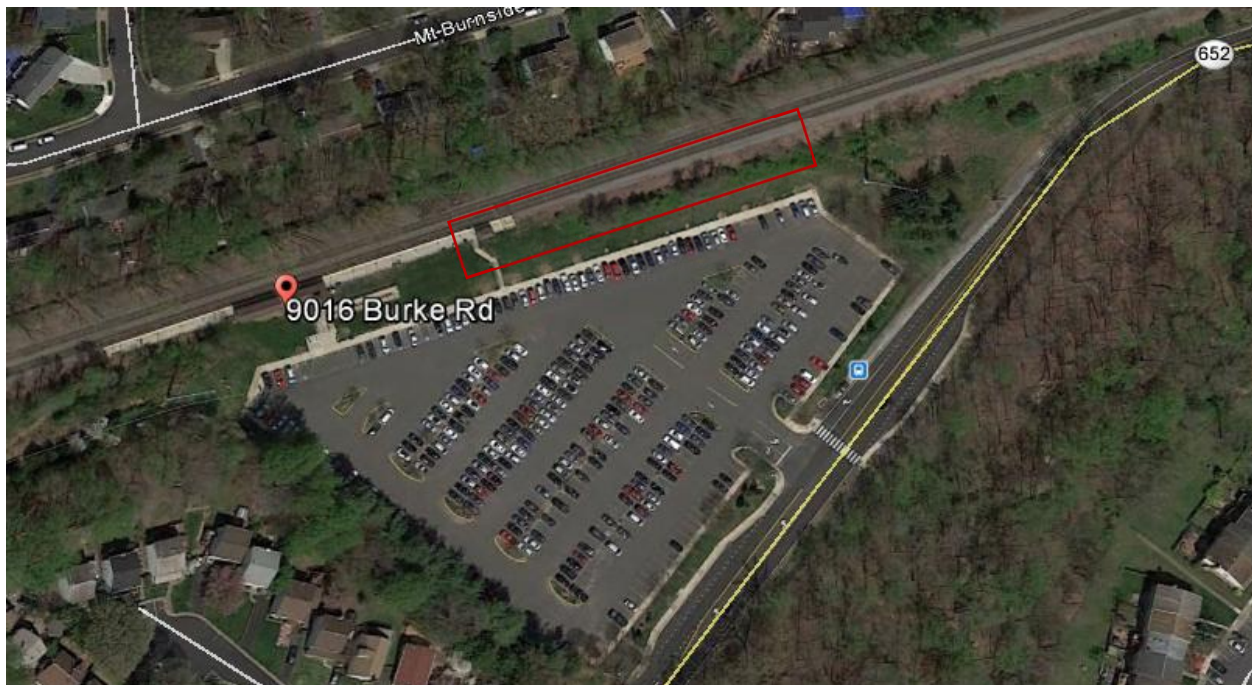


Figure 1: Aerial Image of the Site (Copyright Google Earth 2016)

Based on information from the Request for Proposal (RFP) No. 016-011 dated February 4, 2016, the proposed construction will consist of two configurations to be constructed in a 2-step process. The first configuration, referred to as "Expanded Configuration", will consist of extending the existing platform by about 300 feet.

The second configuration, referred to as the "Ultimate Configuration", consists of further expansion of the station to two platforms of up to 850 feet in length to be able to accommodate 10 train sets. The ultimate configuration design will require a grade separated connection between the two platforms. Two alternatives are being considered for this purpose. The first concept consists of constructing a pedestrian bridge over the tracks and the second concept consists of installing a tunnel under the tracks.

## 3.0 Subsurface Conditions

Subsurface conditions were investigated by drilling a total of three test borings in the proposed platform extension area. Test boring logs and a boring location plan (Figure A-1) are presented in Appendix A of this report.

### 3.1 Geology

The site lies within the Piedmont Physiographic Province of Virginia. The Piedmont is bordered to the east by the Coastal Plain Physiographic Province and to the west by the Blue Ridge Physiographic Province and contains several fault bordered basins. Bedrock in the Piedmont typically consists of highly weathered metamorphic and igneous rocks. Surface topography in the Piedmont is the result of millions of years of erosion.

Specifically, according to the Fairfax Quadrangle GC-1600 of the Geologic Quadrangle Map taken from the United States Geological Survey (USGS), bedrock beneath the project area consists of a metasedimentary mixture (or mélangé) of well-foliated, schist, metasandstone, felsic and mafic metavolcanic rocks, metagabbro, and ultramafic rocks such as serpentinite or soapstone, belonging to the Indian Run Formation dating from the Cambrian Geologic Period. The residual materials derived from the physical and chemical weathering of the parent bedrock generally consist of silty sand and sandy silt. Based on our subsurface investigation, the sediments and strata correspond favorably to the geologic publications.

### 3.2 Mapped Soil Units and Properties

Based on our review of the United States Department of Agriculture's Natural Resources Conservation Services (NRCS) Web Soil Survey 2.0, two soil units were mapped in the project vicinity. The mapped soil units are 105B and 105C as shown in Custom Soil Resource Report for Fairfax County presented in Appendix A. Table 3.2-1 below summarizes the soil units and selected properties based on the published information summarized in the NRCS Web Soil Survey 2.0, NRCS 2016 and Description & Interpretive Guide to Soils in Fairfax County dated May 2013. It is important to note that the properties described herein are general in nature.

Table 3.2-1: Soil Type Characteristics by Mapping Unit

Mapping Unit	Soil Group	Typical Terrain	Parent Material	Problems/Limiting Factors for Foundation Support	Soil Class
105B	Wheaton – Glenelg complex	Interfluvies	Mine spoil or earthy fill derived from phyllite	Good (subject to flooding/seasonal high water table)	IVB
105C	Wheaton – Glenelg complex	Interfluvies	Mine spoil or earthy fill derived from phyllite	Good (subject to flooding/seasonal high water table)	IVB

### 3.3 Stratification

The subsurface materials encountered have been stratified for purposes of our discussions herein. These stratum designations do not imply that the materials encountered are continuous across the site. Stratum designations have been established to characterize similar subsurface conditions based on material gradations and parent geology. The generalized subsurface materials encountered in the test borings completed at the site have been assigned to the following strata. A subsurface profile showing the elevations of the encountered strata is shown as Figure A-2 in Appendix A.

Stratum A (Existing Fill)	generally loose to medium dense, SILTY SAND (SM), or firm to very stiff, SANDY LEAN CLAY (CL) and SANDY ELASTIC SILT (MH), WITH ORGANICS AND QUARTZ, contains debris, moist, red, black, brown, and orange
Stratum B (Residual)	generally firm to very stiff, SANDY SILT (ML) and SANDY ELASTIC SILT (MH), or loose to dense, SILTY SAND (SM), micaceous, moist, green brown, orange, and gray
Stratum C (IGM)	generally dense to very dense, SILTY SAND (SM), micaceous, moist, brown and dark gray

The two letter designations included in the strata descriptions presented above and on the test boring logs represent the Unified Soil Classification System (USCS) group symbol and group name for the samples based on laboratory testing per ASTM D-2487 and visual classifications per ASTM D-2488. It should be noted that visual classifications per ASTM D-2488 may not match classifications determined by laboratory testing per ASTM D-2487.

### 3.4 Groundwater

Groundwater level observations were made in the field during drilling and at the end of the day. A summary of the water level readings rounded off to the nearest 0.5 feet elevation is presented below in Table 3.4-1.

Table 3.4-1: Groundwater Level Readings

Test Boring No.	Depth to Groundwater (ft)	Groundwater Elevation (ft)
B-1	Not Encountered	--
B-2	17.5	279.0
B-3	15.0	278.5

The groundwater observations presented herein are considered to be an indication of the groundwater levels at the dates and times indicated. Where more impervious silt and clay soils of Stratum B are encountered, the amount of water seepage into the borings is limited, and it is generally not possible to establish the location of the groundwater table through short term water level observations. Accordingly, the groundwater information presented herein should be used with caution. Also, fluctuations in groundwater levels should be expected with seasons of the year, construction activity, changes to surface grades, precipitation, or other similar factors.

### 3.5 Soil Laboratory Test Results

Selected soil samples obtained from the field investigation were tested for grain size distribution, Atterberg limits, corrosion and concrete attack characteristics, and natural moisture content. A summary of soil

laboratory test results is presented in the following sections and individual soil laboratory test reports are presented in Appendix B.

### 3.5.1 Classification Test Results

A total of five samples were submitted for classification testing, as summarized below in Table 3.5.1-1. Results of additional natural moisture content tests are presented on the test boring logs in Appendix A.

Table 3.5.1-1: Summary of Laboratory Test Results

Test Boring No.	Depth (ft)	Sample Type	Stratum	Description of Soil Specimen	Sieve Results		Atterberg Limits			Natural Moisture Content (%)
					Percent Retained #4 Sieve	Percent Passing #200 Sieve	LL	PL	PI	
B-1	8.0-10.0	Split Spoon	B	SILTY SAND (SM)	0.0	47.7	48	32	16	34.7
B-2	2.0-4.0	Split Spoon	A	SANDY LEAN CLAY (CL)	3.5	56.9	43	24	19	17.5
B-2	6.0-8.0	Split Spoon	B	SANDY ELASTIC SILT (MH)	0.0	63.0	50	30	20	40.0
B-3	0.0-2.0	Split Spoon	A	SANDY ELASTIC SILT (MH)	0.0	69.4	51	30	21	26.0
B-3	13.5-15.0	Split Spoon	B	SILTY SAND (SM)	0.0	42.6	41	27	14	32.2

Notes:

- Soil tests are in accordance with ASTM D2487-11 "Standard Practice for Classification of Soils for Engineering Purposes (Unified Soil Classification System)"
- Key to abbreviations: LL = liquid limit; PL = plastic limit; PI = plasticity index

### 3.5.2 Metal Corrosion Test Results

In addition to standard geotechnical soil laboratory testing, one soil sample was submitted to an analytical laboratory for metal corrosion. Corrosion testing consisted of analysis for moisture content (ASTM D-2216), pH (CA643), resistivity (ASTM G187), sulfides (EPA 376.2), and reduction-oxidation potential (Electrode). The results of these tests are presented below in Table 3.5.2-1:

Table 3.5.2-1: Metal Corrosion Test Results

Test Boring No.	Sample Depth (ft)	Moisture Content (%)	pH	Resistivity (ohm – cm)	Sulfides (ppm)*	Redox Potential (mV)	Point Total
B-2	5.0-7.0	36	6.1	11,000	<1.2	+380	1

\*ppm = mg/kg

For each test presented above, points are assigned based on the range of the test results. If the total points from the five tests completed for a particular sample are 10 or more, the soil is considered to be corrosive. The methods described herein are based on information from the American Water Works Association (AWWA). Using the methods described by AWWA, the point total for the sample tested is equal to 1. Accordingly, the site soils are considered non-corrosive.

### 3.5.3 Concrete Attack Test Results

Sulfate (EPA 375.4) tests were performed on a selected soil sample to determine the severity of sulfate attack on concrete structures. The results of sulfate testing are presented below in Table 3.5.3-1.

Table 3.5.3-1: Sulfate Attack Test Results

Test Boring No.	Sample Depth (ft)	Sulfate Concentration (ppm) *
B-2	5.0-7.0	6.3

\*ppm = mg/kg

Based on correlations between sulfate concentrations and severity of sulfate attack as presented in American Concrete Institute (ACI) 318, the above sulfate concentrations are considered to pose a negligible threat of sulfate attack on concrete.

## 3.6 Seismic Site Classification

We have evaluated the Soil Profile Type and Site Coefficient for this project according to the International Building Code (IBC). Based on the results of the current and previous subsurface investigation and our knowledge of local geologic conditions, the site soils have been assigned to a site class D.

The site coefficients and adjusted Maximum Considered Earthquake (MCE) spectral response acceleration parameters were obtained from the United States Geological Survey (USGS) website and are presented below in Table 3.6-1.

Table 3.6-1: Site Coefficients and Adjusted MCE Spectral Response Acceleration per IBC

Mapped Spectral Accelerations for Site Class D and 5% Damping (Step 1)	Site Coefficients to Modify Accelerations Based on Site Classification D (Step 2)
$S_s = 0.121 \text{ g}$	$F_a = 1.6$
$S_1 = 0.052 \text{ g}$	$F_v = 2.4$
MCE Spectral Response Accelerations (Step 3)	Design Spectral Response Accelerations (Step 4)
$S_{MS} = 0.194 \text{ g}$	$S_{DS} = 0.129 \text{ g}$
$S_{M1} = 0.124 \text{ g}$	$S_{D1} = 0.083 \text{ g}$

## 4.0 Engineering Analysis

Recommendations regarding the platform extension foundations, slope stability analysis, and earthwork are presented herein.

### 4.1 Drilled Pier Foundations for the "Expanded Configuration"

We understand that the proposed platform extensions will be an elevated structural slab supported by 3-foot diameter drilled shafts. Project loads at typical supports were provided to us by Dewberry and are presented in Appendix C. The primary, and a combination of primary and secondary loads, as well as load combinations used for design are summarized below in Table 4.1-1. The analyses were performed for both Load Resistance Factored Design (LRFD) and Allowable Stress Design (ASD) load combinations.



Table 4.1-1: Summary of Platform Loading for Lateral Load Analyses

Load Type	L/Pile Load Case	Shear (lbs)	Axial Load (lbs)	Resultant Moment (lb-in.)*
Unfactored Loads				
Primary Loads	1	0	10,4000	5,014,935
Secondary Loads	2	-1300	116,000	5,497,571
Uplift	3	1300	-8,000	449,695
Factored Loads (LRFD)				
16-2	4	0	135,000	6,634,768
16-6a	5	-1300	71,000	3,405,399
16-6b	6	1300	56,000	2,571,372
Allowable Loads (ASD)				
16-9	4	0	101,000	4,948,283
16-12a	5	-800	75,000	3,567,496
16-13d	6	600	90,000	4,355,711
Applied Lateral Pressure for Train Loads	Applied pressure of $0.8 \times 0.475 \text{ kips/ft}^2 = 0.38 \text{ kips/ft}^2$ , acting with influence length of 25 LF, $0.38 \text{ kips/ft}^2 \times 25 \text{ ft} = 9.5 \text{ kip/ft} = 791.7 \text{ lb/in}$			

\*Resultant Moment =  $\sqrt{M_z^2 + M_x^2}$

The existing subsurface conditions encountered in the test borings performed along the proposed platform extensions are summarized below in Table 4.1-2. Soil design parameters used for drilled shaft load capacity analyses are presented below in Table 4.1-3.

Table 4.1-2: Soil Borings Profile

Test Boring Number	Depth Below Existing Ground Surface (ft)		
	Existing Fill - Stratum A	Fine-Grained Potomac Group - Stratum B	Weathered Rock - Stratum C
B-1	0.0 - 6.0	6.0 - 25.0 (SM)	--
B-2	0.0 - 4.0	4.0 - 37.5 (MH/ML/SM)	37.5 - 50.0 (SM)
B-3	0.0 - 2.0	2.0 - 25.0 (SM)	--

Table 4.1-3: Soil Design Parameters

Soil Design Parameters	Soil Unit Weight (pcf)	Angle of Internal Friction (degrees)	Soil Modulus K (pci)
New Compacted Fill	120	30	30
Stratum A Existing Fill Soil	120	28	30
Stratum B (MH/ML) Above Water Table	120	28	60
Stratum B (MH/ML) Below Water Table*	57.6	28	40
Stratum B (SC/SM) Below Water Table*	62.6	32	90
Stratum C Below Water Table*	67.6	34	125

\*Effective unit weight

LPile version 2015.8.02 was used to analyze the lateral capacity of the proposed drilled shafts. LPile is a computer program based on rational procedures for analyzing a pile or drilled shaft under lateral loading. The program computes the deflection, shear, bending moment, and soil response with respect to depth in nonlinear soils. Soil behavior is modeled with non-linear p-y curves generated by the program based on published recommendations for various types of soil. P-y curves describe the response of the soil as a function of the depth and the shaft deflection. Other factors that influence the analysis include pile geometry, soil properties, type of loading, and pile head boundary conditions. We used a minimum reinforcement provide on the plans (6, #8 bars); however, the actual reinforcing and concrete design must be determined by the structural engineer. Assumed soil properties for the generation of p-y curves were presented above in Table 4.1-3. The lateral earth pressure due to the proximity of the train track was modeled in LPile by applying a distributed pressure of 791.7 lb/in from proposed ground surface to 20 feet below proposed ground surface.

Table 4.1-4 below presents the calculated horizontal deflection and maximum resultant moment for the loads and load combinations provided in Table 4.1-1. The compressive strength of concrete for the analyses is assumed to be 4,000 psi. A permanent steel casing with yield stress of 36 psi and a minimum casing thickness of ¼-inch were used in design. The summary of results for these analyses including deflection, moment, and shear variation with depth are presented in Appendix C. Top deflections under service loads were about 1.0-inch or less. Minimum shaft lengths to satisfy lateral loads are also provided in Table 4.1-4.

Table 4.1-4: Resultant Lateral Response for Shafts

Load Case	Calculated Horizontal Deflection at Shaft Head (inch)	Calculated Resultant Moment (kips-in)	Calculated Resultant Shear (kips)	Depth to Maximum Moment from Top of Shaft (ft)	Minimum Shaft Length for Lateral Loads (ft) *
Unfactored Loads					40
1	0.97	6,343	31	9.5	
2	0.98	6,667	32	9.5	
3	0.59	3,201	24	17.0	



Load Case	Calculated Horizontal Deflection at Shaft Head (inch)	Calculated Resultant Moment (kips-in)	Calculated Resultant Shear (kips)	Depth to Maximum Moment from Top of Shaft (ft)	Minimum Shaft Length for Lateral Loads (ft)*
Factored Loads (LRFD)					40
4	1.12	7,828	37	9.5	
5	0.80	4,792	25	9.5	
6	0.76	4,356	24	9.5	
Allowable Loads (ASD)					
4	1.00	6,280	31	9.5	
5	0.82	4,978	26	9.5	
6	0.92	5,802	29	9.5	

\*Total shaft length is from ground surface which is approximately 2 feet below the top of the shaft.

The caisson embedment shall provide a length where the second point of zero deflection is reached. The second point of zero deflection may be assumed to be the point on the deflection curve where the deflection is decreasing and becomes less than 0.02-inch. In addition, a minimum of one diameter (1D) shaft length was added below the point of fixity to determine the pile minimum length.

The minimum shaft length estimated from the lateral load analysis, as presented above in Table 4.1-4, was used to estimate the axial capacity. We used SHAFT version 2012.7.8 to compute the drilled shaft capacity. The top 5 feet of the drilled shaft and the bottom 3 feet were considered noncontributing to the side resistance of the shaft per AREMA recommendations. Table 4.1-5 below presents the factor of safety and resistance factored used for the design. To account for the reduced skin friction due to the casing the factor or safety and resistance factor for skin friction were reduced by 30%.

Table 4.1-5: Factor of Safety and Resistance Factor for Axial Resistance

	Factor of Safety	Resistance Factor
Skin Friction	3.25*	0.385*
End Bearing	2.5	0.5

\* Reduced by 30% percent to account for the casing.

Drilled shafts axial capacity/resistance plots are presented in Appendix C and are summarized below in Table 4.1-6.

Table 4.1-6: Drilled Shaft Axial Capacity/Resistance

Shaft Diameter (ft)	Ultimate Capacity (kips)	Allowable Capacity (kips)	Nominal Resistance (kips)	Factored Resistance (kips)
	ASD		LRFD	
Skin Friction	290	88	290	110

Shaft Diameter (ft)	Ultimate Capacity (kips)	Allowable Capacity (kips)	Nominal Resistance (kips)	Factored Resistance (kips)
	ASD		LRFD	
Tip Resistance	150	60	150	80
Total	440	148	440	190

\*Total shaft length is from top of shaft that is approximately 2 feet below the proposed grade.

The ultimate axial capacity presented above in Table 4.1-6 is for an isolated/single drilled shaft that are 40 feet long. It is recommended that drilled shafts be spaced at least 3 times the shaft diameter center-to-center. This minimum center-to-center spacing will eliminate the decrease in individual axial pile capacities based upon the group effect. AREMA recommends that a reduction factor of 0.67 be used for a center to center spacing of 3 times the drilled shaft diameter, and no reduction factor for spacing in excess of 6 times the shaft diameter. Linear interpolation shall be used for spacing between 3 times the shaft diameter and 6 times the shaft diameter.

Permanent steel casing extending to the bottom of the drilled shafts should be used to seal out groundwater and to aid in preventing sidewalls from caving. It is recommended that the casing be permanent to protect the drilled shafts from induced train pressures.

Prior to concrete placement, drilled shaft subgrades should be observed by a representative of the geotechnical engineer in order to verify that subgrades are suitable for support of design bearing pressures, and to ensure that subgrades are free of loose or disturbed material. Drilled shafts should extend down to adequate bearing materials as described herein. Bases of drilled shafts should be essentially level. After the shaft is advanced to suitable bearing material, the subgrade should be hand cleaned or suitably mechanically cleaned prior to observation. Pumping of water at the bottom of the caisson may be required to control groundwater during construction.

Concrete should not be placed in standing water in excess of 2 inches in depth. The concrete should have a minimum slump of 5 inches. Concrete may be placed using the free fall method, as long as the concrete does not strike the sides of the casing or any reinforcing steel. If concrete free falls and strikes obstructions, it may segregate and result in zones of low strength concrete. Drilled shafts should be concreted the same day they are drilled and should not be concreted to intermediate depths due to insufficient amounts of concrete at the site. A minimum of 16 hours should be allowed between concrete placement in one drilled shaft before drilling an adjacent drilled shaft.

Drilled piers should be constructed as straight piers at least 30 inches in diameter, to facilitate cleaning of the bottoms and to facilitate observations of end bearing materials. Prior to concrete placement, drilled pier subgrades should be observed by a representative of the geotechnical engineer in order to verify that subgrades are suitable for support of design bearing pressures, and to ensure that subgrades are free of loose or disturbed material.

## 4.2 Slope Stability

Slope stability analyses were performed using the limit equilibrium slope stability program Slope/W version 8.15.1.11236 developed by Geo-Slope International. This computer program was used to generate potential failure surfaces with randomly selected radii and centers. The stability analysis was performed assuming static loading, drained (long-term), and undrained (short-term) soil conditions. A search for the most critical potential failure surfaces occurring within earth materials in the proposed slopes were performed using circular and block failure modes as calculated by the Spencer method. A surcharge load of 175 psf and 650 was used for stairs and train tracks, respectively.

A summary of the critical soil strata shear strength parameters used in the slope stability analyses are presented below in Table 4.2-1. For each analysis, soil shear strength design parameters were selected based on laboratory tests, correlations from SPT blow counts, and our experience with similar soil materials and geologic conditions.

Table 4.2-1: Soil Shear Strength Design Parameters for Slope Stability

Material Description (Stratum)	Unit Weight, g (pcf)	Undrained Strength <sup>1</sup>		Drained Strength	
		Cohesion, c (psf)	Friction Angle, f (degrees)	Cohesion, c' (psf)	Friction Angle, f' (degrees)
New Compacted Fill	120	50	30	50	32
Stratum A Existing Fill Soil	120	0	28	0	28
Stratum B (MH/ML)	120	1,000	0	0	28
Stratum B (SC/SM)	125	0	32	0	32
Stratum C	130	0	34	0	34

Note:

1. Undrained shear strength properties are used for short-term analysis

The results of the slope stability analyses are shown in Table 4.2-2 below and the output files are included in Appendix C.

Table 4.2-2: Slope Stability Analysis

Station Analyzed	Approximate Slope Height (ft)	Condition	Calculated Factor of Safety	Remarks	Target Factor of Safety
Stair	20	Drained	1.5	Satisfactory	1.5
		Undrained	2.2	Satisfactory	

## 4.3 Earthwork

New fill may be required for site grading. Unsuitable existing fill, soft or loose natural soils, organic material, and rubble should be stripped to approved subgrades as determined by the geotechnical engineer. Topsoil depths presented on the boring logs should not be considered as stripping depths. Stripping depths will probably extend to greater depths than the topsoil depths indicated herein due to the presence of minor amounts of organics, roots, and other surficial materials that will require removal as a part of the stripping operations. In addition, seasonal soil moisture variations can affect stripping depths. In general, less stripping may occur during summer months when drier weather conditions can be expected. The depth of required stripping should be determined prior to construction by the excavation contractor using test pits, probes, or other means that the contractor wishes to employ, and this determination should be the responsibility of the excavation contractor. All subgrades should be proofrolled with a minimum 20 ton, loaded dump truck or suitable rubber tire construction equipment approved by the geotechnical engineer, prior to the placement of new fill.

Fill should be placed in horizontal, in lifts not exceeding 8 inches loose thickness. Fill should be compacted at +/- 2% of the optimum moisture content, to at least 95 percent of the maximum dry density per ASTM D-1557 (modified Proctor).

Fill placed along slopes steeper than 5H:1V should be benched into the existing slope. Benches should consist of minimum 8 feet wide level cut, and at least one such bench should be used for each 3 feet of vertical rise of fill placed.

Materials used for compacted fill should consist of soils classifying SM, SP, SW, GM, GP, or GW per ASTM D-2487, with a maximum dry density greater than 105 pcf. It is expected that portions of soils excavated at the site will be suitable for re-use as fill based on classification. However, the Stratum A existing fill may not be suitable for re-use as new compacted fill due to deleterious man-made materials in the fill. In addition, drying of excavated soils by spreading and aerating may be necessary to obtain proper compaction. This may not be practical during the wet period of the year. Accordingly, earthwork operations should be planned for early Spring through late Fall, when drier weather conditions can be expected. Individual borrow areas, both from on-site and off-site sources, should be sampled and tested to verify classification of materials prior to their use as fill.

Fill materials should not be placed on frozen or frost-heaved soils, and/or soils that have been recently subjected to precipitation. All frozen or frost-heaved soils should be removed prior to continuation of fill operations. Borrow fill materials should not contain frozen materials at the time of placement.

Compaction equipment that is compatible with the soil type used for fill should be selected. Theoretically, any equipment type can be used as long as the required density is achieved; however, sheepsfoot roller equipment are best suited for fine-grained soils and vibratory smooth drum rollers are best suited for granular soils. Ideally, a smooth drum roller should be used for sealing the surface soils at the end of the day or prior to upcoming rain events. In addition, compaction equipment used adjacent to walls below grade should be selected so as to not impose undesirable surcharge on walls. All areas receiving fill should be graded to facilitate positive drainage of any water associated with precipitation and surface run-off.

For utility excavation backfill, it is recommended that crushed stone with a maximum 2-inch aggregate size with no more than 5 percent passing the No. 200 sieve be used to backfill the pipe trench to the spring line of the pipe. For backfill above the spring line of the pipe, hand operated compaction equipment should be used until the backfill has reached a level 1 foot above the top of the pipe to prevent damaging the pipe. Also, backfill material within 2 feet of the top of the pipe should not contain rock fragments or gravel greater than 1-inch in diameter. All backfilled pipes laid either perpendicular or parallel to the tracks must be designed so that the backfill material will be positively drained. This may require the placement of lateral drains on pipes laid longitudinally to the track and the installation of perforated pipes at the edge of the slopes.

After completion of compacted fill operations, construction of foundation elements should begin immediately, or the finished subgrade should be protected from exposure to inclement weather conditions. Exposure to precipitation and freeze/thaw cycles will cause the finished subgrade to soften and become excessively disturbed. If development plans require that finished subgrades remain exposed to weather conditions after completion of fill operations, additional fill should be placed above finished grades to protect the newly placed fill. Alternatively, a budget should be established for reworking of the upper 1 to 2 feet of previously placed compacted fill.

## 5.0 Considerations for the “Ultimate Configuration”

A preliminary assessment of the expected subsurface conditions for the “Ultimate Configuration” area for future planning purposes are presented herein.

### 5.1 Design Concept 1: Pedestrian Bridge

Design Concept 1 consists of constructing an elevated pedestrian bridge over the existing tracks. The elevated pedestrian bridge will be supported by stair/elevator towers located on both ends of the pedestrian bridge. Spread footings founded on natural soils for a preliminary design bearing pressure of 3,000 psf are

considered suitable for support of the proposed bridge foundations. However, up to about 6 feet of fill was encountered on the south side of the tracks, and we anticipate that existing fill associated with previous development may be encountered on the northern side as well. If existing fill is encountered, lowering of foundations through the existing fill materials will be required to achieve the design bearing pressure. The feasibility of spread footings will also depend on the magnitude of the loads being transmitted from the pedestrian bridge. In case uplift or lateral forces cannot be controlled using spread footings, a mat foundation system or deep foundations may be considered for support of the pedestrian bridge.

We recommend that additional test borings be performed at each stair/elevator tower to provide a detailed profile of the subsurface conditions along the bridge alignment. We also recommend that additional laboratory tests be performed to assess the compressibility and shear strength properties of the soil profile beneath each stair tower.

## 5.2 Design Concept 2: Tunnel

Design Concept 2 consists of constructing a pedestrian tunnel under the tracks. Tunnel advancing methods will be selected based on the findings of a final subsurface investigation. The feasibility of jack and bore of a box culvert is being considered at this time. The culvert section will be a rectangular section with internal dimensions of about 8.5 feet and will run beneath the train tracks for about 120 feet. The top and bottom of the tunnel lining are planned at approximately EL 296 and EL 286, respectively. It is our understanding that for pipe jacking, the minimum cover over the crown of the casing should be at least 5.5 feet per CSX specifications. The jacking and receiving pits should be no closer to the existing tracks than 15 feet.

Test boring B-2 was drilled at the proposed tunnel alignment. Based on the soil strata encountered in test boring B-2, it appears that the tunneling installation will advance through natural soils, with existing fill materials in the upper part of the excavation that could be variable. We recommend that additional test borings be drilled at each end of the proposed jack and bore operation. We also recommend that additional laboratory tests be performed to assess the shear strength properties of the soil profile, and to determine the soil classification according to the Terzaghi's Tunnelman's Ground Classification System.

Test boring B-2 indicated groundwater at EL 279, or at least 7 feet below the bottom of the tunnel lining. However, no long-term groundwater readings were taken and groundwater elevations might be shallower than indicated. Therefore, we recommend that longer-term groundwater readings be taken to confirm the groundwater elevation for final design.

Ground movement/settlement should be monitored for all structures, tracks, and any other areas of concern within the vicinity of the tunnel bore alignment. Surface settlement and track monitoring points should be established along the centerline and at horizontal offsets from the tunnel centerline.

## 6.0 General Limitations

Recommendations contained in this report are based upon the data obtained from the relatively limited number of test borings. This report does not reflect conditions that may occur between the points investigated, or between sampling intervals in test borings. The nature and extent of variations between test borings and sampling intervals may not become evident until the course of construction. Therefore, it is essential that on-site observations of subgrade conditions be performed during the construction period to determine if re-evaluation of the recommendations in this report must be made. It is critical to the successful completion of this project that GeoConcepts be retained during construction to observe the implementation of the recommendations provided herein.

This report has been prepared to aid in the evaluation of the site and to assist your office and the design professionals in the design of this project. It is intended for use with regard to the specific project as described herein. Changes in proposed construction, grading plans, structural loads, etc. should be brought to our attention so that we may determine any effect on the recommendations presented herein.

An allowance should be established for additional costs that may be required for foundation and earthwork construction as recommended in this report. Additional costs may be incurred for various reasons including wet fill materials, soft subgrade conditions, unexpected groundwater problems, etc.

This report should be made available to bidders prior to submitting their proposals to supply them with facts relative to the subsurface conditions revealed by our investigation and the results of analyses and studies that have been performed for this project. In addition, this report should be given to the successful contractor and subcontractors for their information only.

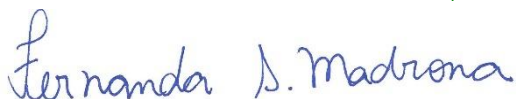
We recommend the project specifications contain the following statement: "A geotechnical engineering report has been prepared for this project by GeoConcepts Engineering, Inc. This report is for informational purposes only and should not be considered part of the contract documents. The opinions expressed in this report are those of the geotechnical engineer and represent their interpretation of the subsoil conditions, tests and results of analyses that they performed. Should the data contained in this report not be adequate for the contractor's purposes, the contractor may make their own investigations, tests and analyses prior to bidding."

This report was prepared in accordance with generally accepted geotechnical engineering practices. No warranties, expressed or implied, are made as to the professional services included in this report.


We appreciate the opportunity to be of service for this project. Please contact the undersigned if you require clarification of any aspect of this report.

Sincerely,

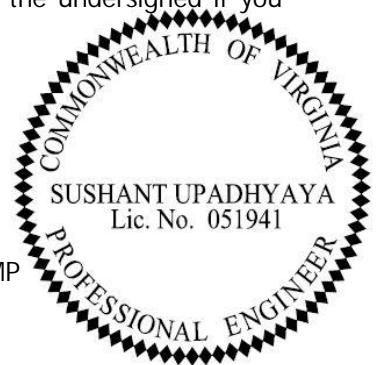
**GEOCONCEPTS ENGINEERING, INC.**



Fernanda Madrona, PE  
Project Manager



Sushant Upadhyaya, PhD, PE, PMP  
Senior Associate

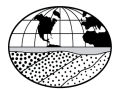


KRH/FM/SU/PEB/shm  
N:\Projects\2018\JD185036\Working Files\Final Report\GER-Rolling Road Platform.docx





COPYRIGHT OPEN STREET MAP



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A Terracon COMPANY

19955 Highland Vista Dr., Suite 170 (703) 726-8030  
Ashburn, Virginia 20147 (703) 726-8032 fax

VRE ROLLING ROAD STATION PLATFORM EXTENSION  
9016 BURKE ROAD, BURKE, VIRGINIA

SITE VICINITY MAP

Scale:  
N.T.S.

Fig.

Date:  
JAN. 2017

Drawn By:  
K.M.H

Checked By:  
F.M.

Project No.:  
16045

1

# Appendix A

## Subsurface Investigation

---

Subsurface Investigation Procedures (1 page)

Identification of Soil (1 page)

Test Boring Notes (1 page)

Test Boring Logs (4 pages)

Boring Location Plan, Figure A-1 (1 page)

Subsurface Diagram, Figure A-2 (1 page)

Soil Resource Report (25 pages)



## Subsurface Investigation Procedures

---

### 1. Test Borings – Hollow Stem Augers

The borings are advanced by turning an auger with a center opening of 3-¼ inches. A plug device blocks off the center opening while augers are advanced. Cuttings are brought to the surface by the auger flights. Sampling is performed through the center opening in the hollow stem auger, by standard methods, after removal of the plug. Usually, no water is introduced into the boring using this procedure.

### 2. Standard Penetration Tests

Standard penetration tests are performed by driving a 2-inch O.D., 1-¾ inch I.D. sampling spoon with a 140-pound hammer falling 30 inches, according to ASTM D-1586. After an initial 6 inches penetration to assure the sampling spoon is in undisturbed material, the number of blows required to drive the sampler an additional 12 inches is generally taken as the N value. In the event 30 or more blows are required to drive the sampling spoon the initial 6-inch interval, the sampling spoon is driven to a total penetration resistance of 100 blows or 18 inches, whichever occurs first.

### 3. Test Boring Stakeout

The test boring stakeout was provided by the project civil engineer.

# Identification of Soil

I. DEFINITION OF SOIL GROUP NAMES		ASTM D-2487	Symbol	Group Name
Coarse-Grained Soils More than 50% retained on No. 200 sieve	<b>Gravels</b> More than 50% of coarse fraction retained on No. 4 sieve	Clean Gravels Less than 5% fines	<i>GW</i>	WELL GRADED GRAVEL
			<i>GP</i>	POORLY GRADED GRAVEL
		Gravels with Fines More than 12% fines	<i>GM</i>	silty GRAVEL
			<i>GC</i>	clayey GRAVEL
	<b>Sands</b> 50% or more of coarse fraction passes No. 4 sieve	Clean Sands Less than 5% fines	<i>SW</i>	WELL GRADED SAND
			<i>SP</i>	POORLY GRADED SAND
		Sands with fines More than 12% fines	<i>SM</i>	silty SAND
			<i>SC</i>	clayey SAND
Fine-Grained Soils 50% or more passes the No. 200 sieve	<b>Silts and Clays</b> Liquid Limit less than 50	Inorganic	<i>CL</i>	LEAN CLAY
			<i>ML</i>	SILT
		Organic	<i>OL</i>	ORGANIC CLAY
				ORGANIC SILT
	<b>Silts and Clays</b> Liquid Limit 50 or more	Inorganic	<i>CH</i>	FAT CLAY
			<i>MH</i>	ELASTIC SILT
		Organic	<i>OH</i>	ORGANIC CLAY
				ORGANIC SILT
Highly Organic Soils	Primarily organic matter, dark in color, and organic odor		<i>PT</i>	PEAT

## II. DEFINITION OF MINOR COMPONENT PROPORTIONS

<u>Minor Component</u>	<u>Approximate Percentage of Fraction by Weight</u>
Gravelly, Sandy (adjective)	30% or more coarse grained
Sand, Gravel	15% to 29% coarse grained
Silt, Clay	5% to 12% fine grained

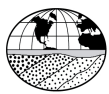
## III. GLOSSARY OF MISCELLANEOUS TERMS

<b>SYMBOLS</b>	Unified Soil Classification Symbols are shown above as group symbols. Use "A" Line Chart for laboratory identification. Dual symbols are used for borderline classification.
<b>BOULDERS &amp; COBBLES</b>	Boulders are considered pieces of rock larger than 12 inches, while cobbles range from 3 to 12 inches.
<b>WEATHERED ROCK</b>	Residual rock material with a standard penetration test (SPT) resistance of at least 60 blows per foot.
<b>ROCK/SPOON REFUSAL</b>	Rock material with a standard penetration test (SPT) resistance of 50 blows for 1 inch.
<b>ROCK FRAGMENTS</b>	Angular pieces of rock which have separated from original vein or strata and are present in a soil matrix. Only used in residual soils
<b>QUARTZ</b>	A hard silicate mineral often found in residual soils. Only used when describing residual soils.
<b>CEMENTED SAND</b>	Usually localized rock-like deposits within a soil stratum composed of sand grains cemented by calcium carbonate, iron oxide, or other minerals. Commonly encountered in Coastal Plain sediments, primarily in the Potomac Group sands (Kps).
<b>MICACEOUS</b>	A term used to describe soil that "glitters" or is shiny. Most commonly encountered in fine-grained soils.
<b>ORGANIC MATERIALS (Excluding Peat)</b>	Topsoil - Surface soils that support plant life and contain organic matter.
<b>FILL</b>	Lignite - Hard, brittle decomposed organic matter with low fixed carbon content (a low grade of coal).
<b>CONTAINS</b>	Man-made deposit containing soil, rock, and other foreign matter.
	This is used when a fill deposit contains a secondary component that does not apply to a USCS classification. Only used for fill deposits
<b>WITH</b>	This is used when a residual soil contains a secondary component that does not contribute to its USCS classification. Only used for natural soils.
<b>PROBABLE FILL LAYERS</b>	Soils which contain no visually detected foreign matter but which are suspect with regard to origin.
<b>COLOR</b>	½ to 12 inch seam of minor soil component.
<b>MOISTURE CONDITIONS</b>	Two most predominant colors present should be described.
<b>GAIN SIZE</b>	Wet, moist, or dry to indicate visual appearance of specimen.
	Fine-medium-coarse

## Test Boring Notes

---

1. Classification of soil is by visual inspection and is in accordance with ASTM D-2488.
2. Estimated groundwater levels are indicated on the logs. These are only estimates from available data and may vary with precipitation, porosity of soil, site topography, etc.
3. Sampling data presents standard penetrations for 6-inch intervals or as indicated with graphic representations adjacent to the sampling data.
4. The logs and related information depict subsurface conditions at the specific locations and at the particular time when drilled. Soil conditions at other locations may differ from conditions occurring at the test locations. Also, the passage of time may result in a change in the subsurface conditions at the test locations.
5. The stratification lines represent the approximate boundary between soil types as determined in the sampling operation. Some variation may be expected vertically between samples taken. The soil profile, groundwater level observations and penetration resistances presented on the logs have been made with reasonable care and accuracy and must be considered only an approximate representation of subsurface conditions to be encountered at the particular location.

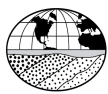


PROJECT: <b>VRE Rolling Road Station Platform Extension</b>		LOGGED BY: <b>K. Hayes</b>	BORING NUMBER: <b>B-1</b>
LOCATION: <b>9016 Burke Road, Burke, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>	
OWNER/CLIENT: <b>Dewberry</b>		DRILLER: <b>C. Gudiel</b>	DATES DRILLED: <b>12/7/16 - 12/7/16</b>
PROJECT NUMBER: <b>16045</b>	GROUND SURFACE ELEVATION (ft): <b>298.2</b>	DRILLING METHOD: <b>Automatic hammer 3.25"</b>	OFFSET NOTES:

ELEV. (ft)	DEPTH (ft)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL			
						SPT BLOW COUNTS	REC (in)	STANDARD PENETRATION TEST RESISTANCE (BPF)	MC (%)
298.2					Topsoil = 0.17ft.				
298.0					Fill, brown, fine to medium, SILTY SAND, contains debris,	4+6+8+12	6		17.9
296.2					medium dense, moist, <b>SM</b>				
					Loose				
294.2			A		Brown and black, fine	4+4+4+4	2		
	5					3+2+5+5	3		
292.2					Residual, light brown, fine, SILT WITH SAND, micaceous, firm,				
					moist, <b>ML</b>	2+2+3+4	16		
290.2					Residual, green brown, fine, SILTY SAND, micaceous, loose,				
					moist, <b>SM</b>	1+2+2+3	21		34.7
	10								
284.7			B		Brown	1+2+3	18		
	15								
279.7					Light brown	3+4+5	18		
	20								
						2+3+4	18		
273.2	25				Bottom of Boring at 25.0 ft				

GROUND WATER LEVELS:	SAMPLE TYPES:
NOT ENCOUNTERED DURING DRILLING	<input checked="" type="checkbox"/> Split Spoon
NOT ENCOUNTERED UPON COMPLETION	
CAVED: <u>15.0</u> ft ELEV. <u>283.2</u>	

REMARKS: Borehold backfilled upon completion.



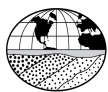
PROJECT: <b>VRE Rolling Road Station Platform Extension</b>		LOGGED BY: <b>K. Hayes</b>		BORING NUMBER: <b>B-2</b>
LOCATION: <b>9016 Burke Road, Burke, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>		
OWNER/CLIENT: <b>Dewberry</b>		DRILLER: <b>C. Gudiel</b>		DATES DRILLED: <b>12/7/16 - 12/7/16</b>
PROJECT NUMBER: <b>16045</b>	GROUND SURFACE ELEVATION (ft): <b>296.4</b>	DRILLING METHOD: <b>Automatic hammer 3.25"</b>		OFFSET NOTES:

ELEV. (ft)	DEPTH (ft)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL			
						SPT BLOW COUNTS	REC (in)	STANDARD PENETRATION TEST RESISTANCE (BPF)	MC (%)
296.4 296.3 295.4 294.4			A		Topsoil = 0.08ft. Fill, red brown, fine, SANDY LEAN CLAY, contains organics, very stiff, moist, <b>CL</b> Orange and brown, contains quartz, stiff, without organics	2+7+9+8	23		
292.4						3+4+5+5	8		17.5
290.4	5				Residual, orange and light brown, fine, SANDY ELASTIC SILT, micaceous, firm, moist, <b>MH</b> Stiff	3+4+4+7	19		
288.4					Light brown and orange, firm	4+5+5+7	19		40.0
282.9	10					4+3+4+8	24		
277.9	15		B		Residual, light brown and orange, fine, sandy SILT, micaceous, stiff, moist, <b>ML</b>	3+3+6	18		34.1
272.9	20				Brown and dark gray, very stiff	4+9+11	18		
272.9	25				Residual, brown and dark gray, fine to medium, silty SAND, micaceous, dense, moist, <b>SM</b>	10+14+17	18		

GROUND WATER LEVELS:				SAMPLE TYPES:			
ENCOUNTERED:	23.0	ft	ELEV.	273.4	<input checked="" type="checkbox"/> Split Spoon		
UPON COMPLETION:	25.0	ft	ELEV.	271.4			
12/7/1980	17.4	ft	ELEV.	279.0			
CAVED:				40.0	ft	ELEV.	256.4

REMARKS:

THE STRATIFICATION LINES REPRESENT APPROXIMATE BOUNDARIES. THE TRANSITION MAY BE GRADUAL.

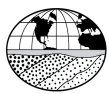


PROJECT: <b>VRE Rolling Road Station Platform Extension</b>	LOGGED BY: <b>K. Hayes</b>	BORING NUMBER: <b>B-2</b>
LOCATION: <b>9016 Burke Road, Burke, Virginia</b>	DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>	
		SHEET 2 OF 2

ELEV. (ft)	DEPTH (ft)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SPT BLOW COUNTS	REC (in)	SOIL		
								STANDARD PENETRATION TEST RESISTANCE (BPF)		
267.9	30	X	B		<i>Residual</i> , brown and dark gray, fine to medium, silty SAND, micaceous, dense, moist, <b>SM</b> (continued) White and gray, very dense	17+24+33	18	20	40	60
262.9	35	X			<i>Weathered rock</i> , brown and dark gray, fine to medium, silty SAND, micaceous, very dense, moist, <b>SM</b>	27+49+50/4	16			
257.9	40	X	C		Light gray, dense	17+15+24	16			
252.9	45	X			Very dense	50/4	4			
246.4	50	X			Bottom of Boring at 50.0 ft	50/4	4			
	55									

GROUND WATER LEVELS:	SAMPLE TYPES:
▽ ENCOUNTERED: <u>23.0</u> ft ELEV. <u>273.4</u> ▽ UPON COMPLETION: <u>25.0</u> ft ELEV. <u>271.4</u> ▽ 12/7/1980 <u>17.4</u> ft ELEV. <u>279.0</u>	▽ Split Spoon CAVED: <u>40.0</u> ft ELEV. <u>256.4</u>

REMARKS:

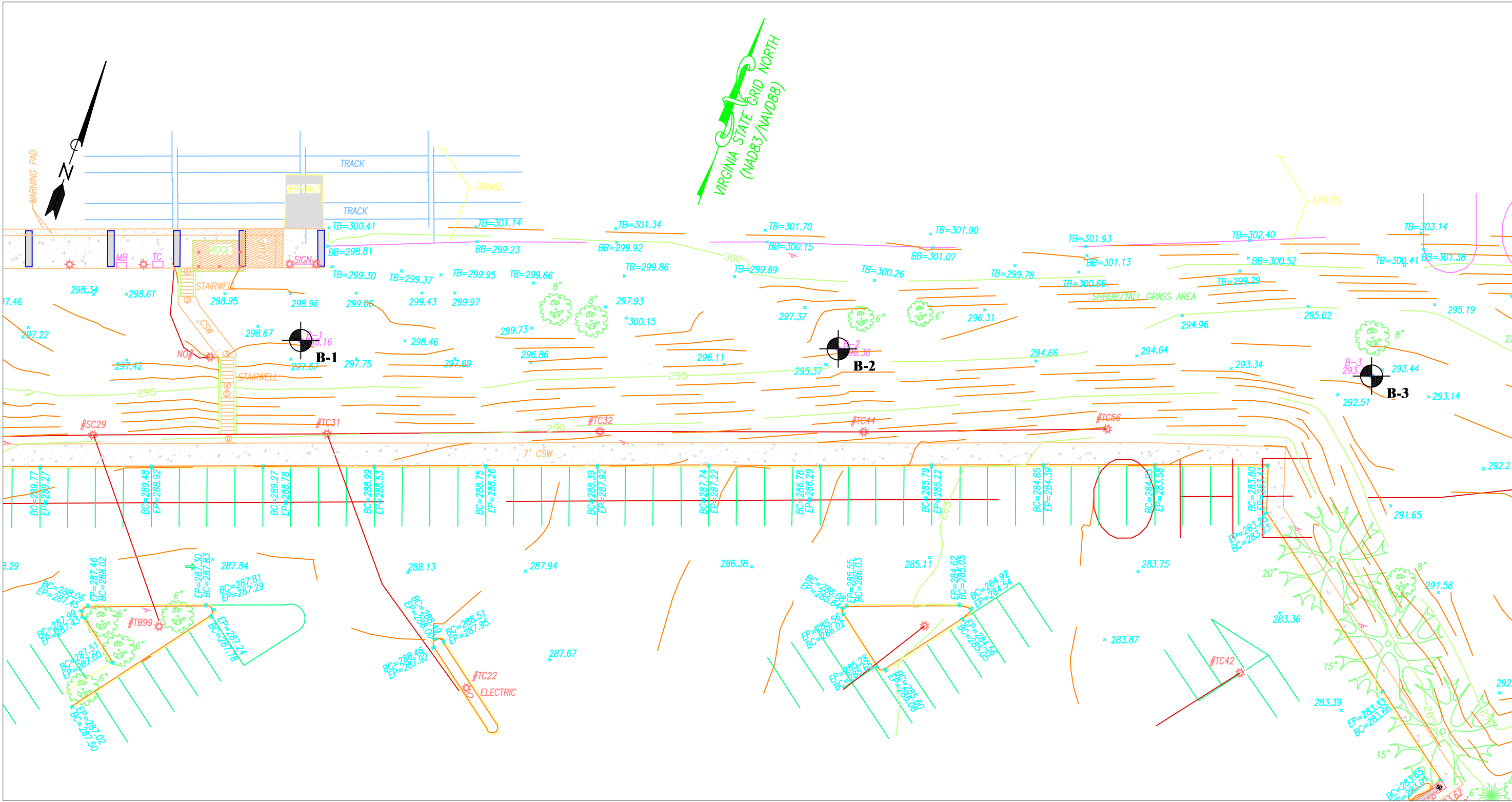


PROJECT: <b>VRE Rolling Road Station Platform Extension</b>		LOGGED BY: <b>K. Hayes</b>	BORING NUMBER: <b>B-3</b>
LOCATION: <b>9016 Burke Road, Burke, Virginia</b>		DRILLING CONTRACTOR: <b>Connelly &amp; Associates Inc.</b>	
OWNER/CLIENT: <b>Dewberry</b>		DRILLER: <b>C. Gudiel</b>	DATES DRILLED: <b>12/7/16 - 12/7/16</b>
PROJECT NUMBER: <b>16045</b>	GROUND SURFACE ELEVATION (ft): <b>293.3</b>	DRILLING METHOD: <b>Automatic hammer 3.25"</b>	OFFSET NOTES:

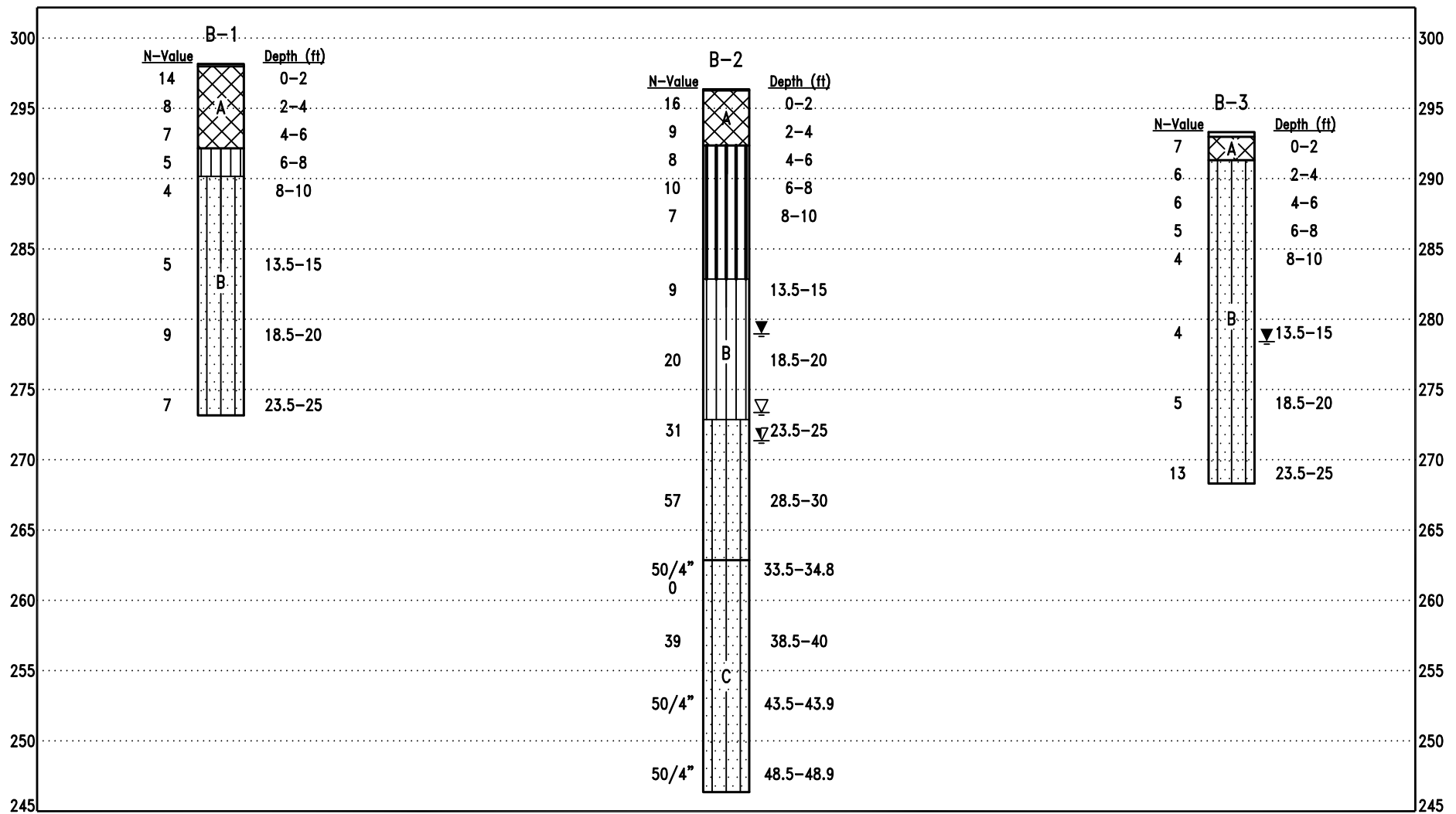
ELEV. (ft)	DEPTH (ft)	SAMPLE TYPE	STRATUM	GRAPHIC	MATERIAL DESCRIPTION	SOIL			
						SPT BLOW COUNTS	REC (in)	STANDARD PENETRATION TEST RESISTANCE (BPF) 20 40 60 80	MC (%)
293.3			A		Topsoil = 0.33ft.				
293.0					Fill, red brown, fine, SANDY ELASTIC SILT, firm, moist, <b>MH</b>	5+4+3+4	21		26.0
293.0									
291.8									
291.3			B		Residual, brown, fine, SILTY SAND, micaceous, loose, moist, <b>SM</b>	2+3+3+4	16		
	5								
						3+3+3+4	21		
						2+2+3+4	23		29.3
	10					2+2+2+3	22		
279.8					Green brown	1+2+2	18		32.2
	15								
274.8					Light brown and orange	2+2+3	18		
	20								
269.8					Light brown, medium dense	4+5+8	18		
	25								
268.3					Bottom of Boring at 25.0 ft				

GROUND WATER LEVELS:		SAMPLE TYPES: Split Spoon
NOT ENCOUNTERED DURING DRILLING		
NOT ENCOUNTERED UPON COMPLETION		
12/7/2016      14.9 ft      ELEV. 278.4 CAVED: 22.0 ft      ELEV. 271.3		

REMARKS:
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# LEGEND

## GROUND WATER LEVELS:

ENCOUNTERED

BEFORE REMOVING CASING

END OF THE DAY



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19955 Highland Vista Dr., Suite 170 (703) 726-8030  
Ashburn, Virginia 20147 (703) 726-8032 fax

VRE ROLLING ROAD STATION PLATFORM EXTENSION  
9016 BURKE ROAD, BURKE, VIRGINIA

## SUBSURFACE DIAGRAM

Scale:  
NONE

Fig.

Date:  
JAN. 2017

Drawn By:  
F.M.

Checked By:  
S.U.

Project No.:  
16045

A-2

# Custom Soil Resource Report for **Fairfax County, Virginia**



# Preface

---

Soil surveys contain information that affects land use planning in survey areas. They highlight soil limitations that affect various land uses and provide information about the properties of the soils in the survey areas. Soil surveys are designed for many different users, including farmers, ranchers, foresters, agronomists, urban planners, community officials, engineers, developers, builders, and home buyers. Also, conservationists, teachers, students, and specialists in recreation, waste disposal, and pollution control can use the surveys to help them understand, protect, or enhance the environment.

Various land use regulations of Federal, State, and local governments may impose special restrictions on land use or land treatment. Soil surveys identify soil properties that are used in making various land use or land treatment decisions. The information is intended to help the land users identify and reduce the effects of soil limitations on various land uses. The landowner or user is responsible for identifying and complying with existing laws and regulations.

Although soil survey information can be used for general farm, local, and wider area planning, onsite investigation is needed to supplement this information in some cases. Examples include soil quality assessments (<http://www.nrcs.usda.gov/wps/portal/nrcs/main/soils/health/>) and certain conservation and engineering applications. For more detailed information, contact your local USDA Service Center (<http://offices.sc.egov.usda.gov/locator/app?agency=nrcs>) or your NRCS State Soil Scientist ([http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2\\_053951](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/contactus/?cid=nrcs142p2_053951)).

Great differences in soil properties can occur within short distances. Some soils are seasonally wet or subject to flooding. Some are too unstable to be used as a foundation for buildings or roads. Clayey or wet soils are poorly suited to use as septic tank absorption fields. A high water table makes a soil poorly suited to basements or underground installations.

The National Cooperative Soil Survey is a joint effort of the United States Department of Agriculture and other Federal agencies, State agencies including the Agricultural Experiment Stations, and local agencies. The Natural Resources Conservation Service (NRCS) has leadership for the Federal part of the National Cooperative Soil Survey.

Information about soils is updated periodically. Updated information is available through the NRCS Web Soil Survey, the site for official soil survey information.

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# Contents

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<b>Preface</b> .....	2
<b>How Soil Surveys Are Made</b> .....	5
<b>Soil Map</b> .....	7
Soil Map.....	8
Legend.....	9
Map Unit Legend.....	10
Map Unit Descriptions.....	10
Fairfax County, Virginia.....	12
4C—Barkers Crossroads-Nathalie complex, 7 to 15 percent slopes.....	12
30A—Codorus and Hatboro soils, 0 to 2 percent slopes, occasionally flooded.....	13
39B—Glenelg silt loam, 2 to 7 percent slopes.....	15
39C—Glenelg silt loam, 7 to 15 percent slopes.....	16
79C—Nathalie gravelly loam, 7 to 15 percent slopes.....	17
95—Urban land.....	18
96—Urban land-Barker Crossroads complex.....	18
101—Urban land-Wheaton complex.....	19
105B—Wheaton-Glenelg complex, 2 to 7 percent slopes.....	20
105C—Wheaton-Glenelg complex, 7 to 15 percent slopes.....	22
<b>References</b> .....	24

# How Soil Surveys Are Made

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Soil surveys are made to provide information about the soils and miscellaneous areas in a specific area. They include a description of the soils and miscellaneous areas and their location on the landscape and tables that show soil properties and limitations affecting various uses. Soil scientists observed the steepness, length, and shape of the slopes; the general pattern of drainage; the kinds of crops and native plants; and the kinds of bedrock. They observed and described many soil profiles. A soil profile is the sequence of natural layers, or horizons, in a soil. The profile extends from the surface down into the unconsolidated material in which the soil formed or from the surface down to bedrock. The unconsolidated material is devoid of roots and other living organisms and has not been changed by other biological activity.

Currently, soils are mapped according to the boundaries of major land resource areas (MLRAs). MLRAs are geographically associated land resource units that share common characteristics related to physiography, geology, climate, water resources, soils, biological resources, and land uses (USDA, 2006). Soil survey areas typically consist of parts of one or more MLRA.

The soils and miscellaneous areas in a survey area occur in an orderly pattern that is related to the geology, landforms, relief, climate, and natural vegetation of the area. Each kind of soil and miscellaneous area is associated with a particular kind of landform or with a segment of the landform. By observing the soils and miscellaneous areas in the survey area and relating their position to specific segments of the landform, a soil scientist develops a concept, or model, of how they were formed. Thus, during mapping, this model enables the soil scientist to predict with a considerable degree of accuracy the kind of soil or miscellaneous area at a specific location on the landscape.

Commonly, individual soils on the landscape merge into one another as their characteristics gradually change. To construct an accurate soil map, however, soil scientists must determine the boundaries between the soils. They can observe only a limited number of soil profiles. Nevertheless, these observations, supplemented by an understanding of the soil-vegetation-landscape relationship, are sufficient to verify predictions of the kinds of soil in an area and to determine the boundaries.

Soil scientists recorded the characteristics of the soil profiles that they studied. They noted soil color, texture, size and shape of soil aggregates, kind and amount of rock fragments, distribution of plant roots, reaction, and other features that enable them to identify soils. After describing the soils in the survey area and determining their properties, the soil scientists assigned the soils to taxonomic classes (units). Taxonomic classes are concepts. Each taxonomic class has a set of soil characteristics with precisely defined limits. The classes are used as a basis for comparison to classify soils systematically. Soil taxonomy, the system of taxonomic classification used in the United States, is based mainly on the kind and character of soil properties and the arrangement of horizons within the profile. After the soil scientists classified and named the soils in the survey area, they compared the

individual soils with similar soils in the same taxonomic class in other areas so that they could confirm data and assemble additional data based on experience and research.

The objective of soil mapping is not to delineate pure map unit components; the objective is to separate the landscape into landforms or landform segments that have similar use and management requirements. Each map unit is defined by a unique combination of soil components and/or miscellaneous areas in predictable proportions. Some components may be highly contrasting to the other components of the map unit. The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The delineation of such landforms and landform segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, onsite investigation is needed to define and locate the soils and miscellaneous areas.

Soil scientists make many field observations in the process of producing a soil map. The frequency of observation is dependent upon several factors, including scale of mapping, intensity of mapping, design of map units, complexity of the landscape, and experience of the soil scientist. Observations are made to test and refine the soil-landscape model and predictions and to verify the classification of the soils at specific locations. Once the soil-landscape model is refined, a significantly smaller number of measurements of individual soil properties are made and recorded. These measurements may include field measurements, such as those for color, depth to bedrock, and texture, and laboratory measurements, such as those for content of sand, silt, clay, salt, and other components. Properties of each soil typically vary from one point to another across the landscape.

Observations for map unit components are aggregated to develop ranges of characteristics for the components. The aggregated values are presented. Direct measurements do not exist for every property presented for every map unit component. Values for some properties are estimated from combinations of other properties.

While a soil survey is in progress, samples of some of the soils in the area generally are collected for laboratory analyses and for engineering tests. Soil scientists interpret the data from these analyses and tests as well as the field-observed characteristics and the soil properties to determine the expected behavior of the soils under different uses. Interpretations for all of the soils are field tested through observation of the soils in different uses and under different levels of management. Some interpretations are modified to fit local conditions, and some new interpretations are developed to meet local needs. Data are assembled from other sources, such as research information, production records, and field experience of specialists. For example, data on crop yields under defined levels of management are assembled from farm records and from field or plot experiments on the same kinds of soil.

Predictions about soil behavior are based not only on soil properties but also on such variables as climate and biological activity. Soil conditions are predictable over long periods of time, but they are not predictable from year to year. For example, soil scientists can predict with a fairly high degree of accuracy that a given soil will have a high water table within certain depths in most years, but they cannot predict that a high water table will always be at a specific level in the soil on a specific date.

After soil scientists located and identified the significant natural bodies of soil in the survey area, they drew the boundaries of these bodies on aerial photographs and identified each as a specific map unit. Aerial photographs show trees, buildings, fields, roads, and rivers, all of which help in locating boundaries accurately.

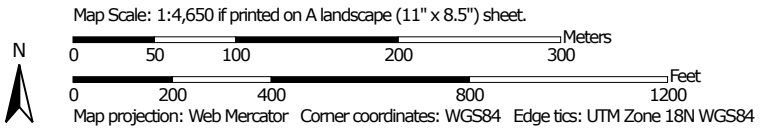
# Soil Map

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The soil map section includes the soil map for the defined area of interest, a list of soil map units on the map and extent of each map unit, and cartographic symbols displayed on the map. Also presented are various metadata about data used to produce the map, and a description of each soil map unit.



# Custom Soil Resource Report Soil Map



## MAP LEGEND

### Area of Interest (AOI)

 Area of Interest (AOI)

### Soils

 Soil Map Unit Polygons

 Soil Map Unit Lines

 Soil Map Unit Points

### Special Point Features

 Blowout


 Borrow Pit


 Clay Spot


 Closed Depression

 Gravel Pit

 Gravelly Spot


 Landfill

 Lava Flow

 Marsh or swamp

 Mine or Quarry


 Miscellaneous Water


 Perennial Water

 Rock Outcrop


 Saline Spot

 Sandy Spot

 Severely Eroded Spot

 Sinkhole


 Slide or Slip

 Sodic Spot

 Spoil Area

 Stony Spot


 Very Stony Spot

 Wet Spot

 Other

 Special Line Features

### Water Features

 Streams and Canals


### Transportation

 Rails


 Interstate Highways

 US Routes

 Major Roads

 Local Roads

### Background

 Aerial Photography

## MAP INFORMATION

The soil surveys that comprise your AOI were mapped at 1:12,000.

Warning: Soil Map may not be valid at this scale.

Enlargement of maps beyond the scale of mapping can cause misunderstanding of the detail of mapping and accuracy of soil line placement. The maps do not show the small areas of contrasting soils that could have been shown at a more detailed scale.

Please rely on the bar scale on each map sheet for map measurements.

Source of Map: Natural Resources Conservation Service  
Web Soil Survey URL: <http://websoilsurvey.nrcs.usda.gov>  
Coordinate System: Web Mercator (EPSG:3857)

Maps from the Web Soil Survey are based on the Web Mercator projection, which preserves direction and shape but distorts distance and area. A projection that preserves area, such as the Albers equal-area conic projection, should be used if more accurate calculations of distance or area are required.

This product is generated from the USDA-NRCS certified data as of the version date(s) listed below.

Soil Survey Area: Fairfax County, Virginia  
Survey Area Data: Version 13, Sep 27, 2016

Soil map units are labeled (as space allows) for map scales 1:50,000 or larger.

Date(s) aerial images were photographed: Data not available.

The orthophoto or other base map on which the soil lines were compiled and digitized probably differs from the background imagery displayed on these maps. As a result, some minor shifting of map unit boundaries may be evident.

## Map Unit Legend

Fairfax County, Virginia (VA059)			
Map Unit Symbol	Map Unit Name	Acres in AOI	Percent of AOI
4C	Barkers Crossroads-Nathalie complex, 7 to 15 percent slopes	5.8	8.4%
30A	Codorus and Hatboro soils, 0 to 2 percent slopes, occasionally flooded	7.8	11.3%
39B	Glenelg silt loam, 2 to 7 percent slopes	0.8	1.2%
39C	Glenelg silt loam, 7 to 15 percent slopes	3.1	4.6%
79C	Nathalie gravelly loam, 7 to 15 percent slopes	0.7	1.0%
95	Urban land	5.6	8.2%
96	Urban land-Barker Crossroads complex	2.2	3.2%
101	Urban land-Wheaton complex	9.7	14.1%
105B	Wheaton-Glenelg complex, 2 to 7 percent slopes	26.1	37.9%
105C	Wheaton-Glenelg complex, 7 to 15 percent slopes	7.0	10.2%
<b>Totals for Area of Interest</b>		<b>68.8</b>	<b>100.0%</b>

## Map Unit Descriptions

The map units delineated on the detailed soil maps in a soil survey represent the soils or miscellaneous areas in the survey area. The map unit descriptions, along with the maps, can be used to determine the composition and properties of a unit.

A map unit delineation on a soil map represents an area dominated by one or more major kinds of soil or miscellaneous areas. A map unit is identified and named according to the taxonomic classification of the dominant soils. Within a taxonomic class there are precisely defined limits for the properties of the soils. On the landscape, however, the soils are natural phenomena, and they have the characteristic variability of all natural phenomena. Thus, the range of some observed properties may extend beyond the limits defined for a taxonomic class. Areas of soils of a single taxonomic class rarely, if ever, can be mapped without including areas of other taxonomic classes. Consequently, every map unit is made up of the soils or miscellaneous areas for which it is named and some minor components that belong to taxonomic classes other than those of the major soils.

Most minor soils have properties similar to those of the dominant soil or soils in the map unit, and thus they do not affect use and management. These are called noncontrasting, or similar, components. They may or may not be mentioned in a particular map unit description. Other minor components, however, have properties

and behavioral characteristics divergent enough to affect use or to require different management. These are called contrasting, or dissimilar, components. They generally are in small areas and could not be mapped separately because of the scale used. Some small areas of strongly contrasting soils or miscellaneous areas are identified by a special symbol on the maps. If included in the database for a given area, the contrasting minor components are identified in the map unit descriptions along with some characteristics of each. A few areas of minor components may not have been observed, and consequently they are not mentioned in the descriptions, especially where the pattern was so complex that it was impractical to make enough observations to identify all the soils and miscellaneous areas on the landscape.

The presence of minor components in a map unit in no way diminishes the usefulness or accuracy of the data. The objective of mapping is not to delineate pure taxonomic classes but rather to separate the landscape into landforms or landform segments that have similar use and management requirements. The delineation of such segments on the map provides sufficient information for the development of resource plans. If intensive use of small areas is planned, however, onsite investigation is needed to define and locate the soils and miscellaneous areas.

An identifying symbol precedes the map unit name in the map unit descriptions. Each description includes general facts about the unit and gives important soil properties and qualities.

Soils that have profiles that are almost alike make up a *soil series*. Except for differences in texture of the surface layer, all the soils of a series have major horizons that are similar in composition, thickness, and arrangement.

Soils of one series can differ in texture of the surface layer, slope, stoniness, salinity, degree of erosion, and other characteristics that affect their use. On the basis of such differences, a soil series is divided into *soil phases*. Most of the areas shown on the detailed soil maps are phases of soil series. The name of a soil phase commonly indicates a feature that affects use or management. For example, Alpha silt loam, 0 to 2 percent slopes, is a phase of the Alpha series.

Some map units are made up of two or more major soils or miscellaneous areas. These map units are complexes, associations, or undifferentiated groups.

A *complex* consists of two or more soils or miscellaneous areas in such an intricate pattern or in such small areas that they cannot be shown separately on the maps. The pattern and proportion of the soils or miscellaneous areas are somewhat similar in all areas. Alpha-Beta complex, 0 to 6 percent slopes, is an example.

An *association* is made up of two or more geographically associated soils or miscellaneous areas that are shown as one unit on the maps. Because of present or anticipated uses of the map units in the survey area, it was not considered practical or necessary to map the soils or miscellaneous areas separately. The pattern and relative proportion of the soils or miscellaneous areas are somewhat similar. Alpha-Beta association, 0 to 2 percent slopes, is an example.

An *undifferentiated group* is made up of two or more soils or miscellaneous areas that could be mapped individually but are mapped as one unit because similar interpretations can be made for use and management. The pattern and proportion of the soils or miscellaneous areas in a mapped area are not uniform. An area can be made up of only one of the major soils or miscellaneous areas, or it can be made up of all of them. Alpha and Beta soils, 0 to 2 percent slopes, is an example.

Some surveys include *miscellaneous areas*. Such areas have little or no soil material and support little or no vegetation. Rock outcrop is an example.



## Fairfax County, Virginia

### 4C—Barkers Crossroads-Nathalie complex, 7 to 15 percent slopes

#### Map Unit Setting

*National map unit symbol:* 2fjkk  
*Mean annual precipitation:* 37 to 49 inches  
*Mean annual air temperature:* 45 to 67 degrees F  
*Frost-free period:* 185 to 212 days  
*Farmland classification:* Not prime farmland

#### Map Unit Composition

*Nathalie and similar soils:* 45 percent  
*Barkers crossroads and similar soils:* 45 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### Description of Nathalie

##### Setting

*Landform:* Interfluves  
*Landform position (two-dimensional):* Shoulder, backslope  
*Landform position (three-dimensional):* Side slope  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Parent material:* Residuum weathered from granite and gneiss

##### Typical profile

*H1 - 0 to 9 inches:* gravelly loam  
*H2 - 9 to 42 inches:* clay  
*H3 - 42 to 60 inches:* clay loam  
*H4 - 60 to 65 inches:* sandy clay loam

##### Properties and qualities

*Slope:* 7 to 15 percent  
*Depth to restrictive feature:* More than 80 inches  
*Natural drainage class:* Well drained  
*Runoff class:* Medium  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.57 to 1.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* Moderate (about 8.8 inches)

##### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 3e  
*Hydrologic Soil Group:* B  
*Hydric soil rating:* No

#### Description of Barkers Crossroads

##### Setting

*Landform:* Interfluves  
*Landform position (two-dimensional):* Shoulder, summit, backslope  
*Landform position (three-dimensional):* Interfluve

## Custom Soil Resource Report

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Parent material:* Mine spoil or earthy fill derived from granite and gneiss

### Typical profile

*H1 - 0 to 3 inches:* loam

*H2 - 3 to 60 inches:* loam

### Properties and qualities

*Slope:* 0 to 20 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Well drained

*Runoff class:* Very high

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* Moderate (about 7.8 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 2e

*Hydrologic Soil Group:* C

*Hydric soil rating:* No

## 30A—Codus and Hatboro soils, 0 to 2 percent slopes, occasionally flooded

### Map Unit Setting

*National map unit symbol:* 2fjmy

*Mean annual precipitation:* 37 to 49 inches

*Mean annual air temperature:* 45 to 67 degrees F

*Frost-free period:* 185 to 212 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Codus and similar soils:* 55 percent

*Hatboro and similar soils:* 35 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Codus

#### Setting

*Landform:* Flood plains

*Down-slope shape:* Linear

*Across-slope shape:* Linear

*Parent material:* Alluvium derived from igneous, metamorphic and sedimentary rock

#### Typical profile

*H1 - 0 to 8 inches:* silt loam

## Custom Soil Resource Report

*H2 - 8 to 50 inches: loam*

*H3 - 50 to 62 inches: stratified very gravelly sand to loam*

### Properties and qualities

*Slope: 0 to 2 percent*

*Depth to restrictive feature: More than 80 inches*

*Natural drainage class: Somewhat poorly drained*

*Runoff class: Low*

*Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high  
(0.57 to 1.98 in/hr)*

*Depth to water table: About 10 to 24 inches*

*Frequency of flooding: Occasional*

*Frequency of ponding: None*

*Available water storage in profile: Moderate (about 8.7 inches)*

### Interpretive groups

*Land capability classification (irrigated): None specified*

*Land capability classification (nonirrigated): 3w*

*Hydrologic Soil Group: B/D*

*Hydric soil rating: No*

## Description of Hatboro

### Setting

*Landform: Flood plains*

*Down-slope shape: Linear*

*Across-slope shape: Linear*

*Parent material: Alluvium derived from igneous and metamorphic rock*

### Typical profile

*H1 - 0 to 6 inches: silt loam*

*H2 - 6 to 23 inches: loam*

*H3 - 23 to 60 inches: clay loam*

### Properties and qualities

*Slope: 0 to 2 percent*

*Depth to restrictive feature: More than 80 inches*

*Natural drainage class: Poorly drained*

*Runoff class: Negligible*

*Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high  
(0.57 to 1.98 in/hr)*

*Depth to water table: About 0 to 18 inches*

*Frequency of flooding: Occasional*

*Frequency of ponding: None*

*Available water storage in profile: Moderate (about 8.6 inches)*

### Interpretive groups

*Land capability classification (irrigated): None specified*

*Land capability classification (nonirrigated): 5w*

*Hydrologic Soil Group: B/D*

*Hydric soil rating: Yes*

### **39B—Glenelg silt loam, 2 to 7 percent slopes**

#### **Map Unit Setting**

*National map unit symbol:* 2fjnw  
*Mean annual precipitation:* 37 to 49 inches  
*Mean annual air temperature:* 45 to 67 degrees F  
*Frost-free period:* 185 to 212 days  
*Farmland classification:* All areas are prime farmland

#### **Map Unit Composition**

*Glenelg and similar soils:* 85 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### **Description of Glenelg**

##### **Setting**

*Landform:* Interfluves  
*Landform position (two-dimensional):* Shoulder, summit  
*Landform position (three-dimensional):* Crest  
*Down-slope shape:* Linear  
*Across-slope shape:* Convex  
*Parent material:* Residuum weathered from mica schist and/or residuum weathered from phyllite

##### **Typical profile**

*H1 - 0 to 6 inches:* silt loam  
*H2 - 6 to 27 inches:* silt loam  
*H3 - 27 to 71 inches:* channery loam

##### **Properties and qualities**

*Slope:* 2 to 7 percent  
*Depth to restrictive feature:* More than 80 inches  
*Natural drainage class:* Well drained  
*Runoff class:* Low  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* High (about 9.6 inches)

##### **Interpretive groups**

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 2e  
*Hydrologic Soil Group:* B  
*Hydric soil rating:* No



### **39C—Glenelg silt loam, 7 to 15 percent slopes**

#### **Map Unit Setting**

*National map unit symbol:* 2fjnx

*Mean annual precipitation:* 37 to 49 inches

*Mean annual air temperature:* 45 to 67 degrees F

*Frost-free period:* 185 to 212 days

*Farmland classification:* Farmland of statewide importance

#### **Map Unit Composition**

*Glenelg and similar soils:* 85 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

#### **Description of Glenelg**

##### **Setting**

*Landform:* Interfluves

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Concave

*Across-slope shape:* Convex

*Parent material:* Residuum weathered from mica schist and/or residuum weathered from phyllite

##### **Typical profile**

*H1 - 0 to 6 inches:* silt loam

*H2 - 6 to 27 inches:* silt loam

*H3 - 27 to 71 inches:* channery loam

##### **Properties and qualities**

*Slope:* 7 to 14 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high (0.57 to 1.98 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* High (about 9.6 inches)

##### **Interpretive groups**

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

*Hydrologic Soil Group:* B

*Hydric soil rating:* No

## 79C—Nathalie gravelly loam, 7 to 15 percent slopes

### Map Unit Setting

*National map unit symbol:* 2fjtm

*Mean annual precipitation:* 37 to 49 inches

*Mean annual air temperature:* 45 to 67 degrees F

*Frost-free period:* 185 to 212 days

*Farmland classification:* Farmland of statewide importance

### Map Unit Composition

*Nathalie and similar soils:* 85 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Nathalie

#### Setting

*Landform:* Interfluves

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Parent material:* Residuum weathered from granite and gneiss

#### Typical profile

*H1 - 0 to 9 inches:* gravelly loam

*H2 - 9 to 42 inches:* clay

*H3 - 42 to 60 inches:* clay loam

*H4 - 60 to 65 inches:* sandy clay loam

#### Properties and qualities

*Slope:* 7 to 15 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.57 to 1.98 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* Moderate (about 8.8 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

*Hydrologic Soil Group:* B

*Hydric soil rating:* No

## 95—Urban land

### Map Unit Setting

*National map unit symbol:* 2fjw2

*Mean annual precipitation:* 28 to 58 inches

*Mean annual air temperature:* 87 to 89 degrees F

*Frost-free period:* 175 to 200 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Urban land:* 95 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Urban Land

#### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 8s

## 96—Urban land-Barker Crossroads complex

### Map Unit Setting

*National map unit symbol:* 2fjw3

*Mean annual precipitation:* 37 to 49 inches

*Mean annual air temperature:* 45 to 67 degrees F

*Frost-free period:* 185 to 212 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Urban land:* 50 percent

*Barkers crossroads and similar soils:* 49 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Urban Land

#### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 8s

### Description of Barkers Crossroads

#### Setting

*Landform:* Interfluves

*Landform position (two-dimensional):* Shoulder, summit, backslope

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Convex

*Across-slope shape:* Convex

## Custom Soil Resource Report

*Parent material:* Mine spoil or earthy fill derived from granite and gneiss

### Typical profile

*H1 - 0 to 3 inches:* loam

*H2 - 3 to 60 inches:* loam

### Properties and qualities

*Slope:* 0 to 45 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Well drained

*Runoff class:* Very high

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* Moderate (about 7.8 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 2e

*Hydrologic Soil Group:* C

*Hydric soil rating:* No

## 101—Urban land-Wheaton complex

### Map Unit Setting

*National map unit symbol:* 2fjw8

*Mean annual precipitation:* 37 to 49 inches

*Mean annual air temperature:* 45 to 67 degrees F

*Frost-free period:* 185 to 212 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Urban land:* 50 percent

*Wheaton and similar soils:* 49 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Urban Land

#### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 8s

### Description of Wheaton

#### Setting

*Landform:* Interfluves

*Landform position (two-dimensional):* Shoulder, summit, backslope

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Convex

## Custom Soil Resource Report

*Across-slope shape:* Convex

*Parent material:* Mine spoil or earthy fill derived from phyllite

### Typical profile

*H1 - 0 to 9 inches:* loam

*H2 - 9 to 60 inches:* loam

### Properties and qualities

*Slope:* 2 to 25 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Well drained

*Runoff class:* Very high

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* High (about 10.5 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 4e

*Hydrologic Soil Group:* C

*Hydric soil rating:* No

## 105B—Wheaton-Glenelg complex, 2 to 7 percent slopes

### Map Unit Setting

*National map unit symbol:* 2fjwl

*Mean annual precipitation:* 37 to 49 inches

*Mean annual air temperature:* 45 to 67 degrees F

*Frost-free period:* 185 to 212 days

*Farmland classification:* Not prime farmland

### Map Unit Composition

*Wheaton and similar soils:* 45 percent

*Glenelg and similar soils:* 40 percent

*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Wheaton

#### Setting

*Landform:* Interfluves

*Landform position (two-dimensional):* Shoulder, summit, backslope

*Landform position (three-dimensional):* Interfluve

*Down-slope shape:* Convex

*Across-slope shape:* Convex

*Parent material:* Mine spoil or earthy fill derived from phyllite

### Typical profile

*H1 - 0 to 9 inches:* loam

## Custom Soil Resource Report

*H2 - 9 to 60 inches: loam*

### Properties and qualities

*Slope: 2 to 15 percent*

*Depth to restrictive feature: More than 80 inches*

*Natural drainage class: Well drained*

*Runoff class: Very high*

*Capacity of the most limiting layer to transmit water (Ksat): Moderately low to moderately high (0.06 to 0.20 in/hr)*

*Depth to water table: More than 80 inches*

*Frequency of flooding: None*

*Frequency of ponding: None*

*Available water storage in profile: High (about 10.5 inches)*

### Interpretive groups

*Land capability classification (irrigated): None specified*

*Land capability classification (nonirrigated): 4e*

*Hydrologic Soil Group: C*

*Hydric soil rating: No*

## Description of Glenelg

### Setting

*Landform: Interfluves*

*Landform position (two-dimensional): Shoulder, summit*

*Landform position (three-dimensional): Crest*

*Down-slope shape: Linear*

*Across-slope shape: Convex*

*Parent material: Residuum weathered from mica schist and/or residuum weathered from phyllite*

### Typical profile

*H1 - 0 to 6 inches: silt loam*

*H2 - 6 to 27 inches: silt loam*

*H3 - 27 to 71 inches: channery loam*

### Properties and qualities

*Slope: 2 to 7 percent*

*Depth to restrictive feature: More than 80 inches*

*Natural drainage class: Well drained*

*Runoff class: Low*

*Capacity of the most limiting layer to transmit water (Ksat): Moderately high to high (0.57 to 1.98 in/hr)*

*Depth to water table: More than 80 inches*

*Frequency of flooding: None*

*Frequency of ponding: None*

*Available water storage in profile: High (about 9.6 inches)*

### Interpretive groups

*Land capability classification (irrigated): None specified*

*Land capability classification (nonirrigated): 2e*

*Hydrologic Soil Group: B*

*Hydric soil rating: No*

## 105C—Wheaton-Glenelg complex, 7 to 15 percent slopes

### Map Unit Setting

*National map unit symbol:* 2fjwm  
*Mean annual precipitation:* 37 to 49 inches  
*Mean annual air temperature:* 45 to 67 degrees F  
*Frost-free period:* 185 to 212 days  
*Farmland classification:* Not prime farmland

### Map Unit Composition

*Wheaton and similar soils:* 45 percent  
*Glenelg and similar soils:* 40 percent  
*Estimates are based on observations, descriptions, and transects of the mapunit.*

### Description of Wheaton

#### Setting

*Landform:* Interfluves  
*Landform position (two-dimensional):* Shoulder, summit, backslope  
*Landform position (three-dimensional):* Interfluve  
*Down-slope shape:* Convex  
*Across-slope shape:* Convex  
*Parent material:* Mine spoil or earthy fill derived from phyllite

#### Typical profile

*H1 - 0 to 9 inches:* loam  
*H2 - 9 to 60 inches:* loam

#### Properties and qualities

*Slope:* 2 to 25 percent  
*Depth to restrictive feature:* More than 80 inches  
*Natural drainage class:* Well drained  
*Runoff class:* Very high  
*Capacity of the most limiting layer to transmit water (Ksat):* Moderately low to moderately high (0.06 to 0.20 in/hr)  
*Depth to water table:* More than 80 inches  
*Frequency of flooding:* None  
*Frequency of ponding:* None  
*Available water storage in profile:* High (about 10.5 inches)

#### Interpretive groups

*Land capability classification (irrigated):* None specified  
*Land capability classification (nonirrigated):* 4e  
*Hydrologic Soil Group:* C  
*Hydric soil rating:* No

### Description of Glenelg

#### Setting

*Landform:* Interfluves

## Custom Soil Resource Report

*Landform position (two-dimensional):* Shoulder, backslope

*Landform position (three-dimensional):* Side slope

*Down-slope shape:* Concave

*Across-slope shape:* Convex

*Parent material:* Residuum weathered from mica schist and/or residuum weathered from phyllite

### Typical profile

*H1 - 0 to 6 inches:* silt loam

*H2 - 6 to 27 inches:* silt loam

*H3 - 27 to 71 inches:* channery loam

### Properties and qualities

*Slope:* 7 to 14 percent

*Depth to restrictive feature:* More than 80 inches

*Natural drainage class:* Well drained

*Runoff class:* Medium

*Capacity of the most limiting layer to transmit water (Ksat):* Moderately high to high  
(0.57 to 1.98 in/hr)

*Depth to water table:* More than 80 inches

*Frequency of flooding:* None

*Frequency of ponding:* None

*Available water storage in profile:* High (about 9.6 inches)

### Interpretive groups

*Land capability classification (irrigated):* None specified

*Land capability classification (nonirrigated):* 3e

*Hydrologic Soil Group:* B

*Hydric soil rating:* No



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United States Department of Agriculture, Natural Resources Conservation Service. National forestry manual. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2\\_053374](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/home/?cid=nrcs142p2_053374)

United States Department of Agriculture, Natural Resources Conservation Service. National range and pasture handbook. <http://www.nrcs.usda.gov/wps/portal/nrcs/detail/national/landuse/rangepasture/?cid=stelprdb1043084>

## Custom Soil Resource Report

United States Department of Agriculture, Natural Resources Conservation Service. National soil survey handbook, title 430-VI. [http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2\\_054242](http://www.nrcs.usda.gov/wps/portal/nrcs/detail/soils/scientists/?cid=nrcs142p2_054242)

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United States Department of Agriculture, Soil Conservation Service. 1961. Land capability classification. U.S. Department of Agriculture Handbook 210. [http://www.nrcs.usda.gov/Internet/FSE\\_DOCUMENTS/nrcs142p2\\_052290.pdf](http://www.nrcs.usda.gov/Internet/FSE_DOCUMENTS/nrcs142p2_052290.pdf)

## Appendix B

### Soil Laboratory Test Results

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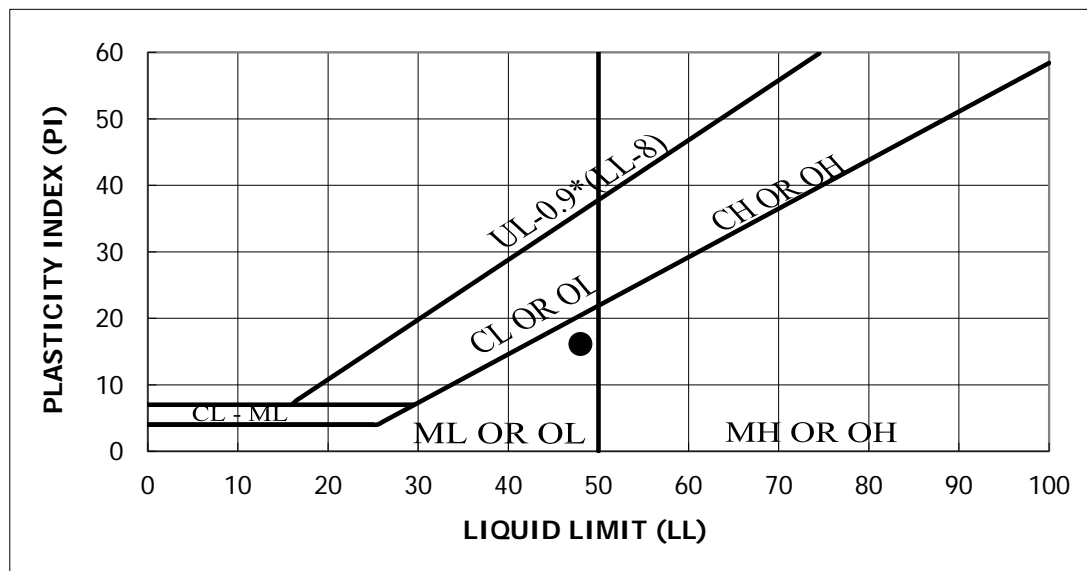
Liquid and Plastic Limit, and Grain Size Analysis Test Data (10 pages)

Corrosion Series Test Results (1 page)



**LIQUID AND PLASTIC LIMIT - ASTM D4318**

Project No.	16045.00	Project Name	VRE Rolling Rd Station Platform Extension
Test Boring No.	B-1	Depth (Feet)	8.0-10.0
Lab Order No.	3918-5	Date	12/12/2016

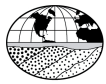


Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
SILTY SAND	48	32	16	100.0	47.7	SM	34.7
Color	greenish brown		AASHTO Classification			A-7-5	

Test Method: ASTM D 4318

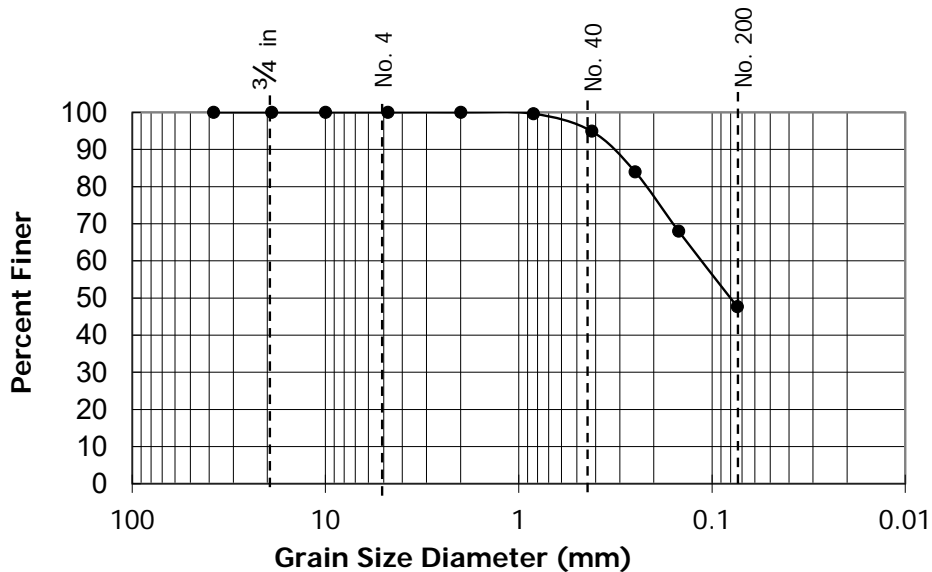
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by Lindsay Bantz



### GRAIN SIZE ANALYSIS - ASTM D422

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-1	<b>Depth (Feet)</b>	8.0-10.0
<b>Lab Order No.</b>	3918-5	<b>Date</b>	12/12/2016



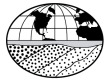
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	100
#20	100
#40	95
#60	84
#100	68
#200	48
Pan	--

<b>USCS Group Symbol</b>	<b>SM</b>
<b>USCS Group Name</b>	<b>SILTY SAND</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	48
<b>PI</b>	16
<b>Gravel</b>	0.0
<b>Sand</b>	52.3
<b>Fines</b>	47.7
<b>AASHTO Classification</b>	<b>A-7-5</b>
<b>Color</b>	<b>greenish brown</b>

Test Method: ASTM D 422

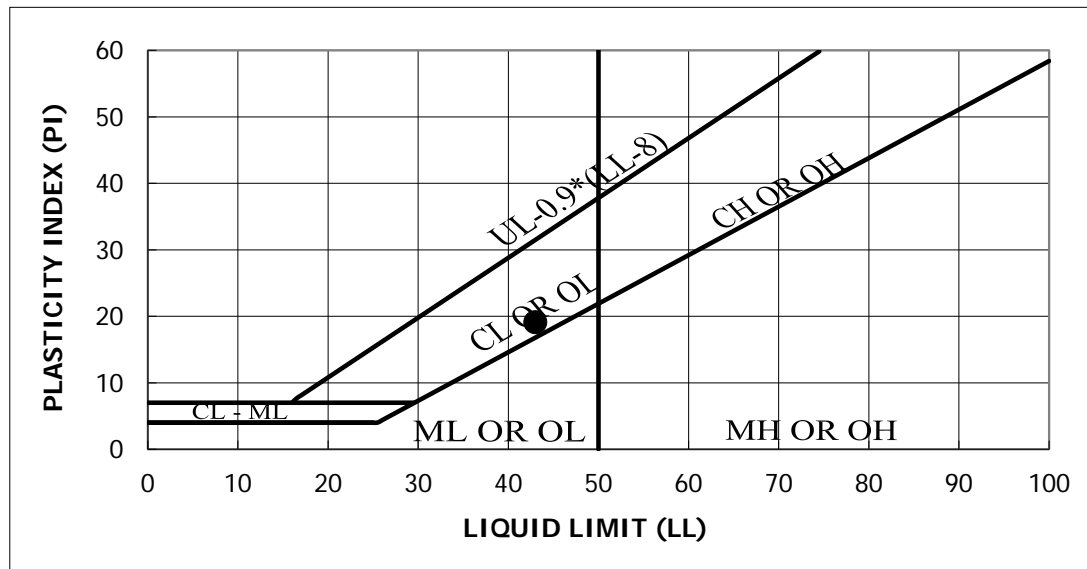
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by: *Lindsay Bantz*



**LIQUID AND PLASTIC LIMIT - ASTM D4318**

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-2	<b>Depth (Feet)</b>	2.0-4.0
<b>Lab Order No.</b>	3918-4	<b>Date</b>	12/12/2016



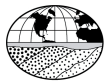
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Lean Clay	43	24	19	96.5	56.9	CL	17.5
Color	reddish brown		AASHTO Classification			A-7-6	

Test Method: ASTM D 4318

Soil Classification by ASTM D2487 and AASHTO M 145

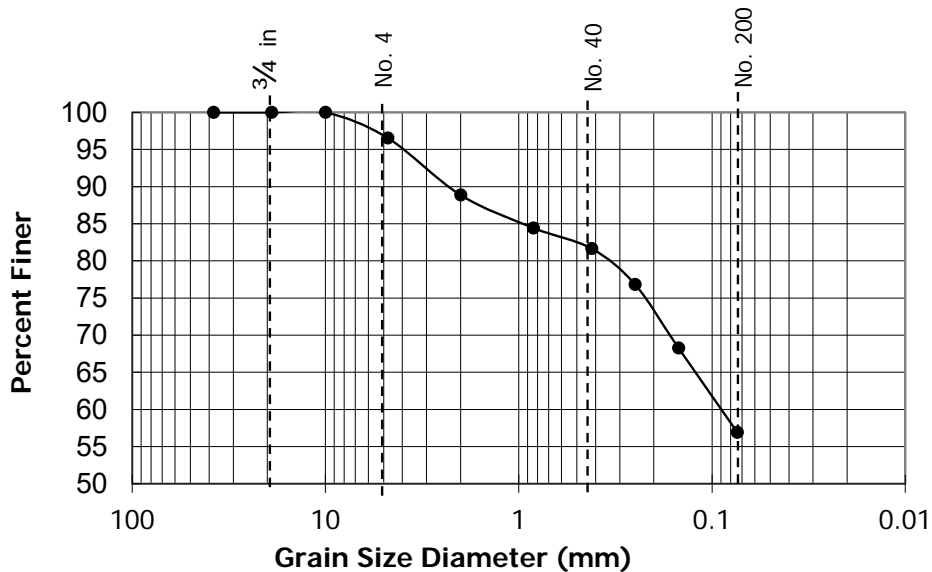
Reviewed by

*Lindsay Bantz*



### GRAIN SIZE ANALYSIS - ASTM D422

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-2	<b>Depth (Feet)</b>	2.0-4.0
<b>Lab Order No.</b>	3918-4	<b>Date</b>	12/12/2016



SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	97
#10	89
#20	84
#40	82
#60	77
#100	68
#200	57
Pan	--

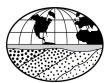
<b>USCS Group Symbol</b>	CL
<b>USCS Group Name</b>	sandy Lean Clay
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	43
<b>PI</b>	19
<b>Gravel</b>	3.5
<b>Sand</b>	39.6
<b>Fines</b>	56.9
<b>AASHTO Classification</b>	A-7-6
<b>Color</b>	reddish brown

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

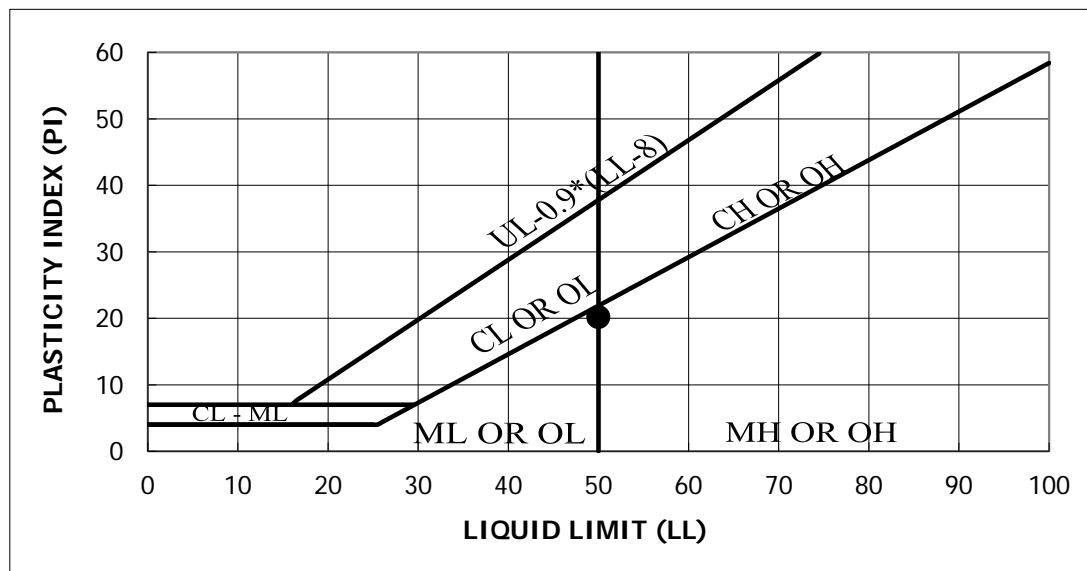
Reviewed by:

*Lindsay Bantz*



**LIQUID AND PLASTIC LIMIT - ASTM D4318**

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-2	<b>Depth (Feet)</b>	6.0-8.0
<b>Lab Order No.</b>	3918-6	<b>Date</b>	12/12/2016



Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Elastic Silt	50	30	20	100.0	63.0	MH	40.0
Color	brown		AASHTO Classification			A-7-5	

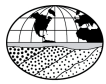
Test Method: ASTM D 4318

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by

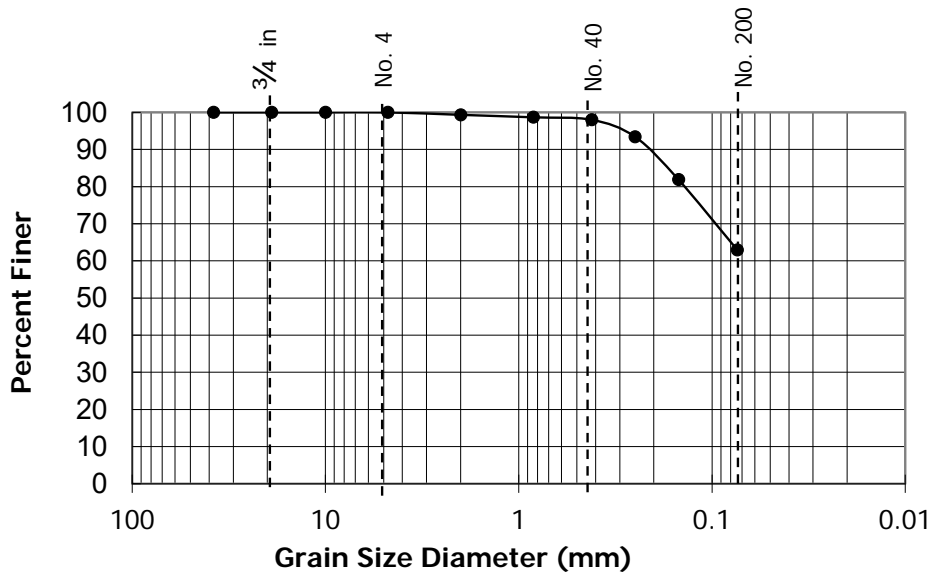
*Lindsay Bantz*





### GRAIN SIZE ANALYSIS - ASTM D422

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-2	<b>Depth (Feet)</b>	6.0-8.0
<b>Lab Order No.</b>	3918-6	<b>Date</b>	12/12/2016



SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	99
#20	99
#40	98
#60	93
#100	82
#200	63
Pan	--

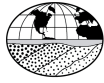
<b>USCS Group Symbol</b>	<b>MH</b>
<b>USCS Group Name</b>	<b>sandy Elastic Silt</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	50
<b>PI</b>	20
<b>Gravel</b>	0.0
<b>Sand</b>	37.0
<b>Fines</b>	63.0
<b>AASHTO Classification</b>	<b>A-7-5</b>
<b>Color</b>	<b>brown</b>

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

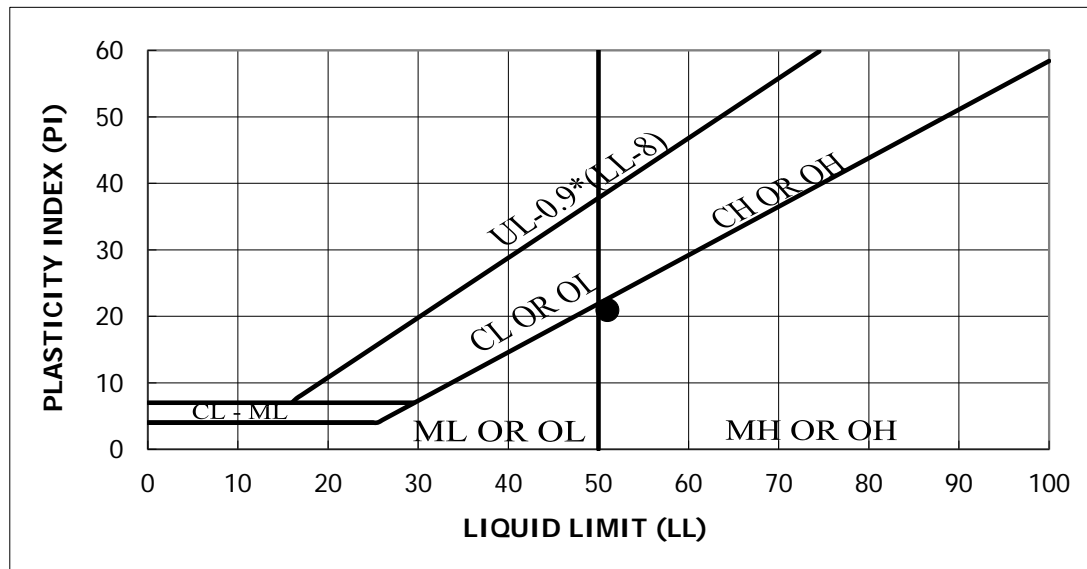
Reviewed by:

*Lindsay Bantz*



**LIQUID AND PLASTIC LIMIT - ASTM D4318**

Project No.	16045.00	Project Name	VRE Rolling Rd Station Platform Extension
Test Boring No.	B-3	Depth (Feet)	1.5-2.0
Lab Order No.	3918-7	Date	12/12/2016



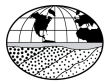
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
sandy Elastic Silt	51	30	21	100.0	69.4	MH	26.0
Color	reddish brown		AASHTO Classification			A-7-5	

Test Method: ASTM D 4318

Soil Classification by ASTM D2487 and AASHTO M 145

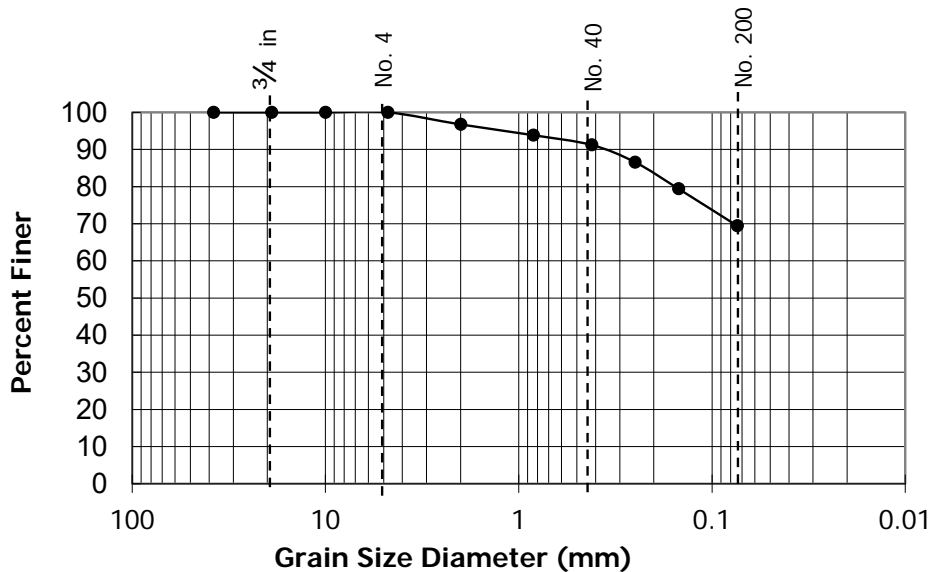
Reviewed by

*Lindsay Bantz*



### GRAIN SIZE ANALYSIS - ASTM D422

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-3	<b>Depth (Feet)</b>	1.5-2.0
<b>Lab Order No.</b>	3918-7	<b>Date</b>	12/12/2016



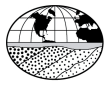
SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	97
#20	94
#40	91
#60	87
#100	79
#200	69
Pan	--

<b>USCS Group Symbol</b>	MH
<b>USCS Group Name</b>	sandy Elastic Silt
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	51
<b>PI</b>	21
<b>Gravel</b>	0.0
<b>Sand</b>	30.6
<b>Fines</b>	69.4
<b>AASHTO Classification</b>	A-7-5
<b>Color</b>	reddish brown

Test Method: ASTM D 422

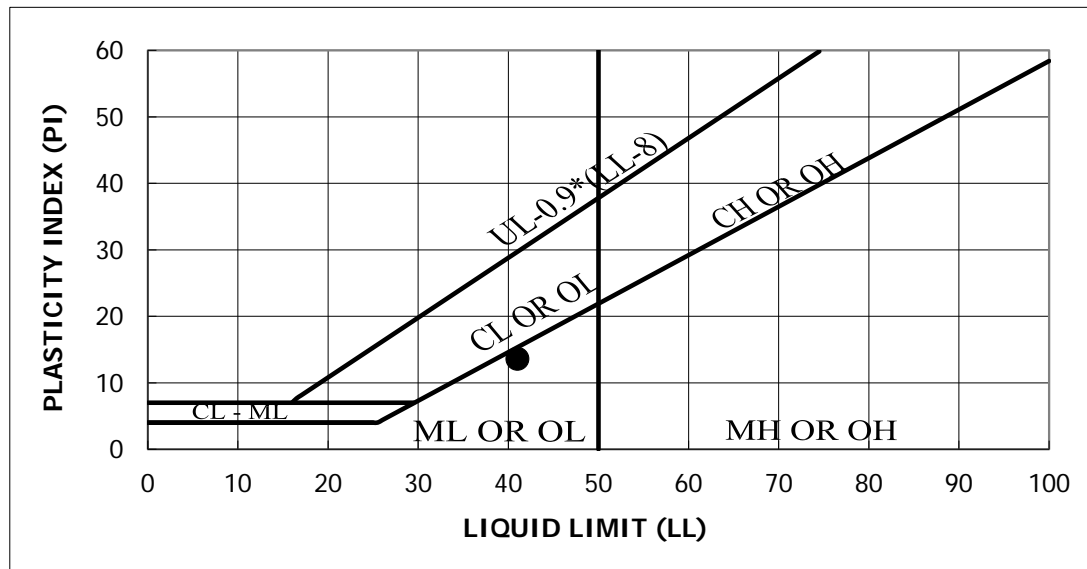
Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by: Lindsay Bantz



**LIQUID AND PLASTIC LIMIT - ASTM D4318**

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-3	<b>Depth (Feet)</b>	13.5-15.0
<b>Lab Order No.</b>	3918-8	<b>Date</b>	12/12/2016



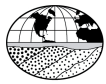
Material Description	LL	PL	PI	% Passing		USCS	w (%)
				#4	#200		
<b>SILTY SAND</b>	41	27	14	100.0	42.6	SM	32.2
<b>Color</b>	greenish brown		AASHTO Classification			A-7-6	

Test Method: ASTM D 4318

Soil Classification by ASTM D2487 and AASHTO M 145

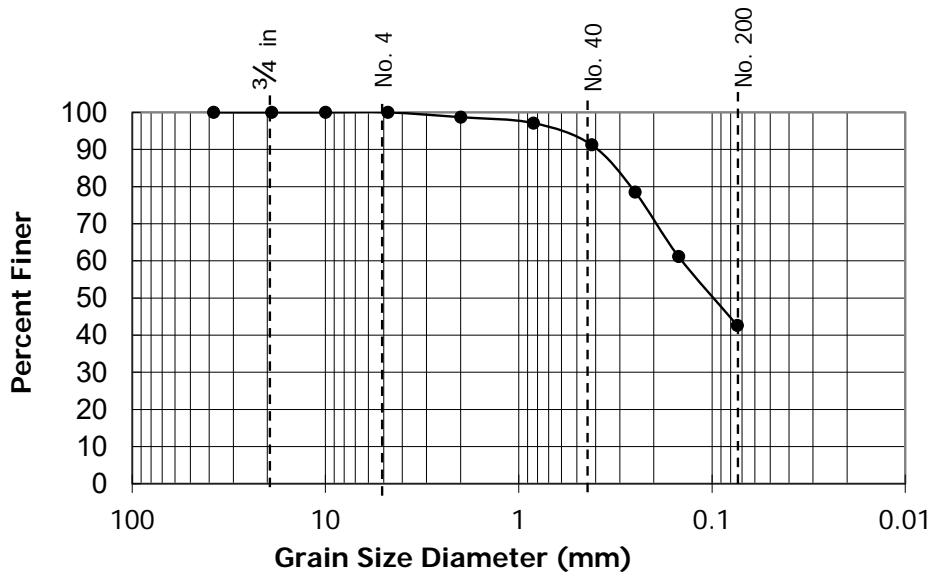
Reviewed by

*Lindsay Bantz*



### GRAIN SIZE ANALYSIS - ASTM D422

<b>Project No.</b>	16045.00	<b>Project Name</b>	VRE Rolling Rd Station Platform Extension
<b>Test Boring No.</b>	B-3	<b>Depth (Feet)</b>	13.5-15.0
<b>Lab Order No.</b>	3918-8	<b>Date</b>	12/12/2016



SIEVE	% Passing
1 1/2 "	100
3/4"	100
3/8"	100
#4	100
#10	99
#20	97
#40	91
#60	79
#100	61
#200	43
Pan	--

<b>USCS Group Symbol</b>	<b>SM</b>
<b>USCS Group Name</b>	<b>SILTY SAND</b>
<b>Cu</b>	---
<b>Cc</b>	---
<b>LL</b>	41
<b>PI</b>	14
<b>Gravel</b>	0.0
<b>Sand</b>	57.4
<b>Fines</b>	42.6
<b>AASHTO Classification</b>	<b>A-7-6</b>
<b>Color</b>	<b>greenish brown</b>

Test Method: ASTM D 422

Soil Classification by ASTM D2487 and AASHTO M 145

Reviewed by:

*Lindsay Bantz*



Report Number: **165192**

HP ENVIRONMENTAL  
INCORPORATED

Page 1 of 2

### Certificate of Laboratory Analysis

GeoConcepts Engineering, Inc.  
Attn: Fernanda Madrona  
19955 Highland Vista Dr.  
Suite 170  
Ashburn, VA 20147

Date Received: 12/13/16  
Date Reported: 12/14/16  
Project Location: **VRE Rolling Rd Station  
Burke, VA**

1. Client Sample No: **B-2** HPE Sample No.: 165192-01  
Sample Matrix: Soil Date Collected:  
Sample Location: 5'-7'

Test(s) Requested: **Soil Corrosion Potential Profile**  
Analysis Method(s): Various

Date Analyzed: 12/13/16

<u>Analyte</u>	<u>Result</u>	<u>Units</u>	<u>Reporting Limit</u>	<u>Qualifier</u>
Resistivity - ASTM G187	<b>11000</b>	ohm-cm	N/A	
Redox Potential - Electrode	<b>+ 380</b>	mV	N/A	
pH - CA643	<b>6.1</b>	pH	N/A	
Chloride (Water Soluble) - CA422	<b>2.6</b>	mg/Kg	2.5	
Sulfate (Water Soluble) - EPA 375.4	<b>6.3</b>	mg/Kg	5.0	
Sulfide (Water Soluble) EPA 376.2	<b>&lt; 1.2</b>	mg/Kg	1.2	U
Moisture (Percent)	<b>36</b>	%	N/A	

**JP**

12/14/16

Approved by

Date

Analyte Qualifier Codes

U = Analyte was not detected

## Appendix C

### Engineering Calculations

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Structural Loads (2 pages)

Figure C-1: LPile Subsurface Profile (1page)

Drilled Shaft Lateral and Axial Load Capacities per ASD Design (59 pages)

Drilled Shaft Lateral and Axial Load Resistances per LRFD Design (61 pages)

Slope Stability Calculations (15 pages)

<b><u>Unfactored Loading</u></b>								
	<b>Typical Pier</b>				<b>End Pier</b>			
	Fx	Fy	Mz	Mx	Fx	Fy	Mz	Mx
Dead	0	71	-3260	-602	0	44	-2070	1120
Live	0	30	-1500	-750	0	15	-750	750
Snow	0	4	-88	43	0	0	0	0
Roof Live	0	3	-80	39	0	0	0	0
Downward Wind	-1.3	8	-441	88	0	0	0	0
Uplift Wind	1.3	-8	441	-88	0	0	0	0
<b><u>Allowable Stress Design Load Combinations</u></b>								
	<b>Typical Pier</b>				<b>End Pier</b>			
	Fx	Fy	Mz	Mx	Fx	Fy	Mz	Mx
16-8	0.0	71	-3260	-602	0	44	-2070	1120
16-9	0.0	101	-4760	-1352	0	59	-2820	1870
16-10	0.0	75	-3348	-563	0	44	-2070	1120
16-11	0.0	96	-4451	-1135	0	55	-2633	1683
16-12a	-0.8	75	-3525	-549	0	44	-2070	1120
16-12b	0.8	66	-2995	-655	0	44	-2070	1120
16-13a	-0.6	100	-4650	-1096	0	55	-2633	1683
16-13b	0.6	68	-3061	-642	0	44	-2070	1120
16-13c	0.6	90	-4186	-1204	0	55	-2633	1683
16-13d	0.6	93	-4252	-1175	0	55	-2633	1683
16-14	0.0	96	-4451	-1133	0	55	-2633	1683
16-15a	-0.8	47	-2221	-308	0	26	-1242	672
16-15b	0.8	38	-1691	-414	0	26	-1242	672
16-6	0	43	-1956	-361	0	26	-1242	672

Note: Sign Convention is shown on the attached

Units are in kips and kip-in

$f_1$  1  
 $f_2$  0.2



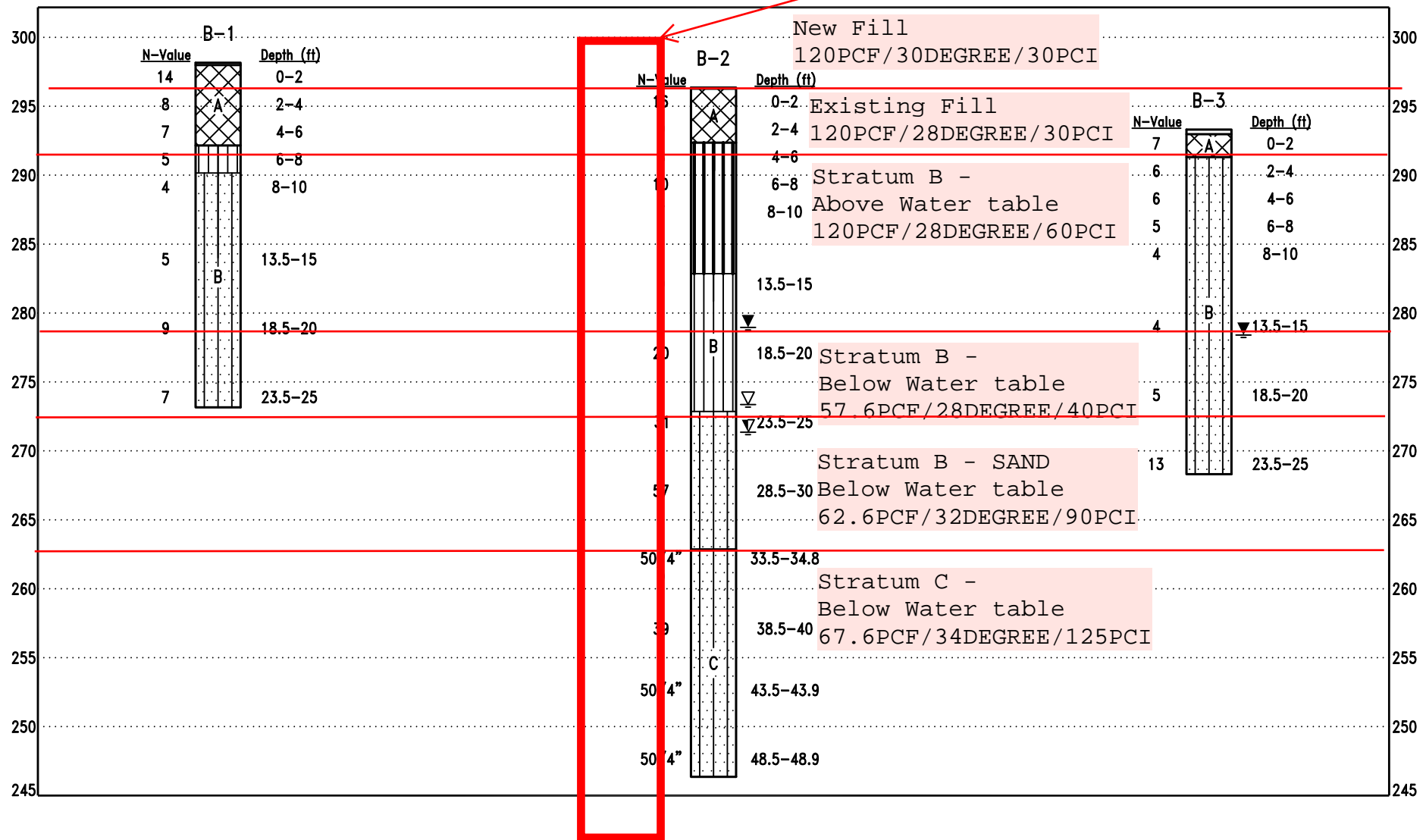
<b>Unfactored Loading</b>								
	<b>Typical Pier</b>				<b>End Pier</b>			
	Fx	Fy	Mz	Mx	Fx	Fy	Mz	Mx
Dead	0	71	-3260	-602	0	44	-2070	1120
Live	0	30	-1500	-750	0	15	-750	750
Snow	0	4	-88	43	0	0	0	0
Roof Live	0	3	-80	39	0	0	0	0
Downward Wind	-1.3	8	-441	88	0	0	0	0
Uplift Wind	1.3	-8	441	-88	0	0	0	0
<b>Factored Loading</b>								
	<b>Typical Pier</b>				<b>End Pier</b>			
	Fx	Fy	Mz	Mx	Fx	Fy	Mz	Mx
16-1	0.0	99	-4564	-843	0	61	-2898	1568
16-2	0.0	135	-6356	-1903	0	76	-3684	2544
16-3a	-0.6	121	-5553	-1410	0	67	-3234	2094
16-3b	0.6	81	-3691	-767	0	52	-2484	1344
16-4a	-1.3	124	-5897	-1365	0	67	-3234	2094
16-4b	1.3	78	-3471	-811	0	52	-2484	1344
16-5	0.0	116	-5430	-1464	0	67	-3234	2094
16-6a	-1.3	71	-3375	-454	0	39	-1863	1008
16-6b	1.3	56	-2493	-630	0	39	-1863	1008
16-7	0.0	64	-2934	-542	0	39	-1863	1008

Note: Sign Convention is shown on the attached

Units are in kips and kip-in

$f_1$  1  
 $f_2$  0.2

"A" Load Cases are maximums while  
 "B" are minimums due to uplift



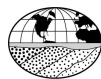
## LEGEND

### GROUND WATER LEVELS:

ENCOUNTERED

BEFORE REMOVING CASING

END OF THE DAY



**GeoConcepts  
Engineering, Inc.**

A Terracon COMPANY

19955 Highland Vista Dr., Suite 170 (703) 726-8030  
Ashburn, Virginia 20147 (703) 726-8032 fax

VRE ROLLING ROAD STATION PLATFORM EXTENSION  
9016 BURKE ROAD, BURKE, VIRGINIA

LPile - SUBSURFACE PROFILE

Date:  
FEB. 2018

Drawn By:  
F.M.

Checked By:  
S.U.

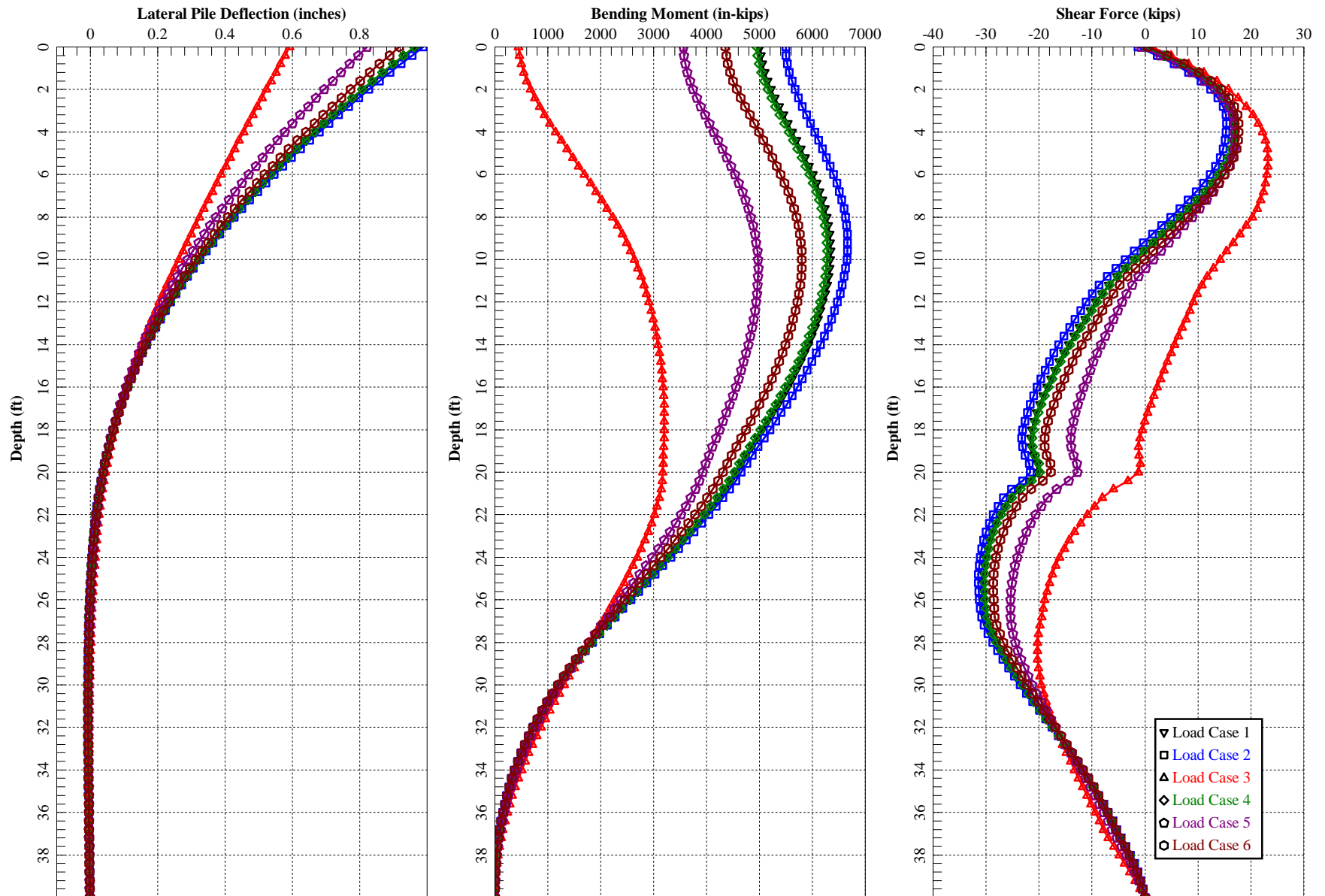
Scale:  
NONE

Project No.:  
16045

Fig.

C-1

VRE Rolling Road Station Platform Extension - 3-Foot Dia. Shaft with Casing (ASD)



=====

LPile for Windows, Version 2016-09.008

Analysis of Individual Piles and Drilled Shafts  
Subjected to Lateral Loading Using the p-y Method  
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-----

Files Used for Analysis

-----

Path to file locations:  
\\Projects\\2018\\JD185036\\Working Files\\Calculations-Analyses\\Rolling Road Shaft Analysis\\

Name of input data file:  
Lpile Run 3 ft shaft.lp9d

Name of output report file:  
Lpile Run 3 ft shaft.lp9o

Name of plot output file:  
Lpile Run 3 ft shaft.lp9p

Name of runtime message file:  
Lpile Run 3 ft shaft.lp9r

-----

Date and Time of Analysis

-----

Date: February 19, 2018

Time: 11:38:57

-----  
Problem Title  
-----

Project Name: Rolling Road Platform

Job Number: JD185036

Client: Dewberry

Engineer: FM

Description: Drilled Shafts

-----  
Program Options and Settings  
-----

Computational Options:

- Use unfactored loads in computations (conventional analysis)

Engineering Units Used for Data Input and Computations:

- US Customary System Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed	=	500
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in
- Number of pile increments	=	100

Loading Type and Number of Cycles of Loading:

- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis includes loading by one distributed lateral load acting on pile
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats

---

 Pile Structural Properties and Geometry
 

---

Number of pile sections defined = 1  
 Total length of pile = 40.000 ft  
 Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	36.0000
2	40.000	36.0000

---

 Input Structural Properties for Pile Sections:
 

---

Pile Section No. 1:

Section 1 is a drilled shaft with permanent casing  
 Length of section = 40.000000 ft  
 Casing outside diameter = 36.000000 in  
 Shear capacity of section = 0.0000 lbs

---

 Ground Slope and Pile Batter Angles
 

---

Ground Slope Angle = 0.000 degrees  
 = 0.000 radians  
 Pile Batter Angle = 0.000 degrees  
 = 0.000 radians

---

 Soil and Rock Layering Information
 

---

The soil profile is modelled using 6 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft

		Lpile Run 3 ft shaft.lp9o
Distance from top of pile to bottom of layer	=	4.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	30.000000 deg.
Friction angle at bottom of layer	=	30.000000 deg.
Subgrade k at top of layer	=	30.000000 pci
Subgrade k at bottom of layer	=	30.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	4.000000 ft
Distance from top of pile to bottom of layer	=	8.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	28.000000 deg.
Friction angle at bottom of layer	=	28.000000 deg.
Subgrade k at top of layer	=	30.000000 pci
Subgrade k at bottom of layer	=	30.000000 pci

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	8.000000 ft
Distance from top of pile to bottom of layer	=	21.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	28.000000 deg.
Friction angle at bottom of layer	=	28.000000 deg.
Subgrade k at top of layer	=	60.000000 pci
Subgrade k at bottom of layer	=	60.000000 pci

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	21.000000 ft
Distance from top of pile to bottom of layer	=	27.000000 ft
Effective unit weight at top of layer	=	57.600000 pcf
Effective unit weight at bottom of layer	=	57.600000 pcf
Friction angle at top of layer	=	28.000000 deg.
Friction angle at bottom of layer	=	28.000000 deg.
Subgrade k at top of layer	=	40.000000 pci
Subgrade k at bottom of layer	=	40.000000 pci

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	27.000000 ft
Distance from top of pile to bottom of layer	=	37.000000 ft
Effective unit weight at top of layer	=	62.600000 pcf
Effective unit weight at bottom of layer	=	62.600000 pcf
Friction angle at top of layer	=	32.000000 deg.
Friction angle at bottom of layer	=	32.000000 deg.
Subgrade k at top of layer	=	90.000000 pci

Subgrade k at bottom of layer = Lpile Run 3 ft shaft.1p9o  
90.000000 pci

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 37.000000 ft  
Distance from top of pile to bottom of layer = 53.000000 ft  
Effective unit weight at top of layer = 67.600000 pcf  
Effective unit weight at bottom of layer = 67.600000 pcf  
Friction angle at top of layer = 34.000000 deg.  
Friction angle at bottom of layer = 34.000000 deg.  
Subgrade k at top of layer = 125.000000 pci  
Subgrade k at bottom of layer = 125.000000 pci

(Depth of the lowest soil layer extends 13.000 ft below the pile tip)

#### Summary of Input Soil Properties

Layer Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	0.00 4.0000	120.0000 120.0000	30.0000 30.0000	30.0000 30.0000
2	Sand (Reese, et al.)	4.0000 8.0000	120.0000 120.0000	28.0000 28.0000	30.0000 30.0000
3	Sand (Reese, et al.)	8.0000 21.0000	120.0000 120.0000	28.0000 28.0000	60.0000 60.0000
4	Sand (Reese, et al.)	21.0000 27.0000	57.6000 57.6000	28.0000 28.0000	40.0000 40.0000
5	Sand (Reese, et al.)	27.0000 37.0000	62.6000 62.6000	32.0000 32.0000	90.0000 90.0000
6	Sand (Reese, et al.)	37.0000 53.0000	67.6000 67.6000	34.0000 34.0000	125.0000 125.0000

#### Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

#### Distributed Lateral Loading Used For All Load Cases

Distributed lateral load intensity defined using 2 points



Lpile Run 3 ft shaft.lp9o

Point No.	Depth X in	Dist. Load lb/in
1	0.000	791.700
2	240.000	791.700

-----  
Pile-head Loading and Pile-head Fixity Conditions  
-----

Number of Loads specified = 6

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 5014935. in-lbs	104000.	Yes
2	1	V = -1300. lbs	M = 5497571. in-lbs	116000.	Yes
3	1	V = 1300. lbs	M = 449695. in-lbs	-8000.	Yes
4	1	V = 0.0000 lbs	M = 4948283. in-lbs	101000.	Yes
5	1	V = -800.000000 lbs	M = 3567496. in-lbs	75000.	Yes
6	1	V = 600.000000 lbs	M = 4355711. in-lbs	90000.	Yes

V = shear force applied normal to pile axis

M = bending moment applied to pile head

y = lateral deflection normal to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).

Thrust force is assumed to be acting axially for all pile batter angles.

-----  
Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness  
-----

Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

-----  
Dimensions and Properties of Drilled Shaft (Bored Pile) with Permanent Casing:  
-----

Length of Section	=	40.000000 ft
Outer Diameter of Casing	=	36.000000 in
Concrete Cover Thickness Inside Casing	=	3.000000 in

Lpile Run 3 ft shaft.lp9o

Casing Wall Thickness	=	0.250000 in
Moment of Inertia of Steel Casing	=	4486. in^4
Yield Stress of Casing	=	36000. psi
Elastic Modulus of Casing	=	29000000. psi
Number of Reinforcing Bars	=	6 bars
Area of Single Reinforcing Bar	=	0.790000 sq. in.
Edge-to-Edge Bar Spacing	=	13.250000 in
Maximum Concrete Aggregate Size	=	0.750000 in
Ratio of Bar Spacing to Aggregate Size	=	17.67
Offset of Center of Rebar Cage from Center of Pile	=	0.0000 in
Yield Stress of Reinforcing Bars	=	60000. psi
Modulus of Elasticity of Reinforcing Bars	=	29000000. psi
Gross Area of Pile	=	1018. sq. in.
Area of Concrete	=	985.058035 sq. in.
Cross-sectional Area of Steel Casing	=	28.077984 sq. in.
Area of All Steel (Casing and Bars)	=	32.817984 sq. in.
Area Ratio of All Steel to Gross Area of Pile	=	3.22 percent

#### Axial Structural Capacities:

-----

Nom. Axial Structural Capacity = $0.85 F_c A_c + F_y A_s$	=	4644.405 kips
Tensile Load for Cracking of Concrete	=	-519.495 kips
Nominal Axial Tensile Capacity	=	-1295.207 kips

#### Reinforcing Bar Dimensions and Positions Used in Computations:

Bar Number	Bar Diam. inches	Bar Area sq. in.	X inches	Y inches
1	1.000000	0.790000	14.250000	0.000000
2	1.000000	0.790000	7.125000	12.340862
3	1.000000	0.790000	-7.125000	12.340862
4	1.000000	0.790000	-14.250000	0.000000
5	1.000000	0.790000	-7.125000	-12.340862
6	1.000000	0.790000	7.125000	-12.340862

NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero = 13.250 inches  
between bars 5 and 6.

#### Concrete Properties:

-----

Compressive Strength of Concrete	=	4000. psi
Modulus of Elasticity of Concrete	=	3604997. psi
Modulus of Rupture of Concrete	=	-474.341649 psi
Compression Strain at Peak Stress	=	0.001886
Tensile Strain at Fracture of Concrete	=	-0.0001154
Maximum Coarse Aggregate Size	=	0.0000 in

Lpile Run 3 ft shaft.lp9o

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 6

Number	Axial Thrust Force kips
-----	-----
1	-8.000
2	75.000
3	90.000
4	101.000
5	104.000
6	116.000

Definitions of Run Messages and Notes:

-----

C = concrete in section has cracked in tension.  
Y = stress in reinforcing steel has reached yield stress.  
T = ACI 318 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than 0.003. See ACI 318, Section 10.3.4.  
Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.  
Position of neutral axis is measured from edge of compression side of pile.  
Compressive stresses and strains are positive in sign.  
Tensile stresses and strains are negative in sign.

Axial Thrust Force = -8.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in <sup>2</sup>	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6.25000E-07	295.0122744	472019639.	15.4995453	0.00000969	-0.00001281	0.0405050	-0.3683082	-0.3683082	
0.00000125	589.2240656	471379252.	16.7472518	0.00002093	-0.00002407	0.0873486	-0.6913871	-0.6913871	
0.00000188	882.6156065	470728323.	17.1631415	0.00003218	-0.00003532	0.1339133	-1.0144667	-1.0144667	
0.00000250	1175.	470074738.	17.3710802	0.00004343	-0.00004657	0.1801993	-1.3375467	-1.3375467	
0.00000313	1467.	469420087.	17.4958387	0.00005467	-0.00005783	0.2262065	-1.6606271	-1.6606271	
0.00000375	1758.	468764904.	17.5790075	0.00006592	-0.00006908	0.2719348	-1.9837079	-1.9837079	
0.00000438	2048.	468109417.	17.6384107	0.00007717	-0.00008033	0.3173844	-2.3067891	-2.3067891	
0.00000500	2337.	467453739.	17.6829604	0.00008841	-0.00009159	0.3625551	-2.6298707	-2.6298707	
0.00000563	2626.	466797934.	17.7176078	0.00009966	-0.0001028	0.4074471	-2.9529527	-2.9529527	
0.00000625	2913.	466142040.	17.7453235	0.0001109	-0.0001141	0.4520603	-3.2760351	-3.2760351	
0.00000688	2913.	423765491.	11.4082407	0.00007843	-0.0001691	0.3206945	-4.8670946	-4.8670946	C
0.00000750	2913.	388451700.	11.4577789	0.00008593	-0.0001841	0.3506895	-5.2987831	-5.2987831	C
0.00000813	2913.	358570800.	11.5001905	0.00009344	-0.0001991	0.3805778	-5.7303551	-5.7303551	C
0.00000875	2913.	332958600.	11.5370040	0.0001009	-0.0002141	0.4103595	-6.1618102	-6.1618102	C
0.00000938	2913.	310761360.	11.5693401	0.0001085	-0.0002290	0.4400343	-6.5931481	-6.5931481	C
0.00001000	2913.	291338775.	11.5980397	0.0001160	-0.0002440	0.4696021	-7.0243685	-7.0243685	C

Page 8

Lpile Run 3 ft shaft. lp9o									
0.00001063	2913.	274201200.	11.6237454	0.0001235	-0.0002590	0.4990627	-7.4554709	-7.4554709	C
0.00001125	2913.	258967800.	11.6469573	0.0001310	-0.0002740	0.5284160	-7.8864555	-7.8864555	C
0.00001188	2913.	245337916.	11.6680701	0.0001386	-0.0002889	0.5576618	-8.3173211	-8.3173211	C
0.00001250	2913.	233071020.	11.6873996	0.0001461	-0.0003039	0.5867999	-8.7480679	-8.7480679	C
0.00001313	2913.	221972400.	11.7050761	0.0001536	-0.0003189	0.6158239	-9.1787429	-9.1787429	C
0.00001375	2940.	213816605.	11.7211619	0.0001612	-0.0003338	0.6447247	-9.6094119	-9.6094119	C
0.00001438	3075.	213917137.	11.7361290	0.0001687	-0.0003488	0.6735172	-10.0399639	-10.0399639	C
0.00001500	3210.	214004783.	11.7501179	0.0001763	-0.0003637	0.7022012	-10.4703989	-10.4703989	C
0.00001563	3345.	214081078.	11.7632468	0.0001838	-0.0003787	0.7307764	-10.9007164	-10.9007164	C
0.00001625	3480.	214147322.	11.7756157	0.0001914	-0.0003936	0.7592429	-11.3309162	-11.3309162	C
0.00001688	3615.	214204621.	11.7873096	0.0001989	-0.0004086	0.7876003	-11.7609980	-11.7609980	C
0.00001750	3749.	214253925.	11.7984016	0.0002065	-0.0004235	0.8158486	-12.1909613	-12.1909613	C
0.00001813	3884.	214296051.	11.8089545	0.0002140	-0.0004385	0.8439876	-12.6208059	-12.6208059	C
0.00001875	4019.	214331708.	11.8190229	0.0002216	-0.0004534	0.8720170	-13.0505314	-13.0505314	C
0.00001938	4153.	214361514.	11.8286542	0.0002292	-0.0004683	0.8999369	-13.4801375	-13.4801375	C
0.00002000	4288.	214386008.	11.8378901	0.0002368	-0.0004832	0.9277469	-13.9096238	-13.9096238	C
0.00002063	4422.	214405665.	11.8467671	0.0002443	-0.0004982	0.9554469	-14.3389900	-14.3389900	C
0.00002125	4556.	214420904.	11.8553173	0.0002519	-0.0005131	0.9830368	-14.7682358	-14.7682358	C
0.00002188	4691.	214432095.	11.8635694	0.0002595	-0.0005280	1.0105164	-15.1973607	-15.1973607	C
0.00002250	4825.	214439569.	11.8715487	0.0002671	-0.0005429	1.0378855	-15.6263645	-15.6263645	C
0.00002313	4959.	214443618.	11.8792779	0.0002747	-0.0005578	1.0651440	-16.0552468	-16.0552468	C
0.00002375	5093.	214444507.	11.8867772	0.0002823	-0.0005727	1.0922916	-16.4840073	-16.4840073	C
0.00002438	5227.	214442471.	11.8940648	0.0002899	-0.0005876	1.1193283	-16.9126455	-16.9126455	C
0.00002563	5495.	214430444.	11.9080689	0.0003051	-0.0006174	1.1730680	-17.7695543	-17.7695543	C
0.00002688	5762.	214409017.	11.9214030	0.0003204	-0.0006471	1.2263619	-18.6259695	-18.6259695	C
0.00002813	6029.	214379386.	11.9341601	0.0003356	-0.0006769	1.2792084	-19.4818887	-19.4818887	C
0.00002938	6296.	214342548.	11.9464172	0.0003509	-0.0007066	1.3316062	-20.3373088	-20.3373088	C
0.00003063	6563.	214299337.	11.9582389	0.0003662	-0.0007363	1.3835540	-21.1922270	-21.1922270	C
0.00003188	6829.	214250458.	11.9696798	0.0003815	-0.0007660	1.4350502	-22.0466403	-22.0466403	C
0.00003313	7095.	214196506.	11.9807859	0.0003969	-0.0007956	1.4860935	-22.9005455	-22.9005455	C
0.00003438	7361.	214137992.	11.9915971	0.0004122	-0.0008253	1.5366825	-23.7539397	-23.7539397	C
0.00003563	7626.	214075351.	12.0021472	0.0004276	-0.0008549	1.5868156	-24.6068197	-24.6068197	C
0.00003688	7892.	214008963.	12.0124658	0.0004430	-0.0008845	1.6364916	-25.4591824	-25.4591824	C
0.00003813	8156.	213939155.	12.0225785	0.0004584	-0.0009141	1.6857087	-26.3110247	-26.3110247	C
0.00003938	8421.	213866212.	12.0325078	0.0004738	-0.0009437	1.7344657	-27.1623433	-27.1623433	C
0.00004063	8685.	213790386.	12.0422732	0.0004892	-0.0009733	1.7827610	-28.0131350	-28.0131350	C
0.00004188	8949.	213711894.	12.0518922	0.0005047	-0.0010028	1.8305930	-28.8633965	-28.8633965	C
0.00004313	9213.	213630963.	12.0613459	0.0005201	-0.0010324	1.8779558	-29.7131667	-29.7131667	C
0.00004438	9476.	213547856.	12.0704832	0.0005356	-0.0010619	1.9248250	-30.5626601	-30.5626601	C
0.00004563	9739.	213462623.	12.0795171	0.0005511	-0.0010914	1.9712256	-31.4116271	-31.4116271	C
0.00004688	10002.	213375392.	12.0884582	0.0005666	-0.0011209	2.0171561	-32.2600654	-32.2600654	C
0.00004813	10264.	213286285.	12.0973160	0.0005822	-0.0011503	2.0626148	-33.1079715	-33.1079715	C
0.00004938	10527.	213195410.	12.1060993	0.0005977	-0.0011798	2.1076002	-33.9553423	-33.9553423	C
0.00005063	10788.	213102865.	12.1148158	0.0006133	-0.0012092	2.1521108	-34.8021743	-34.8021743	C
0.00005188	11050.	213008739.	12.1234727	0.0006289	-0.0012386	2.1961449	-35.6484641	-35.6484641	C
0.00005313	11294.	212595617.	12.1253464	0.0006442	-0.0012683	2.2386950	-36.5045755	-36.0000000	CY
0.00005438	11506.	211604360.	12.1147397	0.0006587	-0.0012988	2.2788627	-37.3802321	-36.0000000	CY
0.00005563	11701.	210361812.	12.0984524	0.0006730	-0.0013295	2.3176252	-38.2658213	-36.0000000	CY
0.00005688	11883.	208927412.	12.0776380	0.0006869	-0.0013606	2.3551352	-39.1600581	-36.0000000	CY
0.00005813	12054.	207377317.	12.0537502	0.0007006	-0.0013919	2.3916021	-40.0609847	-36.0000000	CY
0.00005938	12216.	205747020.	12.0271691	0.0007141	-0.0014234	2.4270761	-40.9682805	-36.0000000	CY
0.00006063	12370.	204040513.	11.9983795	0.0007274	-0.0014551	2.4616277	-41.8813864	-36.0000000	CY
0.00006188	12517.	202297604.	11.9683178	0.0007405	-0.0014870	2.4954036	-42.7988621	-36.0000000	CY
0.00006313	12658.	200530053.	11.9372463	0.0007535	-0.0015190	2.5284473	-43.7203658	-36.0000000	CY

Lpile Run 3 ft shaft. lp9o

0.00006438	12794.	198747464.	11.9053838	0.0007664	-0.0015511	2.5607970	-44.6455989	-36.0000000	CY
0.00006563	12925.	196957753.	11.8729152	0.0007792	-0.0015833	2.5924867	-45.5742955	-36.0000000	CY
0.00006688	13052.	195164926.	11.8399256	0.0007918	-0.0016157	2.6235350	-46.5063566	-36.0000000	CY
0.00006813	13174.	193377720.	11.8066409	0.0008043	-0.0016482	2.6539846	-47.4413924	-36.0000000	CY
0.00006938	13292.	191601813.	11.7732123	0.0008168	-0.0016807	2.6838670	-48.3791307	-36.0000000	CY
0.00007063	13408.	189840775.	11.7397379	0.0008291	-0.0017134	2.7132051	-49.3193866	-36.0000000	CY
0.00007188	13520.	188097599.	11.7063039	0.0008414	-0.0017461	2.7420204	-50.2619851	-36.0000000	CY
0.00007313	13628.	186368463.	11.6720360	0.0008535	-0.0017790	2.7701695	-51.2087759	-36.0000000	CY
0.00007438	13734.	184659702.	11.6377070	0.0008656	-0.0018119	2.7977903	-52.1581829	-36.0000000	CY
0.00007938	14134.	178070796.	11.5030255	0.0009131	-0.0019444	2.9036957	-55.9746354	-36.0000000	CY
0.00008438	14503.	171891706.	11.3735676	0.0009596	-0.0020779	3.0028011	-59.8173639	-36.0000000	CY
0.00008938	14847.	166115935.	11.2472400	0.0010052	-0.0022123	3.0951664	-60.0000000	-36.0000000	CY
0.00009438	15170.	160745368.	11.1268391	0.0010501	-0.0023474	3.1816938	-60.0000000	-36.0000000	CY
0.00009938	15478.	155749786.	11.0130974	0.0010944	-0.0024831	3.2628866	-60.0000000	-36.0000000	CY
0.0001044	15770.	151089157.	10.9031701	0.0011380	-0.0026195	3.3385639	-60.0000000	-36.0000000	CY
0.0001094	15981.	146113136.	10.7776354	0.0011788	-0.0027587	3.4055638	-60.0000000	-36.0000000	CY
0.0001144	16140.	141117268.	10.6472675	0.0012178	-0.0028997	3.4661889	-60.0000000	-36.0000000	CY
0.0001194	16289.	136451629.	10.5211009	0.0012560	-0.0030415	3.5223792	-60.0000000	-36.0000000	CY
0.0001244	16420.	132020895.	10.4097648	0.0012947	-0.0031828	3.5762505	-60.0000000	36.0000000	CY
0.0001294	16538.	127831842.	10.3102441	0.0013339	-0.0033236	3.6274369	-60.0000000	36.0000000	CY
0.0001344	16646.	123878696.	10.2180076	0.0013730	-0.0034645	3.6753098	-60.0000000	36.0000000	CY
0.0001394	16746.	120148287.	10.1316376	0.0014121	-0.0036054	3.7197744	-60.0000000	36.0000000	CY
0.0001444	16838.	116627804.	10.0526405	0.0014513	-0.0037462	3.7611743	-60.0000000	36.0000000	CY
0.0001494	16926.	113310389.	9.97789101	0.0014906	-0.0038869	3.7992637	-60.0000000	36.0000000	CY
0.0001544	17008.	110173229.	9.9110252	0.0015300	-0.0040275	3.8341889	-60.0000000	36.0000000	CY
0.0001594	17086.	107203332.	9.8449807	0.0015690	-0.0041685	3.8654791	-60.0000000	36.0000000	CY
0.0001644	17159.	104389600.	9.7831148	0.0016081	-0.0043094	3.8935188	-60.0000000	36.0000000	CY
0.0001694	17230.	101724732.	9.7251392	0.0016472	-0.0044503	3.9183094	-60.0000000	36.0000000	CY
0.0001744	17297.	99192418.	9.6711910	0.0016864	-0.0045911	3.9398834	-60.0000000	36.0000000	CY
0.0001794	17361.	96788660.	9.6198542	0.0017256	-0.0047319	3.9581252	-60.0000000	36.0000000	CY
0.0001844	17423.	94499213.	9.5728824	0.0017650	-0.0048725	3.9731791	-60.0000000	36.0000000	CY
0.0001894	17483.	92319636.	9.5275732	0.0018043	-0.0050132	3.9848531	-60.0000000	36.0000000	CY
0.0001944	17540.	90238418.	9.4830333	0.0018433	-0.0051542	3.9931613	-60.0000000	36.0000000	CY
0.0001994	17595.	88252259.	9.4420392	0.0018825	-0.0052950	3.9982324	-60.0000000	36.0000000	CY
0.0002044	17648.	86352799.	9.4025872	0.0019217	-0.0054358	3.9999978	-60.0000000	36.0000000	CY
0.0002094	17701.	84539865.	9.3658541	0.0019610	-0.0055765	3.9983459	-60.0000000	36.0000000	CY
0.0002144	17750.	82798556.	9.3314235	0.0020004	-0.0057171	3.9999971	-60.0000000	36.0000000	CY
0.0002194	17799.	81133071.	9.2994054	0.0020401	-0.0058574	3.9978579	-60.0000000	36.0000000	CY
0.0002244	17845.	79531913.	9.2682753	0.0020796	-0.0059979	3.9999161	-60.0000000	36.0000000	CY
0.0002294	17888.	77987246.	9.2387624	0.0021191	-0.0061384	3.9964565	60.0000000	36.0000000	CY
0.0002344	17924.	76473727.	9.2074126	0.0021580	-0.0062795	3.9993741	60.0000000	36.0000000	CY
0.0002394	17954.	75003077.	9.1751429	0.0021963	-0.0064212	3.9973612	60.0000000	36.0000000	CY
0.0002444	17973.	73546953.	9.1369243	0.0022328	-0.0065647	3.9972651	60.0000000	36.0000000	CY
0.0002494	17990.	72140532.	9.0991567	0.0022691	-0.0067084	3.9994968	60.0000000	36.0000000	CY
0.0002544	18005.	70781533.	9.0630911	0.0023054	-0.0068521	3.9977848	60.0000000	36.0000000	CY
0.0002594	18019.	69471217.	9.0288691	0.0023419	-0.0069956	3.9962220	60.0000000	36.0000000	CY
0.0002644	18032.	68206770.	8.9956190	0.0023782	-0.0071393	3.9988833	60.0000000	36.0000000	CY
0.0002694	18045.	66988414.	8.9639804	0.0024147	-0.0072828	3.9999723	60.0000000	36.0000000	CY
0.0002744	18057.	65811549.	8.9337033	0.0024512	-0.0074263	3.9933131	60.0000000	36.0000000	CY
0.0003044	18116.	59517286.	8.7727627	0.0026702	-0.0082873	3.9983874	60.0000000	36.0000000	CY
0.0003344	18156.	54299729.	8.6373214	0.0028881	-0.0091494	3.9994874	60.0000000	36.0000000	CY
0.0003644	18186.	49909909.	8.5288244	0.0031077	-0.0100098	3.9993117	60.0000000	36.0000000	CY
0.0003944	18207.	46166895.	8.4384024	0.0033279	-0.0108696	3.9972882	60.0000000	36.0000000	CY
0.0004244	18221.	42935872.	8.3576925	0.0035468	-0.0117307	3.9895553	60.0000000	36.0000000	CY

Lpile Run 3 ft shaft.lp9o

0.0004544	18231.	40122415.	8.2887929	0.0037662	-0.0125913	3.9999985	60.0000000	36.0000000	CY
0.0004844	18231.	37637414.	8.2375057	0.0039900	-0.0134475	3.9935207	60.0000000	36.0000000	CY

Axial Thrust Force = 75.000 kips

Bendi ng Curvature rad/in.	Bendi ng Moment in-kip	Bendi ng Sti ffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6.25000E-07	293.8418112	470146898.	41.4790235	0.00002592	0.00000342	0.1087237	0.7485448	0.7485448	
0.00000125	587.6304144	470104332.	29.7550395	0.00003719	-0.00000781	0.1552546	1.0720952	1.0720952	
0.00000188	880.9133848	469820472.	25.8505114	0.00004847	-0.00001903	0.2015325	1.3958341	1.3958341	
0.00000250	1173.	469376219.	23.8991017	0.00005975	-0.00003025	0.2475390	1.7196349	1.7196349	
0.00000313	1465.	468853400.	22.7285629	0.00007103	-0.00004147	0.2932691	2.0434635	2.0434635	
0.00000375	1756.	468288175.	21.9483499	0.00008231	-0.00005269	0.3387210	2.3673081	2.3673081	
0.00000438	2046.	467697784.	21.3911393	0.00009359	-0.00006391	0.3838941	2.6911633	2.6911633	
0.00000500	2335.	467091317.	20.9732872	0.0001049	-0.00007513	0.4287878	3.0150267	3.0150267	
0.00000563	2624.	466473985.	20.6483319	0.0001161	-0.00008635	0.4734021	3.3388967	3.3388967	
0.00000625	2912.	465848976.	20.3883994	0.0001274	-0.00009757	0.5177367	3.6627724	3.6627724	
0.00000688	3198.	465218351.	20.1757538	0.0001387	-0.0001088	0.5617916	3.9866534	3.9866534	
0.00000750	3198.	426450155.	16.1015465	0.0001208	-0.0001492	0.4904148	-4.2887636	-4.2887636	C
0.00000813	3198.	393646297.	15.8219044	0.0001286	-0.0001639	0.5208542	-4.7120513	-4.7120513	C
0.00000875	3198.	365528704.	15.5796045	0.0001363	-0.0001787	0.5510712	-5.1360003	-5.1360003	C
0.00000938	3198.	341160124.	15.3671218	0.0001441	-0.0001934	0.5810650	-5.5606262	-5.5606262	C
0.00001000	3198.	319837616.	15.1790851	0.0001518	-0.0002082	0.6108452	-5.9858653	-5.9858653	C
0.00001063	3198.	301023639.	15.0122758	0.0001595	-0.0002230	0.6404582	-6.4113800	-6.4113800	C
0.00001125	3198.	284300103.	14.8627111	0.0001672	-0.0002378	0.6698851	-6.8373155	-6.8373155	C
0.00001188	3198.	269336940.	14.7278202	0.0001749	-0.0002526	0.6991336	-7.2636194	-7.2636194	C
0.00001250	3198.	255870093.	14.6067134	0.0001826	-0.0002674	0.7282672	-7.6898164	-7.6898164	C
0.00001313	3292.	250784722.	14.4956224	0.0001903	-0.0002822	0.7571956	-8.1165912	-8.1165912	C
0.00001375	3427.	249201567.	14.3943720	0.0001979	-0.0002971	0.7859820	-8.5434691	-8.5434691	C
0.00001438	3561.	247751014.	14.3021849	0.0002056	-0.0003119	0.8146542	-8.9702391	-8.9702391	C
0.00001500	3696.	246416261.	14.2178828	0.0002133	-0.0003267	0.8432094	-9.3969210	-9.3969210	C
0.00001563	3831.	245175728.	14.1388865	0.0002209	-0.0003416	0.8715517	-9.8242545	-9.8242545	C
0.00001625	3965.	244026179.	14.0661990	0.0002286	-0.0003564	0.8997803	-10.2514787	-10.2514787	C
0.00001688	4100.	242957494.	13.9991197	0.0002362	-0.0003713	0.9278950	-10.6785932	-10.6785932	C
0.00001750	4234.	241961001.	13.9370484	0.0002439	-0.0003861	0.9558956	-11.1055979	-11.1055979	C
0.00001813	4369.	241029222.	13.8794675	0.0002516	-0.0004009	0.9837821	-11.5324924	-11.5324924	C
0.00001875	4503.	240152767.	13.8251534	0.0002592	-0.0004158	1.0115009	-11.9596978	-11.9596978	C
0.00001938	4637.	239327577.	13.7741286	0.0002669	-0.0004306	1.0390766	-12.3870239	-12.3870239	C
0.00002000	4771.	238550350.	13.7264861	0.0002745	-0.0004455	1.0665385	-12.8142380	-12.8142380	C
0.00002063	4905.	237816716.	13.6819189	0.0002822	-0.0004603	1.0938865	-13.2413397	-13.2413397	C
0.00002125	5039.	237122822.	13.6401561	0.0002899	-0.0004751	1.1211204	-13.6683287	-13.6683287	C
0.00002188	5173.	236465254.	13.6009578	0.0002975	-0.0004900	1.1482400	-14.0952048	-14.0952048	C
0.00002250	5306.	235840977.	13.5641107	0.0003052	-0.0005048	1.1752452	-14.5219677	-14.5219677	C
0.00002313	5440.	235247284.	13.5294246	0.0003129	-0.0005196	1.2021358	-14.9486171	-14.9486171	C
0.00002375	5574.	234681541.	13.4966531	0.0003205	-0.0005345	1.2289052	-15.3752051	-15.3752051	C
0.00002438	5707.	234140009.	13.4650758	0.0003282	-0.0005493	1.2555044	-15.8021370	-15.8021370	C
0.00002563	5974.	233127656.	13.4070109	0.0003436	-0.0005789	1.3083595	-16.6556525	-16.6556525	C
0.00002688	6240.	232198581.	13.3549458	0.0003589	-0.0006086	1.3607562	-17.5087015	-17.5087015	C
0.00002813	6506.	231341630.	13.3080837	0.0003743	-0.0006382	1.4126931	-18.3612816	-18.3612816	C
0.00002938	6772.	230547548.	13.2657635	0.0003897	-0.0006678	1.4641687	-19.2133902	-19.2133902	C
0.00003063	7038.	229808590.	13.2274318	0.0004051	-0.0006974	1.5151818	-20.0650246	-20.0650246	C

Lpile Run 3 ft shaft. Ip9o

0.00003188	7303.	229118226.	13.1926223	0.0004205	-0.0007270	1.5657309	-20.9161822	-20.9161822	C
0.00003313	7568.	228470911.	13.1609390	0.0004360	-0.0007565	1.6158146	-21.7668604	-21.7668604	C
0.00003438	7833.	227861580.	13.1318517	0.0004514	-0.0007861	1.6654103	-22.6172477	-22.6172477	C
0.00003563	8097.	227285753.	13.1048150	0.0004669	-0.0008156	1.7144858	-23.4676254	-23.4676254	C
0.00003688	8361.	226740767.	13.0800755	0.0004823	-0.0008452	1.7630943	-24.3175067	-24.3175067	C
0.00003813	8625.	226223547.	13.0574099	0.0004978	-0.0008747	1.8112343	-25.1668886	-25.1668886	C
0.00003938	8888.	225731410.	13.0366232	0.0005133	-0.0009042	1.8589044	-26.0157683	-26.0157683	C
0.00004063	9151.	225262003.	13.0175445	0.0005288	-0.0009337	1.9061031	-26.8641427	-26.8641427	C
0.00004188	9414.	224813251.	13.0000234	0.0005444	-0.0009631	1.9528289	-27.7120090	-27.7120090	C
0.00004313	9677.	224383324.	12.9839267	0.0005599	-0.0009926	1.9990804	-28.5593640	-28.5593640	C
0.00004438	9939.	223970592.	12.9691366	0.0005755	-0.0010220	2.0448560	-29.4062047	-29.4062047	C
0.00004563	10201.	223573609.	12.9555478	0.0005911	-0.0010514	2.0901542	-30.2525281	-30.2525281	C
0.00004688	10462.	223191078.	12.9430667	0.0006067	-0.0010808	2.1349734	-31.0983310	-31.0983310	C
0.00004813	10723.	222821840.	12.9316092	0.0006223	-0.0011102	2.1793121	-31.9436103	-31.9436103	C
0.00004938	10984.	222464841.	12.9210997	0.0006380	-0.0011395	2.2231687	-32.7883641	-32.7883641	C
0.00005063	11245.	222119162.	12.9114702	0.0006536	-0.0011689	2.2665418	-33.6325864	-33.6325864	C
0.00005188	11505.	221783942.	12.9026593	0.0006693	-0.0011982	2.3094296	-34.4762753	-34.4762753	C
0.00005313	11765.	221458409.	12.8946113	0.0006850	-0.0012275	2.3518306	-35.3194277	-35.3194277	C
0.00005438	12019.	221040600.	12.8851949	0.0007006	-0.0012569	2.3934390	-36.1653220	-36.0000000	CY
0.00005563	12241.	220055684.	12.8645250	0.0007156	-0.0012869	2.4327917	-37.0300505	-36.0000000	CY
0.00005688	12442.	218753701.	12.8375127	0.0007301	-0.0013174	2.4705751	-37.9067399	-36.0000000	CY
0.00005813	12628.	217258722.	12.8065986	0.0007444	-0.0013481	2.5071349	-38.7919645	-36.0000000	CY
0.00005938	12804.	215649987.	12.7732053	0.0007584	-0.0013791	2.5426779	-39.6836995	-36.0000000	CY
0.00006063	12970.	213936806.	12.7368592	0.0007722	-0.0014103	2.5771287	-40.5830467	-36.0000000	CY
0.00006188	13128.	212165230.	12.6992108	0.0007858	-0.0014417	2.6107389	-41.4873660	-36.0000000	CY
0.00006313	13279.	210356079.	12.6606863	0.0007992	-0.0014733	2.6435784	-42.3960184	-36.0000000	CY
0.00006438	13424.	208521879.	12.6215327	0.0008125	-0.0015050	2.6756912	-43.3086384	-36.0000000	CY
0.00006563	13563.	206672445.	12.5819434	0.0008257	-0.0015368	2.7071144	-44.2249263	-36.0000000	CY
0.00006688	13697.	204811305.	12.5419591	0.0008387	-0.0015688	2.7378616	-45.1448504	-36.0000000	CY
0.00006813	13826.	202952727.	12.5019135	0.0008517	-0.0016008	2.7679937	-46.0677945	-36.0000000	CY
0.00006938	13951.	201101952.	12.4619174	0.0008645	-0.0016330	2.7975370	-46.9935422	-36.0000000	CY
0.00007063	14073.	199263345.	12.4220660	0.0008773	-0.0016652	2.8265155	-47.9218933	-36.0000000	CY
0.00007188	14191.	197435894.	12.3813203	0.0008899	-0.0016976	2.8547686	-48.8549978	-36.0000000	CY
0.00007313	14305.	195626798.	12.3408058	0.0009024	-0.0017301	2.8824870	-49.7905661	-36.0000000	CY
0.00007438	14417.	193837417.	12.3006036	0.0009149	-0.0017626	2.9096930	-50.7283980	-36.0000000	CY
0.00007938	14836.	186909050.	12.1437214	0.0009639	-0.0018936	3.0137046	-54.4998335	-36.0000000	CY
0.00008438	15221.	180393238.	11.9926945	0.0010119	-0.0020256	3.1103549	-58.3024382	-36.0000000	CY
0.00008938	15578.	174301240.	11.8478156	0.0010589	-0.0021586	3.2002013	-60.0000000	-36.0000000	CY
0.00009438	15914.	168621838.	11.7114048	0.0011053	-0.0022922	3.2841011	-60.0000000	-36.0000000	CY
0.00009938	16231.	163328409.	11.5797485	0.0011507	-0.0024268	3.3618435	-60.0000000	-36.0000000	CY
0.0001044	16533.	158402922.	11.4560240	0.0011957	-0.0025618	3.4343397	-60.0000000	-36.0000000	CY
0.0001094	16805.	153643789.	11.3344815	0.0012397	-0.0026978	3.5009712	-60.0000000	-36.0000000	CY
0.0001144	16975.	148418309.	11.1977046	0.0012807	-0.0028368	3.5592744	-60.0000000	-36.0000000	CY
0.0001194	17118.	143396674.	11.0753129	0.0013221	-0.0029754	3.6144172	-60.0000000	-36.0000000	CY
0.0001244	17246.	138665050.	10.9644321	0.0013637	-0.0031138	3.6661306	-60.0000000	-36.0000000	CY
0.0001294	17363.	134207952.	10.8596208	0.0014050	-0.0032525	3.7137552	-60.0000000	-36.0000000	CY
0.0001344	17471.	130013629.	10.7643224	0.0014465	-0.0033910	3.7579569	-60.0000000	-36.0000000	CY
0.0001394	17571.	126068372.	10.6760478	0.0014880	-0.0035295	3.7984786	-60.0000000	-36.0000000	CY
0.0001444	17665.	122352898.	10.5927194	0.0015293	-0.0036682	3.8351455	-60.0000000	-36.0000000	CY
0.0001494	17752.	118838899.	10.5137911	0.0015705	-0.0038070	3.8679979	-60.0000000	-36.0000000	CY
0.0001544	17834.	115525617.	10.4398368	0.0016116	-0.0039459	3.8971889	-60.0000000	-36.0000000	CY
0.0001594	17912.	112391977.	10.3713279	0.0016529	-0.0040846	3.9228125	-60.0000000	-36.0000000	CY
0.0001644	17987.	109426649.	10.3069654	0.0016942	-0.0042233	3.9447680	-60.0000000	-36.0000000	CY
0.0001694	18057.	106612189.	10.2464606	0.0017355	-0.0043620	3.9630618	-60.0000000	-36.0000000	CY

Lpile Run 3 ft shaft. l p90								
0. 0001744	18125.	103940724.	10. 1870097	0. 0017764	-0. 0045011	3. 9775546	-60. 0000000	36. 0000000 CY
0. 0001794	18189.	101400002.	10. 1322520	0. 0018175	-0. 0046400	3. 9885124	-60. 0000000	36. 0000000 CY
0. 0001844	18250.	98983996.	10. 0801974	0. 0018585	-0. 0047790	3. 9958275	-60. 0000000	36. 0000000 CY
0. 0001894	18309.	96682345.	10. 0314085	0. 0018997	-0. 0049178	3. 9995201	-60. 0000000	36. 0000000 CY
0. 0001944	18366.	94488725.	9. 9862451	0. 0019411	-0. 0050564	3. 9971718	-60. 0000000	36. 0000000 CY
0. 0001994	18421.	92392900.	9. 9430118	0. 0019824	-0. 0051951	3. 9998501	-60. 0000000	36. 0000000 CY
0. 0002044	18474.	90391577.	9. 9030528	0. 0020239	-0. 0053336	3. 9975929	-60. 0000000	36. 0000000 CY
0. 0002094	18524.	88471231.	9. 8634641	0. 0020652	-0. 0054723	3. 9998976	-60. 0000000	36. 0000000 CY
0. 0002144	18572.	86634404.	9. 8262126	0. 0021065	-0. 0056110	3. 9972019	-60. 0000000	36. 0000000 CY
0. 0002194	18619.	84873185.	9. 7905992	0. 0021478	-0. 0057497	3. 9997514	60. 0000000	36. 0000000 CY
0. 0002244	18664.	83183569.	9. 7583143	0. 0021895	-0. 0058880	3. 9959208	60. 0000000	36. 0000000 CY
0. 0002294	18708.	81558978.	9. 7273196	0. 0022312	-0. 0060263	3. 9992013	60. 0000000	36. 0000000 CY
0. 0002344	18750.	80000383.	9. 6983079	0. 0022730	-0. 0061645	3. 9977795	60. 0000000	36. 0000000 CY
0. 0002394	18789.	78492549.	9. 6696707	0. 0023147	-0. 0063028	3. 9976669	60. 0000000	36. 0000000 CY
0. 0002444	18824.	77027197.	9. 6411768	0. 0023561	-0. 0064414	3. 9997774	60. 0000000	36. 0000000 CY
0. 0002494	18851.	75593380.	9. 6112374	0. 0023968	-0. 0065807	3. 9947425	60. 0000000	36. 0000000 CY
0. 0002544	18872.	74190238.	9. 5791919	0. 0024367	-0. 0067208	3. 9977435	60. 0000000	36. 0000000 CY
0. 0002594	18889.	72823810.	9. 5463290	0. 0024761	-0. 0068614	3. 9996701	60. 0000000	36. 0000000 CY
0. 0002644	18903.	71500514.	9. 5124026	0. 0025148	-0. 0070027	3. 9968858	60. 0000000	36. 0000000 CY
0. 0002694	18915.	70218059.	9. 4785842	0. 0025533	-0. 0071442	3. 9959136	60. 0000000	36. 0000000 CY
0. 0002744	18927.	68980674.	9. 4469068	0. 0025920	-0. 0072855	3. 9986159	60. 0000000	36. 0000000 CY
0. 0003044	18985.	62372141.	9. 2806054	0. 0028248	-0. 0081327	3. 9977659	60. 0000000	36. 0000000 CY
0. 0003344	19025.	56898332.	9. 1481032	0. 0030589	-0. 0089786	3. 9908879	60. 0000000	36. 0000000 CY
0. 0003644	19053.	52290750.	9. 0330160	0. 0032914	-0. 0098261	3. 9912851	60. 0000000	36. 0000000 CY
0. 0003944	19073.	48362476.	8. 9394384	0. 0035255	-0. 0106720	3. 9979597	60. 0000000	36. 0000000 CY
0. 0004244	19086.	44975488.	8. 8612708	0. 0037605	-0. 0115170	3. 9985867	60. 0000000	36. 0000000 CY
0. 0004544	19087.	42007404.	8. 8008511	0. 0039989	-0. 0123586	3. 9897153	60. 0000000	36. 0000000 CY

Axial Thrust Force = 90.000 kips

Bendi ng Curvature rad/in.	Bendi ng Moment in-kip	Bendi ng Sti ffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6. 25000E-07	293. 5206102	469632976.	46. 1906708	0. 00002887	0. 00000637	0. 1210323	0. 8339434	0. 8339434	
0. 00000125	587. 0304597	469624368.	32. 1113062	0. 00004014	-0. 00000486	0. 1674917	1. 1575099	1. 1575099	
0. 00000188	880. 2084747	469444520.	27. 4230416	0. 00005142	-0. 00001608	0. 2137087	1. 4813404	1. 4813404	
0. 00000250	1173.	469077576.	25. 0803080	0. 00006270	-0. 00002730	0. 2596597	1. 8052723	1. 8052723	
0. 00000313	1464.	468607603.	23. 6751700	0. 00007398	-0. 00003852	0. 3053366	2. 1292498	2. 1292498	
0. 00000375	1755.	468079796.	22. 7386448	0. 00008527	-0. 00004973	0. 3507364	2. 4532526	2. 4532526	
0. 00000438	2045.	467517025.	22. 0698283	0. 00009656	-0. 00006094	0. 3958578	2. 7772720	2. 7772720	
0. 00000500	2335.	466931691.	21. 5682987	0. 0001078	-0. 00007216	0. 4407002	3. 1013033	3. 1013033	
0. 00000563	2623.	466331014.	21. 1782786	0. 0001191	-0. 00008337	0. 4852632	3. 4253442	3. 4253442	
0. 00000625	2911.	465719451.	20. 8663069	0. 0001304	-0. 00009459	0. 5295465	3. 7493931	3. 7493931	
0. 00000688	3198.	465099896.	20. 6110929	0. 0001417	-0. 0001058	0. 5735501	4. 0734492	4. 0734492	
0. 00000750	3198.	426341571.	16. 8255163	0. 0001262	-0. 0001438	0. 5119524	-4. 1313002	-4. 1313002	C
0. 00000813	3198.	393546066.	16. 5018599	0. 0001341	-0. 0001584	0. 5426721	-4. 5518367	-4. 5518367	C
0. 00000875	3198.	365435633.	16. 2203328	0. 0001419	-0. 0001731	0. 5731149	-4. 9734155	-4. 9734155	C
0. 00000938	3198.	341073257.	15. 9737277	0. 0001498	-0. 0001877	0. 6033273	-5. 3957053	-5. 3957053	C
0. 00001000	3198.	319756179.	15. 7547756	0. 0001575	-0. 0002025	0. 6332824	-5. 8189151	-5. 8189151	C
0. 00001063	3198.	300946992.	15. 5599086	0. 0001653	-0. 0002172	0. 6630360	-6. 2426406	-6. 2426406	C
0. 00001125	3198.	284227714.	15. 3852860	0. 0001731	-0. 0002319	0. 6925965	-6. 6668254	-6. 6668254	C
0. 00001188	3198.	269268361.	15. 2278708	0. 0001808	-0. 0002467	0. 7219719	-7. 0914145	-7. 0914145	C



Lpile Run 3 ft shaft. Ip9o

0.00001250	3242.	259321981.	15.0848802	0.0001886	-0.0002614	0.7511533	-7.5164809	-7.5164809 C
0.00001313	3377.	257286076.	14.9557909	0.0001963	-0.0002762	0.7802185	-7.9414396	-7.9414396 C
0.00001375	3512.	255415638.	14.8365324	0.0002040	-0.0002910	0.8090538	-8.3671577	-8.3671577 C
0.00001438	3647.	253700669.	14.7275943	0.0002117	-0.0003058	0.8377567	-8.7928966	-8.7928966 C
0.00001500	3782.	252123656.	14.6279836	0.0002194	-0.0003206	0.8663440	-9.2185271	-9.2185271 C
0.00001563	3917.	250662759.	14.5356303	0.0002271	-0.0003354	0.8947600	-9.6444800	-9.6444800 C
0.00001625	4051.	249304325.	14.4496435	0.0002348	-0.0003502	0.9230019	-10.0707804	-10.0707804 C
0.00001688	4186.	248042152.	14.3702498	0.0002425	-0.0003650	0.9511288	-10.4969715	-10.4969715 C
0.00001750	4320.	246865915.	14.2967433	0.0002502	-0.0003798	0.9791405	-10.9230527	-10.9230527 C
0.00001813	4455.	245766716.	14.2285154	0.0002579	-0.0003946	1.0070368	-11.3490240	-11.3490240 C
0.00001875	4589.	244731208.	14.1638079	0.0002656	-0.0004094	1.0347333	-11.7755544	-11.7755544 C
0.00001938	4723.	243757908.	14.1032948	0.0002733	-0.0004242	1.0623025	-12.2020737	-12.2020737 C
0.00002000	4857.	242841770.	14.0467560	0.0002809	-0.0004391	1.0897568	-12.6284815	-12.6284815 C
0.00002063	4991.	241977588.	13.9938307	0.0002886	-0.0004539	1.1170961	-13.0547774	-13.0547774 C
0.00002125	5125.	241160770.	13.9442005	0.0002963	-0.0004687	1.1443203	-13.4809614	-13.4809614 C
0.00002188	5258.	240387248.	13.8975835	0.0003040	-0.0004835	1.1714291	-13.9070329	-13.9070329 C
0.00002250	5392.	239652888.	13.8535852	0.0003117	-0.0004983	1.1984109	-14.3330856	-14.3330856 C
0.00002313	5526.	238952092.	13.8113217	0.0003194	-0.0005131	1.2252109	-14.7595698	-14.7595698 C
0.00002375	5659.	238285086.	13.7714487	0.0003271	-0.0005279	1.2518959	-15.1859397	-15.1859397 C
0.00002438	5793.	237649263.	13.737826	0.0003348	-0.0005427	1.2784658	-15.6121949	-15.6121949 C
0.00002563	6059.	236462012.	13.6644271	0.0003502	-0.0005723	1.3312597	-16.4643600	-16.4643600 C
0.00002688	6326.	235374160.	13.6021165	0.0003656	-0.0006019	1.3835911	-17.3160628	-17.3160628 C
0.00002813	6592.	234372404.	13.5459146	0.0003810	-0.0006315	1.4354588	-18.1673009	-18.1673009 C
0.00002938	6857.	233445402.	13.4949275	0.0003964	-0.0006611	1.4868499	-19.0181710	-19.0181710 C
0.00003063	7123.	232581724.	13.4476482	0.0004118	-0.0006907	1.5376745	-19.8694449	-19.8694449 C
0.00003188	7388.	231776387.	13.4045954	0.0004273	-0.0007202	1.5880344	-20.7202395	-20.7202395 C
0.00003313	7653.	231022743.	13.3652935	0.0004427	-0.0007498	1.6379281	-21.5705523	-21.5705523 C
0.00003438	7917.	230315109.	13.3293360	0.0004582	-0.0007793	1.6873542	-22.4203806	-22.4203806 C
0.00003563	8181.	229648601.	13.2963735	0.0004737	-0.0008088	1.7363113	-23.2697215	-23.2697215 C
0.00003688	8445.	229018995.	13.2661041	0.0004892	-0.0008383	1.7847980	-24.1185723	-24.1185723 C
0.00003813	8709.	228422622.	13.2382653	0.0005047	-0.0008678	1.8328129	-24.9669303	-24.9669303 C
0.00003938	8972.	227856277.	13.2126281	0.0005202	-0.0008973	1.8803544	-25.8147926	-25.8147926 C
0.00004063	9235.	227317152.	13.1889918	0.0005358	-0.0009267	1.9274212	-26.6621564	-26.6621564 C
0.00004188	9497.	226802770.	13.1671795	0.0005514	-0.0009561	1.9740117	-27.5090187	-27.5090187 C
0.00004313	9760.	226310944.	13.1470350	0.0005670	-0.0009855	2.0201244	-28.3553767	-28.3553767 C
0.00004438	10022.	225839332.	13.1281353	0.0005826	-0.0010149	2.0657208	-29.2015933	-29.2015933 C
0.00004563	10283.	225386430.	13.1105014	0.0005982	-0.0010443	2.1108165	-30.0475052	-30.0475052 C
0.00004688	10545.	224950937.	13.0941930	0.0006138	-0.0010737	2.1554324	-30.8928938	-30.8928938 C
0.00004813	10806.	224531459.	13.0791091	0.0006294	-0.0011031	2.1995667	-31.7377557	-31.7377557 C
0.00004938	11066.	224126748.	13.0651589	0.0006451	-0.0011324	2.2432180	-32.5820879	-32.5820879 C
0.00005063	11327.	223735675.	13.0522608	0.0006608	-0.0011617	2.2863847	-33.4258870	-33.4258870 C
0.00005188	11587.	223357222.	13.0403407	0.0006765	-0.0011910	2.3290651	-34.2691498	-34.2691498 C
0.00005313	11846.	222990465.	13.0293319	0.0006922	-0.0012203	2.3712576	-35.1118729	-35.1118729 C
0.00005438	12106.	222634555.	13.0191736	0.0007079	-0.0012496	2.4129605	-35.9540544	-35.9540544 C
0.00005563	12333.	221717326.	12.9979741	0.0007230	-0.0012795	2.4524361	-36.8147804	-36.0000000 CY
0.00005688	12539.	220457384.	12.9700119	0.0007377	-0.0013098	2.4902743	-37.6881990	-36.0000000 CY
0.00005813	12728.	218981311.	12.9377495	0.0007520	-0.0013405	2.5268211	-38.5708933	-36.0000000 CY
0.00005938	12906.	217368683.	12.9027588	0.0007661	-0.0013714	2.5623032	-39.4606245	-36.0000000 CY
0.00006063	13075.	215671229.	12.8660757	0.0007800	-0.0014025	2.5968753	-40.3558681	-36.0000000 CY
0.00006188	13235.	213902011.	12.8278984	0.0007937	-0.0014338	2.6305697	-41.2564522	-36.0000000 CY
0.00006313	13388.	212085129.	12.7887022	0.0008073	-0.0014652	2.6634630	-42.1616694	-36.0000000 CY
0.00006438	13534.	210239444.	12.7480764	0.0008207	-0.0014968	2.6954963	-43.0723971	-36.0000000 CY
0.00006563	13675.	208377343.	12.7068242	0.0008339	-0.0015286	2.7267996	-43.9872625	-36.0000000 CY
0.00006688	13810.	206508163.	12.6653559	0.0008470	-0.0015605	2.7574448	-44.9055377	-36.0000000 CY

Lpile Run 3 ft shaft. Ip9o

0.00006813	13941.	204638823.	12.6238110	0.0008600	-0.0015925	2.7874625	-45.8269707	-36.0000000	CY
0.00006938	14068.	202775047.	12.5823070	0.0008729	-0.0016246	2.8168801	-46.7513334	-36.0000000	CY
0.00007063	14190.	200921595.	12.5409439	0.0008857	-0.0016568	2.8457227	-47.6784166	-36.0000000	CY
0.00007188	14309.	199082432.	12.4998074	0.0008984	-0.0016891	2.8740135	-48.6080262	-36.0000000	CY
0.00007313	14425.	197260863.	12.4589715	0.0009111	-0.0017214	2.9017735	-49.5399807	-36.0000000	CY
0.00007438	14537.	195459454.	12.4184554	0.0009236	-0.0017539	2.9290152	-50.4742064	-36.0000000	CY
0.00007938	14960.	188476313.	12.2563970	0.0009729	-0.0018846	3.0324500	-54.2404684	-36.0000000	CY
0.00008438	15348.	181905072.	12.1024459	0.0010211	-0.0020164	3.1287805	-58.0338899	-36.0000000	CY
0.00008938	15708.	175750040.	11.9539886	0.0010684	-0.0021491	3.2180960	-60.0000000	-36.0000000	CY
0.00009438	16045.	170017089.	11.8135054	0.0011149	-0.0022826	3.3012856	-60.0000000	-36.0000000	CY
0.00009938	16365.	164679149.	11.6811801	0.0011608	-0.0024167	3.3788047	-60.0000000	-36.0000000	CY
0.0001044	16669.	159700810.	11.5537455	0.0012059	-0.0025516	3.4504902	-60.0000000	-36.0000000	CY
0.0001094	16948.	154953903.	11.4309167	0.0012503	-0.0026872	3.5166467	-60.0000000	-36.0000000	CY
0.0001144	17122.	149698185.	11.2984740	0.0012923	-0.0028252	3.5753506	-60.0000000	36.0000000	CY
0.0001194	17263.	144608472.	11.1746178	0.0013340	-0.0029635	3.6298691	-60.0000000	36.0000000	CY
0.0001244	17391.	139827161.	11.0629757	0.0013760	-0.0031015	3.6809796	-60.0000000	36.0000000	CY
0.0001294	17508.	135328861.	10.9598589	0.0014179	-0.0032396	3.7282793	-60.0000000	36.0000000	CY
0.0001344	17616.	131095656.	10.8617453	0.0014595	-0.0033780	3.7714221	-60.0000000	36.0000000	CY
0.0001394	17716.	127108612.	10.7720751	0.0015014	-0.0035161	3.8110180	-60.0000000	36.0000000	CY
0.0001444	17810.	123357446.	10.6886675	0.0015432	-0.0036543	3.8468568	-60.0000000	36.0000000	CY
0.0001494	17898.	119820432.	10.6106531	0.0015850	-0.0037925	3.8789101	-60.0000000	36.0000000	CY
0.0001544	17980.	116470776.	10.5354498	0.0016264	-0.0039311	3.9069802	-60.0000000	36.0000000	CY
0.0001594	18058.	113307645.	10.4647141	0.0016678	-0.0040697	3.9313321	-60.0000000	36.0000000	CY
0.0001644	18132.	110310283.	10.3993045	0.0017094	-0.0042081	3.9520733	-60.0000000	36.0000000	CY
0.0001694	18203.	107472802.	10.3377184	0.0017510	-0.0043465	3.9690928	-60.0000000	36.0000000	CY
0.0001744	18271.	104779436.	10.2805632	0.0017927	-0.0044848	3.9824382	-60.0000000	36.0000000	CY
0.0001794	18335.	102216816.	10.2251063	0.0018341	-0.0046234	3.9919861	-60.0000000	36.0000000	CY
0.0001844	18396.	99777300.	10.1715359	0.0018754	-0.0047621	3.9978154	-60.0000000	36.0000000	CY
0.0001894	18455.	97452944.	10.1221671	0.0019169	-0.0049006	3.9999864	-60.0000000	36.0000000	CY
0.0001944	18512.	95237143.	10.0752924	0.0019584	-0.0050391	3.9987869	-60.0000000	36.0000000	CY
0.0001994	18566.	93122264.	10.0311547	0.0020000	-0.0051775	3.9981100	-60.0000000	36.0000000	CY
0.0002044	18618.	91099596.	9.9905537	0.0020418	-0.0053157	3.9990940	-60.0000000	36.0000000	CY
0.0002094	18669.	89164067.	9.9518886	0.0020837	-0.0054538	3.9971882	-60.0000000	36.0000000	CY
0.0002144	18718.	87312837.	9.9156990	0.0021257	-0.0055918	3.9989401	60.0000000	36.0000000	CY
0.0002194	18764.	85533840.	9.8808663	0.0021676	-0.0057299	3.9984538	60.0000000	36.0000000	CY
0.0002244	18809.	83826795.	9.8474493	0.0022095	-0.0058680	3.9981799	60.0000000	36.0000000	CY
0.0002294	18852.	82188983.	9.8156763	0.0022515	-0.0060060	3.9999541	60.0000000	36.0000000	CY
0.0002344	18894.	80614645.	9.7856285	0.0022935	-0.0061440	3.9963696	60.0000000	36.0000000	CY
0.0002394	18934.	79095781.	9.7575356	0.0023357	-0.0062818	3.9993239	60.0000000	36.0000000	CY
0.0002444	18971.	77628985.	9.7300467	0.0023778	-0.0064197	3.9976025	60.0000000	36.0000000	CY
0.0002494	18998.	76184032.	9.6994306	0.0024188	-0.0065587	3.9970744	60.0000000	36.0000000	CY
0.0002544	19024.	74787305.	9.6693562	0.0024596	-0.0066979	3.9994625	60.0000000	36.0000000	CY
0.0002594	19040.	73407805.	9.6352771	0.0024991	-0.0068384	3.9981372	60.0000000	36.0000000	CY
0.0002644	19055.	72076366.	9.6035240	0.0025389	-0.0069786	3.9957959	60.0000000	36.0000000	CY
0.0002694	19068.	70786467.	9.5722281	0.0025785	-0.0071190	3.9986178	60.0000000	36.0000000	CY
0.0002744	19080.	69540144.	9.5418002	0.0026180	-0.0072595	3.9999079	60.0000000	36.0000000	CY
0.0003044	19137.	62873666.	9.3721309	0.0028526	-0.0081049	3.9937450	60.0000000	36.0000000	CY
0.0003344	19178.	57353936.	9.2379826	0.0030890	-0.0089485	3.9957813	60.0000000	36.0000000	CY
0.0003644	19206.	52709233.	9.1261865	0.0033254	-0.0097921	3.9945808	60.0000000	36.0000000	CY
0.0003944	19225.	48747852.	9.0292473	0.0035609	-0.0106366	3.9887467	60.0000000	36.0000000	CY
0.0004244	19238.	45332283.	8.9491995	0.0037978	-0.0114797	3.9994174	60.0000000	36.0000000	CY
0.0004544	19238.	42339230.	8.9336224	0.0040592	-0.0122983	3.9985976	60.0000000	36.0000000	CY

Lpile Run 3 ft shaft.lp9o

Axial Thrust Force = 101.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in <sup>2</sup>	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6.25000E-07	293.2848009	469255681.	49.6497192	0.00003103	0.00000853	0.1300563	0.8966386	0.8966386	
0.00000125	586.5677161	469254173.	33.8409267	0.00004230	-0.00000270	0.1764619	1.2202086	1.2202086	
0.00000188	879.6343123	469138300.	28.5770461	0.00005358	-0.00001392	0.2226318	1.5440894	1.5440894	
0.00000250	1172.	468829749.	25.9469979	0.00006487	-0.00002513	0.2685406	1.8681074	1.8681074	
0.00000313	1464.	468401916.	24.3696555	0.00007616	-0.00003634	0.3141775	2.1921875	2.1921875	
0.00000375	1755.	467904638.	23.3184100	0.00008744	-0.00004756	0.3595383	2.5163021	2.5163021	
0.00000438	2045.	467364680.	22.5676934	0.00009873	-0.00005877	0.4046214	2.8404386	2.8404386	
0.00000500	2334.	466796932.	22.0047643	0.0001100	-0.00006998	0.4494257	3.1645908	3.1645908	
0.00000563	2622.	466210174.	21.5670049	0.0001213	-0.00008119	0.4939508	3.4887552	3.4887552	
0.00000625	2910.	465609883.	21.2168528	0.0001326	-0.00009239	0.5381962	3.8129296	3.8129296	
0.00000688	3197.	464999631.	20.9304085	0.0001439	-0.0001036	0.5821619	4.1371127	4.1371127	
0.00000750	3483.	464381841.	20.6917408	0.0001552	-0.0001148	0.6258477	4.4613036	4.4613036	
0.00000813	3483.	428660161.	16.9857385	0.0001380	-0.0001545	0.5581567	-4.4378228	-4.4378228	C
0.00000875	3483.	398041578.	16.6775105	0.0001459	-0.0001691	0.5888005	-4.8574067	-4.8574067	C
0.00000938	3483.	371505473.	16.4066282	0.0001538	-0.0001837	0.6191702	-5.2780104	-5.2780104	C
0.00001000	3483.	348286381.	16.1658004	0.0001617	-0.0001983	0.6492563	-5.6997179	-5.6997179	C
0.00001063	3483.	327798946.	15.9518358	0.0001695	-0.0002130	0.6791477	-6.1218781	-6.1218781	C
0.00001125	3483.	309587894.	15.7593495	0.0001773	-0.0002277	0.7088058	-6.5447872	-6.5447872	C
0.00001188	3483.	293293794.	15.5859385	0.0001851	-0.0002424	0.7382769	-6.9681049	-6.9681049	C
0.00001250	3483.	278629104.	15.4283183	0.0001929	-0.0002571	0.7675415	-7.3919846	-7.3919846	C
0.00001313	3483.	265361052.	15.2856989	0.0002006	-0.0002719	0.7966738	-7.8158683	-7.8158683	C
0.00001375	3574.	259921320.	15.1538576	0.0002084	-0.0002866	0.8255605	-8.2406242	-8.2406242	C
0.00001438	3709.	258021309.	15.0337411	0.0002161	-0.0003014	0.8543305	-8.6652716	-8.6652716	C
0.00001500	3844.	256272340.	14.9235373	0.0002239	-0.0003161	0.8829641	-9.0899612	-9.0899612	C
0.00001563	3979.	254646537.	14.8205353	0.0002316	-0.0003309	0.9113727	-9.5153824	-9.5153824	C
0.00001625	4114.	253141189.	14.7256883	0.0002393	-0.0003457	0.9396653	-9.9406943	-9.9406943	C
0.00001688	4248.	251742902.	14.6380908	0.0002470	-0.0003605	0.9678416	-10.3658968	-10.3658968	C
0.00001750	4383.	250437426.	14.5564598	0.0002547	-0.0003753	0.9958690	-10.7912466	-10.7912466	C
0.00001813	4517.	249211378.	14.4794803	0.0002624	-0.0003901	1.0237013	-11.2171106	-11.2171106	C
0.00001875	4651.	248063104.	14.4078362	0.0002701	-0.0004049	1.0514180	-11.6428640	-11.6428640	C
0.00001938	4785.	246985067.	14.3410116	0.0002779	-0.0004196	1.0790189	-12.0685065	-12.0685065	C
0.00002000	4919.	245970674.	14.2785552	0.0002856	-0.0004344	1.1065038	-12.4940379	-12.4940379	C
0.00002063	5053.	245014132.	14.2200703	0.0002933	-0.0004492	1.1338726	-12.9194579	-12.9194579	C
0.00002125	5187.	244104800.	14.1639736	0.0003010	-0.0004640	1.1610315	-13.3455262	-13.3455262	C
0.00002188	5321.	243244038.	14.1112587	0.0003087	-0.0004788	1.1880748	-13.7714827	-13.7714827	C
0.00002250	5455.	242427795.	14.0616456	0.0003164	-0.0004936	1.2150024	-14.1973262	-14.1973262	C
0.00002313	5588.	241652455.	14.0148832	0.0003241	-0.0005084	1.2418143	-14.6230564	-14.6230564	C
0.00002375	5722.	240914781.	13.9707469	0.0003318	-0.0005232	1.2685102	-15.0486730	-15.0486730	C
0.00002438	5855.	240211869.	13.9290352	0.0003395	-0.0005380	1.2950900	-15.4741757	-15.4741757	C
0.00002563	6122.	238899497.	13.8519969	0.0003550	-0.0005675	1.3478845	-16.3249723	-16.3249723	C
0.00002688	6388.	237693030.	13.7812803	0.0003704	-0.0005971	1.4000811	-17.1764271	-17.1764271	C
0.00002813	6654.	236583177.	13.7174215	0.0003858	-0.0006267	1.4518135	-18.0274155	-18.0274155	C
0.00002938	6920.	235557554.	13.6595480	0.0004012	-0.0006563	1.5030801	-18.8779350	-18.8779350	C
0.00003063	7185.	234605801.	13.6069297	0.0004167	-0.0006858	1.5538797	-19.7279830	-19.7279830	C
0.00003188	7450.	233719182.	13.5589512	0.0004322	-0.0007153	1.6042109	-20.5775569	-20.5775569	C
0.00003313	7714.	232890280.	13.5150899	0.0004477	-0.0007448	1.6540722	-21.4266541	-21.4266541	C
0.00003438	7979.	232111294.	13.4743025	0.0004632	-0.0007743	1.7033964	-22.2758671	-22.2758671	C
0.00003563	8243.	231377591.	13.4365179	0.0004787	-0.0008038	1.7522125	-23.1249348	-23.1249348	C

Lpile Run 3 ft shaft. lp9o

0.00003688	8507.	230685323.	13.4017550	0.0004942	-0.0008333	1.8005575	-23.9735106	-23.9735106 C
0.00003813	8770.	230030375.	13.3697191	0.0005097	-0.0008628	1.8484300	-24.8215917	-24.8215917 C
0.00003938	9033.	229409152.	13.3401530	0.0005253	-0.0008922	1.8958286	-25.6691751	-25.6691751 C
0.00004063	9296.	228818504.	13.3128312	0.0005408	-0.0009217	1.9427517	-26.5162581	-26.5162581 C
0.00004188	9558.	228255654.	13.2875550	0.0005564	-0.0009511	1.9891979	-27.3628377	-27.3628377 C
0.00004313	9820.	227718150.	13.2641490	0.0005720	-0.0009805	2.0351658	-28.2089111	-28.2089111 C
0.00004438	10082.	227203812.	13.2424573	0.0005876	-0.0010099	2.0806536	-29.0544751	-29.0544751 C
0.00004563	10344.	226710702.	13.2223414	0.0006033	-0.0010392	2.1256601	-29.8995269	-29.8995269 C
0.00004688	10605.	226237085.	13.2036775	0.0006189	-0.0010686	2.1701835	-30.7440633	-30.7440633 C
0.00004813	10866.	225781410.	13.1863545	0.0006346	-0.0010979	2.2142225	-31.5880814	-31.5880814 C
0.00004938	11126.	225342279.	13.1702728	0.0006503	-0.0011272	2.2577753	-32.4315780	-32.4315780 C
0.00005063	11386.	224918434.	13.1553426	0.0006660	-0.0011565	2.3008405	-33.2745500	-33.2745500 C
0.00005188	11646.	224508736.	13.1414828	0.0006817	-0.0011858	2.3434164	-34.1169942	-34.1169942 C
0.00005313	11906.	224111829.	13.1283359	0.0006974	-0.0012151	2.3854607	-34.9593448	-34.9593448 C
0.00005438	12165.	223727104.	13.1161041	0.0007132	-0.0012443	2.4270096	-35.8012057	-35.8012057 C
0.00005563	12401.	222933996.	13.0960594	0.0007285	-0.0012740	2.4667957	-36.6565565	-36.0000000 CY
0.00005688	12608.	221685706.	13.0669864	0.0007432	-0.0013043	2.5046110	-37.5282517	-36.0000000 CY
0.00005813	12801.	220239533.	13.0340834	0.0007576	-0.0013349	2.5411979	-38.4085105	-36.0000000 CY
0.00005938	12981.	218627066.	12.9978639	0.0007717	-0.0013658	2.5766255	-39.2968654	-36.0000000 CY
0.00006063	13151.	216924538.	12.9598899	0.0007857	-0.0013968	2.6111254	-40.1909309	-36.0000000 CY
0.00006188	13313.	215159226.	12.9206866	0.0007995	-0.0014280	2.6447800	-41.0899554	-36.0000000 CY
0.00006313	13467.	213342598.	12.8804338	0.0008131	-0.0014594	2.6776214	-41.9937432	-36.0000000 CY
0.00006438	13615.	211490993.	12.8394429	0.0008265	-0.0014910	2.7097030	-42.9018274	-36.0000000 CY
0.00006563	13757.	209623924.	12.7981271	0.0008399	-0.0015226	2.7410962	-43.8135016	-36.0000000 CY
0.00006688	13893.	207747073.	12.7559813	0.0008531	-0.0015544	2.7717296	-44.7297811	-36.0000000 CY
0.00006813	14025.	205867758.	12.7132769	0.0008661	-0.0015864	2.8016527	-45.6502197	-36.0000000 CY
0.00006938	14152.	203993859.	12.6706458	0.0008790	-0.0016185	2.8309738	-46.5736067	-36.0000000 CY
0.00007063	14275.	202130188.	12.6281876	0.0008919	-0.0016506	2.8597180	-47.4997306	-36.0000000 CY
0.00007188	14395.	200280751.	12.5859871	0.0009046	-0.0016829	2.8879085	-48.4283955	-36.0000000 CY
0.00007313	14512.	198448887.	12.5441175	0.0009173	-0.0017152	2.9155666	-49.3594180	-36.0000000 CY
0.00007438	14625.	196637380.	12.5026424	0.0009299	-0.0017476	2.9427121	-50.2926255	-36.0000000 CY
0.00007938	15051.	189615673.	12.3389836	0.0009794	-0.0018781	3.0460754	-54.0503646	-36.0000000 CY
0.00008438	15441.	182998787.	12.1813824	0.0010278	-0.0020097	3.1419136	-57.8407421	-36.0000000 CY
0.00008938	15803.	176811383.	12.0320983	0.0010754	-0.0021421	3.2311317	-60.0000000	-36.0000000 CY
0.00009438	16142.	171037429.	11.8885521	0.0011220	-0.0022755	3.3137835	-60.0000000	-36.0000000 CY
0.00009938	16463.	165661622.	11.7539835	0.0011681	-0.0024094	3.3908379	-60.0000000	-36.0000000 CY
0.0001044	16768.	160651784.	11.6256694	0.0012134	-0.0025441	3.4622277	-60.0000000	-36.0000000 CY
0.0001094	17053.	155913447.	11.5017678	0.0012580	-0.0026795	3.5280041	-60.0000000	-36.0000000 CY
0.0001144	17228.	150626469.	11.3712235	0.0013006	-0.0028169	3.5867710	-60.0000000	-36.0000000 CY
0.0001194	17369.	145496384.	11.2477849	0.0013427	-0.0029548	3.6410517	-60.0000000	-36.0000000 CY
0.0001244	17496.	140673390.	11.1348964	0.0013849	-0.0030926	3.6916036	-60.0000000	-36.0000000 CY
0.0001294	17614.	136143256.	11.0315323	0.0014272	-0.0032303	3.7384327	-60.0000000	-36.0000000 CY
0.0001344	17722.	131882176.	10.9343860	0.0014693	-0.0033682	3.7812113	-60.0000000	-36.0000000 CY
0.0001394	17822.	127868983.	10.8427706	0.0015112	-0.0035063	3.8199921	-60.0000000	-36.0000000 CY
0.0001444	17915.	124088153.	10.7583085	0.0015532	-0.0036443	3.8550869	-60.0000000	-36.0000000 CY
0.0001494	18004.	120527520.	10.6793312	0.0015952	-0.0037823	3.8863619	-60.0000000	-36.0000000 CY
0.0001544	18087.	117160612.	10.6058088	0.0016373	-0.0039202	3.9138724	-60.0000000	-36.0000000 CY
0.0001594	18165.	113974893.	10.5340408	0.0016789	-0.0040586	3.9373346	-60.0000000	-36.0000000 CY
0.0001644	18239.	110957303.	10.4674973	0.0017206	-0.0041969	3.9571359	-60.0000000	-36.0000000 CY
0.0001694	18310.	108101222.	10.4047793	0.0017623	-0.0043352	3.9731823	-60.0000000	-36.0000000 CY
0.0001744	18377.	105388142.	10.3469080	0.0018042	-0.0044733	3.9855389	-60.0000000	-36.0000000 CY
0.0001794	18442.	102810058.	10.2918111	0.0018461	-0.0046114	3.9940966	-60.0000000	-36.0000000 CY
0.0001844	18503.	100355590.	10.2396270	0.0018879	-0.0047496	3.9988826	-60.0000000	-36.0000000 CY
0.0001894	18562.	98016703.	10.1892751	0.0019296	-0.0048879	3.9971044	-60.0000000	-36.0000000 CY

Lpile Run 3 ft shaft. l p9o								
0. 0001944	18618.	95784643.	10. 1411309	0. 0019712	-0. 0050263	3. 9995480	-60. 0000000	36. 0000000 CY
0. 0001994	18672.	93653946.	10. 0968895	0. 0020131	-0. 0051644	3. 9968847	-60. 0000000	36. 0000000 CY
0. 0002044	18724.	91616422.	10. 0551122	0. 0020550	-0. 0053025	3. 9997404	-60. 0000000	36. 0000000 CY
0. 0002094	18774.	89668808.	10. 0158135	0. 0020971	-0. 0054404	3. 9968394	-60. 0000000	36. 0000000 CY
0. 0002144	18823.	87802404.	9. 9790373	0. 0021393	-0. 0055782	3. 9996702	60. 0000000	36. 0000000 CY
0. 0002194	18869.	86013158.	9. 9450020	0. 0021817	-0. 0057158	3. 9959564	60. 0000000	36. 0000000 CY
0. 0002244	18914.	84296156.	9. 9126338	0. 0022241	-0. 0058534	3. 9992626	60. 0000000	36. 0000000 CY
0. 0002294	18958.	82649414.	9. 8812515	0. 0022665	-0. 0059910	3. 9972869	60. 0000000	36. 0000000 CY
0. 0002344	18999.	81061854.	9. 8508960	0. 0023088	-0. 0061287	3. 9980610	60. 0000000	36. 0000000 CY
0. 0002394	19039.	79534479.	9. 8223706	0. 0023512	-0. 0062663	3. 9999089	60. 0000000	36. 0000000 CY
0. 0002444	19076.	78058865.	9. 7946277	0. 0023936	-0. 0064039	3. 9953163	60. 0000000	36. 0000000 CY
0. 0002494	19106.	76616176.	9. 7648904	0. 0024351	-0. 0065424	3. 9986472	60. 0000000	36. 0000000 CY
0. 0002544	19133.	75213981.	9. 7346412	0. 0024762	-0. 0066813	3. 9999689	60. 0000000	36. 0000000 CY
0. 0002594	19151.	73833384.	9. 7021831	0. 0025165	-0. 0068210	3. 9944788	60. 0000000	36. 0000000 CY
0. 0002644	19166.	72493882.	9. 6698125	0. 0025565	-0. 0069610	3. 9978603	60. 0000000	36. 0000000 CY
0. 0002694	19179.	71197981.	9. 6381664	0. 0025963	-0. 0071012	3. 9996634	60. 0000000	36. 0000000 CY
0. 0002744	19191.	69943854.	9. 6071891	0. 0026360	-0. 0072415	3. 9972130	60. 0000000	36. 0000000 CY
0. 0003044	19249.	63239844.	9. 4403480	0. 0028734	-0. 0080841	3. 9967427	60. 0000000	36. 0000000 CY
0. 0003344	19289.	57685751.	9. 3030178	0. 0031107	-0. 0089268	3. 9982449	60. 0000000	36. 0000000 CY
0. 0003644	19317.	53014488.	9. 1943440	0. 0033502	-0. 0097673	3. 9977643	60. 0000000	36. 0000000 CY
0. 0003944	19336.	49029708.	9. 0966445	0. 0035875	-0. 0106100	3. 9939318	60. 0000000	36. 0000000 CY
0. 0004244	19348.	45592714.	9. 0156147	0. 0038260	-0. 0114515	3. 9905808	60. 0000000	36. 0000000 CY

Axial Thrust Force = 104.000 kips

Bendi ng Curvature rad/in.	Bendi ng Moment in-kip	Bendi ng Sti ffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6. 25000E-07	293. 2204506	469152721.	50. 5936615	0. 00003162	0. 00000912	0. 1325170	0. 9137476	0. 9137476	
0. 00000125	586. 4397749	469151820.	34. 3129080	0. 00004289	-0. 00000211	0. 1789079	1. 2373179	1. 2373179	
0. 00000188	879. 4703650	469050861.	28. 8919062	0. 00005417	-0. 00001333	0. 2250646	1. 5612099	1. 5612099	
0. 00000250	1172.	468758181.	26. 1834443	0. 00006546	-0. 00002454	0. 2709616	1. 8852497	1. 8852497	
0. 00000313	1464.	468342222.	24. 5591106	0. 00007675	-0. 00003575	0. 3165874	2. 2093569	2. 2093569	
0. 00000375	1754.	467853669.	23. 4765629	0. 00008804	-0. 00004696	0. 3619376	2. 5335012	2. 5335012	
0. 00000438	2045.	467320279.	22. 7035010	0. 00009933	-0. 00005817	0. 4070101	2. 8576692	2. 8576692	
0. 00000500	2334.	466757614.	22. 1238204	0. 0001106	-0. 00006938	0. 4518039	3. 1818540	3. 1818540	
0. 00000563	2622.	466174894.	21. 6730373	0. 0001219	-0. 00008059	0. 4963186	3. 5060517	3. 5060517	
0. 00000625	2910.	465577878.	21. 3124695	0. 0001332	-0. 00009180	0. 5405537	3. 8302601	3. 8302601	
0. 00000688	3197.	464970332.	21. 0175055	0. 0001445	-0. 0001030	0. 5845091	4. 1544777	4. 1544777	
0. 00000750	3483.	464354813.	20. 7717399	0. 0001558	-0. 0001142	0. 6281845	4. 4787034	4. 4787034	
0. 00000813	3483.	428635212.	17. 1162679	0. 0001391	-0. 0001534	0. 5623278	-4. 4070669	-4. 4070669	C
0. 00000875	3483.	398018411.	16. 8002810	0. 0001470	-0. 0001680	0. 5930066	-4. 8262537	-4. 8262537	C
0. 00000938	3483.	371483850.	16. 5223896	0. 0001549	-0. 0001826	0. 6234005	-5. 2465378	-5. 2465378	C
0. 00001000	3483.	348266110.	16. 2765628	0. 0001628	-0. 0001972	0. 6535545	-5. 6675968	-5. 6675968	C
0. 00001063	3483.	327779868.	16. 0575103	0. 0001706	-0. 0002119	0. 6834852	-6. 0893171	-6. 0893171	C
0. 00001125	3483.	309569875.	15. 8599434	0. 0001784	-0. 0002266	0. 7131580	-6. 5119684	-6. 5119684	C
0. 00001188	3483.	293276724.	15. 6828074	0. 0001862	-0. 0002413	0. 7426809	-6. 9347457	-6. 9347457	C
0. 00001250	3483.	278612888.	15. 5208599	0. 0001940	-0. 0002560	0. 7719503	-7. 3584383	-7. 3584383	C
0. 00001313	3483.	265345607.	15. 3741939	0. 0002018	-0. 0002707	0. 8010806	-7. 7821849	-7. 7821849	C
0. 00001375	3591.	261145560.	15. 2398899	0. 0002095	-0. 0002855	0. 8300284	-8. 2063189	-8. 2063189	C
0. 00001438	3726.	259191070.	15. 1160952	0. 0002173	-0. 0003002	0. 8587814	-8. 6309403	-8. 6309403	C
0. 00001500	3861.	257394391.	15. 0028671	0. 0002250	-0. 0003150	0. 8874175	-9. 0554528	-9. 0554528	C

Lpile Run 3 ft shaft. lp9o

0.00001563	3996.	255730904.	14.8980525	0.0002328	-0.0003297	0.9158850	-9.4802574	-9.4802574 C
0.00001625	4130.	254182735.	14.8002827	0.0002405	-0.0003445	0.9441604	-9.9055417	-9.9055417 C
0.00001688	4265.	252744796.	14.7099790	0.0002482	-0.0003593	0.9723195	-10.3307165	-10.3307165 C
0.00001750	4400.	251405266.	14.6263421	0.0002560	-0.0003740	1.0003622	-10.7557814	-10.7557814 C
0.00001813	4534.	250150206.	14.5479929	0.0002637	-0.0003888	1.0282426	-11.1810987	-11.1810987 C
0.00001875	4668.	248969659.	14.4741192	0.0002714	-0.0004036	1.0559417	-11.6068227	-11.6068227 C
0.00001938	4802.	247861430.	14.4052090	0.0002791	-0.0004184	1.0835251	-12.0324357	-12.0324357 C
0.00002000	4936.	246818730.	14.3407975	0.0002868	-0.0004332	1.1109924	-12.4579374	-12.4579374 C
0.00002063	5070.	245835593.	14.2804762	0.0002945	-0.0004480	1.1383436	-12.8833276	-12.8833276 C
0.00002125	5204.	244906757.	14.2238846	0.0003023	-0.0004627	1.1655785	-13.3086061	-13.3086061 C
0.00002188	5338.	244022606.	14.1695924	0.0003100	-0.0004775	1.1926105	-13.7344772	-13.7344772 C
0.00002250	5472.	243183904.	14.1184073	0.0003177	-0.0004923	1.2195202	-14.1602892	-14.1602892 C
0.00002313	5605.	242387316.	14.0701581	0.0003254	-0.0005071	1.2463141	-14.5859877	-14.5859877 C
0.00002375	5739.	241629511.	14.0246134	0.0003331	-0.0005219	1.2729920	-15.0115725	-15.0115725 C
0.00002438	5872.	240907498.	13.9815655	0.0003408	-0.0005367	1.2995538	-15.4370433	-15.4370433 C
0.00002563	6139.	239560346.	13.9022313	0.0003562	-0.0005663	1.3523281	-16.2876418	-16.2876418 C
0.00002688	6405.	238324961.	13.8301935	0.0003717	-0.0005958	1.4045740	-17.1383054	-17.1383054 C
0.00002813	6671.	237185645.	13.7642445	0.0003871	-0.0006254	1.4562693	-17.9892255	-17.9892255 C
0.00002938	6936.	236133060.	13.7044592	0.0004026	-0.0006549	1.5074988	-18.8396762	-18.8396762 C
0.00003063	7202.	235156539.	13.6500858	0.0004180	-0.0006845	1.5582611	-19.6896550	-19.6896550 C
0.00003188	7467.	234247088.	13.6004902	0.0004335	-0.0007140	1.6085549	-20.5391593	-20.5391593 C
0.00003313	7731.	233397070.	13.5551344	0.0004490	-0.0007435	1.6583786	-21.3881864	-21.3881864 C
0.00003438	7996.	232599958.	13.5135585	0.0004645	-0.0007730	1.7077310	-22.2367338	-22.2367338 C
0.00003563	8260.	231848728.	13.4747799	0.0004800	-0.0008025	1.7565441	-23.0854054	-23.0854054 C
0.00003688	8523.	231139382.	13.4387904	0.0004956	-0.0008319	1.8048504	-23.9339059	-23.9339059 C
0.00003813	8787.	230468468.	13.4056088	0.0005111	-0.0008614	1.8526840	-24.7819112	-24.7819112 C
0.00003938	9050.	229832289.	13.3749702	0.0005266	-0.0008909	1.9000435	-25.6294183	-25.6294183 C
0.00004063	9312.	229227598.	13.3466422	0.0005422	-0.0009203	1.9469274	-26.4764245	-26.4764245 C
0.00004188	9575.	228651538.	13.3204205	0.0005578	-0.0009497	1.9933342	-27.3229268	-27.3229268 C
0.00004313	9837.	228101584.	13.2961241	0.0005734	-0.0009791	2.0392624	-28.1689222	-28.1689222 C
0.00004438	10099.	227575492.	13.2735927	0.0005890	-0.0010085	2.0847105	-29.0144078	-29.0144078 C
0.00004563	10360.	227071266.	13.2526834	0.0006047	-0.0010378	2.1296770	-29.8593806	-29.8593806 C
0.00004688	10621.	226587122.	13.2332689	0.0006203	-0.0010672	2.1741603	-30.7038375	-30.7038375 C
0.00004813	10882.	226121460.	13.2152347	0.0006360	-0.0010965	2.2181589	-31.5477755	-31.5477755 C
0.00004938	11143.	225672843.	13.1984782	0.0006517	-0.0011258	2.2616712	-32.3911914	-32.3911914 C
0.00005063	11403.	225239975.	13.1829069	0.0006674	-0.0011551	2.3046956	-33.2340821	-33.2340821 C
0.00005188	11663.	224821685.	13.1684373	0.0006831	-0.0011844	2.3472305	-34.0764445	-34.0764445 C
0.00005313	11922.	224416911.	13.1549937	0.0006989	-0.0012136	2.3892744	-34.9182752	-34.9182752 C
0.00005438	12181.	224024689.	13.1425073	0.0007146	-0.0012429	2.4308257	-35.7595712	-35.7595712 C
0.00005563	12419.	223265540.	13.1228428	0.0007300	-0.0012725	2.4707052	-36.6133515	-36.0000000 CY
0.00005688	12627.	222020441.	13.0934671	0.0007447	-0.0013028	2.5085141	-37.4845750	-36.0000000 CY
0.00005813	12821.	220575479.	13.0602361	0.0007591	-0.0013334	2.5450888	-38.3644268	-36.0000000 CY
0.00005938	13001.	218970027.	13.0238358	0.0007733	-0.0013642	2.5805242	-39.2521450	-36.0000000 CY
0.00006063	13172.	217266124.	12.9855098	0.0007872	-0.0013953	2.6150044	-40.1458879	-36.0000000 CY
0.00006188	13334.	215499072.	12.9459599	0.0008010	-0.0014265	2.6486377	-41.0446054	-36.0000000 CY
0.00006313	13489.	213685340.	12.9054861	0.0008147	-0.0014578	2.6814750	-41.9478817	-36.0000000 CY
0.00006438	13637.	211831186.	12.8641568	0.0008281	-0.0014894	2.7135325	-42.8556895	-36.0000000 CY
0.00006563	13779.	209961463.	12.8225117	0.0008415	-0.0015210	2.7449008	-43.7670947	-36.0000000 CY
0.00006688	13916.	208084678.	12.7807129	0.0008547	-0.0015528	2.7756136	-44.6818172	-36.0000000 CY
0.00006813	14048.	206202733.	12.7377126	0.0008678	-0.0015847	2.8055140	-45.6019438	-36.0000000 CY
0.00006938	14175.	204326080.	12.6947742	0.0008807	-0.0016168	2.8348086	-46.5250635	-36.0000000 CY
0.00007063	14299.	202459627.	12.6520172	0.0008935	-0.0016490	2.8635258	-47.4509246	-36.0000000 CY
0.00007188	14419.	200607394.	12.6095264	0.0009063	-0.0016812	2.8916888	-48.3793307	-36.0000000 CY
0.00007313	14535.	198772729.	12.5673749	0.0009190	-0.0017135	2.9193190	-49.3100979	-36.0000000 CY

Lpile Run 3 ft shaft. Ip9o

0. 00007438	14649.	196958420.	12. 5256258	0. 0009316	-0. 0017459	2. 9464361	-50. 2430531	-36. 0000000	CY
0. 00007938	15075.	189926123.	12. 3615398	0. 0009812	-0. 0018763	3. 0497800	-53. 9984429	-36. 0000000	CY
0. 00008438	15466.	183296794.	12. 2029421	0. 0010296	-0. 0020079	3. 1454832	-57. 7879883	-36. 0000000	CY
0. 00008938	15828.	177100702.	12. 0534389	0. 0010773	-0. 0021402	3. 2346741	-60. 0000000	-36. 0000000	CY
0. 00009438	16168.	171314289.	11. 9090042	0. 0011239	-0. 0022736	3. 3171700	-60. 0000000	-36. 0000000	CY
0. 00009938	16489.	165928786.	11. 7737065	0. 0011700	-0. 0024075	3. 3940775	-60. 0000000	-36. 0000000	CY
0. 0001044	16795.	160911023.	11. 6453236	0. 0012155	-0. 0025420	3. 4654131	-60. 0000000	-36. 0000000	CY
0. 0001094	17081.	156166632.	11. 5208467	0. 0012601	-0. 0026774	3. 5310394	-60. 0000000	-36. 0000000	CY
0. 0001144	17257.	150877874.	11. 3906883	0. 0013028	-0. 0028147	3. 5898003	-60. 0000000	36. 0000000	CY
0. 0001194	17398.	145738433.	11. 2677905	0. 0013451	-0. 0029524	3. 6440795	-60. 0000000	36. 0000000	CY
0. 0001244	17525.	140903772.	11. 1545447	0. 0013873	-0. 0030902	3. 6944747	-60. 0000000	36. 0000000	CY
0. 0001294	17642.	136364554.	11. 0509065	0. 0014297	-0. 0032278	3. 7411441	-60. 0000000	36. 0000000	CY
0. 0001344	17750.	132096551.	10. 9542574	0. 0014720	-0. 0033655	3. 7838519	-60. 0000000	36. 0000000	CY
0. 0001394	17851.	128076230.	10. 8621110	0. 0015139	-0. 0035036	3. 8224092	-60. 0000000	36. 0000000	CY
0. 0001444	17944.	124287305.	10. 7773629	0. 0015560	-0. 0036415	3. 8572992	-60. 0000000	36. 0000000	CY
0. 0001494	18032.	120719235.	10. 6981172	0. 0015980	-0. 0037795	3. 8883591	-60. 0000000	36. 0000000	CY
0. 0001544	18116.	117348059.	10. 6248305	0. 0016402	-0. 0039173	3. 9156902	-60. 0000000	36. 0000000	CY
0. 0001594	18194.	114156339.	10. 5530866	0. 0016819	-0. 0040556	3. 9389356	-60. 0000000	36. 0000000	CY
0. 0001644	18268.	111133617.	10. 4861666	0. 0017237	-0. 0041938	3. 9584726	-60. 0000000	36. 0000000	CY
0. 0001694	18339.	108271753.	10. 4232807	0. 0017654	-0. 0043321	3. 9742595	-60. 0000000	36. 0000000	CY
0. 0001744	18406.	105553222.	10. 3649850	0. 0018074	-0. 0044701	3. 9863315	-60. 0000000	36. 0000000	CY
0. 0001794	18470.	102970825.	10. 3095860	0. 0018493	-0. 0046082	3. 9946046	-60. 0000000	36. 0000000	CY
0. 0001844	18532.	100513137.	10. 2582823	0. 0018914	-0. 0047461	3. 9991131	-60. 0000000	36. 0000000	CY
0. 0001894	18591.	98169531.	10. 2075596	0. 0019331	-0. 0048844	3. 9965400	-60. 0000000	36. 0000000	CY
0. 0001944	18647.	95933794.	10. 1591721	0. 0019747	-0. 0050228	3. 9996923	-60. 0000000	36. 0000000	CY
0. 0001994	18701.	93798783.	10. 1149056	0. 0020167	-0. 0051608	3. 9972953	-60. 0000000	36. 0000000	CY
0. 0002044	18753.	91757206.	10. 0728070	0. 0020586	-0. 0052989	3. 9998493	-60. 0000000	36. 0000000	CY
0. 0002094	18803.	89806304.	10. 0333357	0. 0021007	-0. 0054368	3. 9972616	-60. 0000000	36. 0000000	CY
0. 0002144	18851.	87935609.	9. 9964437	0. 0021430	-0. 0055745	3. 9997983	60. 0000000	36. 0000000	CY
0. 0002194	18898.	86143359.	9. 9622692	0. 0021855	-0. 0057120	3. 9964510	60. 0000000	36. 0000000	CY
0. 0002244	18942.	84423027.	9. 9296291	0. 0022280	-0. 0058495	3. 9994658	60. 0000000	36. 0000000	CY
0. 0002294	18986.	82774331.	9. 8991743	0. 0022706	-0. 0059869	3. 9959979	60. 0000000	36. 0000000	CY
0. 0002344	19027.	81183550.	9. 8688363	0. 0023130	-0. 0061245	3. 9984338	60. 0000000	36. 0000000	CY
0. 0002394	19067.	79653948.	9. 8401619	0. 0023555	-0. 0062620	3. 9999747	60. 0000000	36. 0000000	CY
0. 0002444	19104.	78175943.	9. 8123498	0. 0023979	-0. 0063996	3. 9959237	60. 0000000	36. 0000000	CY
0. 0002494	19136.	76733883.	9. 7828614	0. 0024396	-0. 0065379	3. 9989742	60. 0000000	36. 0000000	CY
0. 0002544	19162.	75328741.	9. 7525110	0. 0024808	-0. 0066767	3. 9999994	60. 0000000	36. 0000000	CY
0. 0002594	19181.	73949252.	9. 7205990	0. 0025213	-0. 0068162	3. 9952058	60. 0000000	36. 0000000	CY
0. 0002644	19196.	72607313.	9. 6879727	0. 0025613	-0. 0069562	3. 9983053	60. 0000000	36. 0000000	CY
0. 0002694	19209.	71309725.	9. 6561927	0. 0026011	-0. 0070964	3. 9998258	60. 0000000	36. 0000000	CY
0. 0002744	19221.	70053747.	9. 6251873	0. 0026409	-0. 0072366	3. 9956648	60. 0000000	36. 0000000	CY
0. 0003044	19279.	63339182.	9. 4589816	0. 0028791	-0. 0080784	3. 9973929	60. 0000000	36. 0000000	CY
0. 0003344	19319.	57775881.	9. 3211430	0. 0031168	-0. 0089207	3. 9987420	60. 0000000	36. 0000000	CY
0. 0003644	19347.	53096810.	9. 2116697	0. 0033565	-0. 0097610	3. 9983525	60. 0000000	36. 0000000	CY
0. 0003944	19366.	49106251.	9. 1155239	0. 0035949	-0. 0106026	3. 9950994	60. 0000000	36. 0000000	CY
0. 0004244	19379.	45663654.	9. 0339499	0. 0038338	-0. 0114437	3. 9881412	60. 0000000	36. 0000000	CY

Axial Thrust Force = 116.000 kips

Bendi ng Curvature rad/in.	Bendi ng Moment in-kip	Bendi ng Sti ffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
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Lpile Run 3 ft shaft. Ip9o									
6. 25000E-07	292. 9628843	468740615.	54. 3718587	0. 00003398	0. 00001148	0. 1423585	0. 9822274	0. 9822274	
0. 00000125	585. 9254582	468740367.	36. 2020268	0. 00004525	2. 52533E-07	0. 1886902	1. 3057985	1. 3057985	
0. 00000188	878. 7872917	468686556.	30. 1519533	0. 00005653	-0. 00001097	0. 2347925	1. 6297250	1. 6297250	
0. 00000250	1171.	468455937.	27. 1295851	0. 00006782	-0. 00002218	0. 2806415	1. 9538449	1. 9538449	
0. 00000313	1463.	468088576.	25. 3171625	0. 00007912	0. 00003338	0. 3262223	2. 2780554	2. 2780554	
0. 00000375	1754.	467636398.	24. 1093377	0. 00009041	-0. 00004459	0. 3715290	2. 6023155	2. 6023155	
0. 00000438	2044.	467130644.	23. 2468523	0. 0001017	-0. 00005580	0. 4165590	2. 9266069	2. 9266069	
0. 00000500	2333.	466589488.	22. 6001389	0. 0001130	-0. 00006700	0. 4613108	3. 2509202	3. 2509202	
0. 00000563	2621.	466023906.	22. 0972413	0. 0001243	-0. 00007820	0. 5057836	3. 5752500	3. 5752500	
0. 00000625	2909.	465440826.	21. 6949968	0. 0001356	-0. 00008941	0. 5499771	3. 8995932	3. 8995932	
0. 00000688	3196.	464844817.	21. 3659445	0. 0001469	-0. 0001006	0. 5938908	4. 2239477	4. 2239477	
0. 00000750	3482.	464238994.	21. 0917801	0. 0001582	-0. 0001118	0. 6375246	4. 5483122	4. 5483122	
0. 00000813	3482.	428528302.	17. 6271534	0. 0001432	-0. 0001493	0. 5786290	-4. 2866895	-4. 2866895	C
0. 00000875	3482.	397919138.	17. 2835143	0. 0001512	-0. 0001638	0. 6095368	-4. 7036332	-4. 7036332	C
0. 00000938	3482.	371391195.	16. 9811659	0. 0001592	-0. 0001783	0. 6401394	-5. 1218080	-5. 1218080	C
0. 00001000	3482.	348179246.	16. 7134010	0. 0001671	-0. 0001929	0. 6704791	-5. 5409137	-5. 5409137	C
0. 00001063	3482.	327698113.	16. 4733316	0. 0001750	-0. 0002075	0. 7005253	-5. 9611922	-5. 9611922	C
0. 00001125	3482.	309492663.	16. 2578834	0. 0001829	-0. 0002221	0. 7303469	-6. 3821405	-6. 3821405	C
0. 00001188	3482.	293203575.	16. 0637659	0. 0001908	-0. 0002367	0. 7599719	-6. 8035531	-6. 8035531	C
0. 00001250	3482.	278543396.	15. 8867006	0. 0001986	-0. 0002514	0. 7893500	-7. 2258210	-7. 2258210	C
0. 00001313	3522.	268334855.	15. 7259800	0. 0002064	-0. 0002661	0. 8185686	-7. 6482863	-7. 6482863	C
0. 00001375	3657.	265996100.	15. 5784854	0. 0002142	-0. 0002808	0. 8475819	-8. 0713039	-8. 0713039	C
0. 00001438	3793.	263844942.	15. 4428278	0. 0002220	-0. 0002955	0. 8764091	-8. 4947336	-8. 4947336	C
0. 00001500	3928.	261867876.	15. 3187268	0. 0002298	-0. 0003102	0. 9051180	-8. 9180538	-8. 9180538	C
0. 00001563	4063.	260029271.	15. 2027761	0. 0002375	-0. 0003250	0. 9335911	-9. 3421795	-9. 3421795	C
0. 00001625	4198.	258324715.	15. 0956111	0. 0002453	-0. 0003397	0. 9619247	-9. 7663682	-9. 7663682	C
0. 00001688	4333.	256741883.	14. 9966089	0. 0002531	-0. 0003544	0. 9901406	-10. 1904470	-10. 1904470	C
0. 00001750	4467.	255262917.	14. 9041354	0. 0002608	-0. 0003692	1. 0181902	-10. 6148012	-10. 6148012	C
0. 00001813	4601.	253874553.	14. 8171099	0. 0002686	-0. 0003839	1. 0460471	-11. 0396441	-11. 0396441	C
0. 00001875	4736.	252574704.	14. 7360896	0. 0002763	-0. 0003987	1. 0737870	-11. 4643762	-11. 4643762	C
0. 00001938	4870.	251354797.	14. 6604940	0. 0002840	-0. 0004135	1. 1014099	-11. 8889974	-11. 8889974	C
0. 00002000	5004.	250207329.	14. 5898150	0. 0002918	-0. 0004282	1. 1289156	-12. 3135073	-12. 3135073	C
0. 00002063	5138.	249119044.	14. 5223575	0. 0002995	-0. 0004430	1. 1562119	-12. 7386523	-12. 7386523	C
0. 00002125	5272.	248090142.	14. 4588460	0. 0003073	-0. 0004577	1. 1833760	-13. 1638111	-13. 1638111	C
0. 00002188	5406.	247116587.	14. 3991410	0. 0003150	-0. 0004725	1. 2104236	-13. 5888574	-13. 5888574	C
0. 00002250	5539.	246193760.	14. 3429257	0. 0003227	-0. 0004873	1. 2373544	-14. 0137909	-14. 0137909	C
0. 00002313	5673.	245317540.	14. 2899176	0. 0003305	-0. 0005020	1. 2641682	-14. 4386115	-14. 4386115	C
0. 00002375	5807.	244484240.	14. 2398639	0. 0003382	-0. 0005168	1. 2908649	-14. 8633187	-14. 8633187	C
0. 00002438	5940.	243687840.	14. 1919157	0. 0003459	-0. 0005316	1. 3173916	-15. 2883520	-15. 2883520	C
0. 00002563	6206.	242199130.	14. 1026666	0. 0003614	-0. 0005611	1. 3700210	-16. 1386933	-16. 1386933	C
0. 00002688	6473.	240837660.	14. 0223115	0. 0003768	-0. 0005907	1. 4221831	-16. 9885734	-16. 9885734	C
0. 00002813	6738.	239586416.	13. 9496675	0. 0003923	-0. 0006202	1. 4738767	-17. 8379899	-17. 8379899	C
0. 00002938	7004.	238431276.	13. 8837530	0. 0004078	-0. 0006497	1. 5251003	-18. 6869403	-18. 6869403	C
0. 00003063	7269.	237357610.	13. 8229032	0. 0004233	-0. 0006792	1. 5757672	-19. 5361715	-19. 5361715	C
0. 00003188	7534.	236356891.	13. 7668330	0. 0004388	-0. 0007087	1. 6259109	-20. 3853962	-20. 3853962	C
0. 00003313	7798.	235422467.	13. 7154931	0. 0004543	-0. 0007382	1. 6755839	-21. 2341419	-21. 2341419	C
0. 00003438	8063.	234547063.	13. 6683702	0. 0004699	-0. 0007676	1. 7247849	-22. 0824059	-22. 0824059	C
0. 00003563	8326.	233724423.	13. 6250229	0. 0004854	-0. 0007971	1. 7735125	-22. 9301857	-22. 9301857	C
0. 00003688	8590.	232949141.	13. 5850698	0. 0005009	-0. 0008266	1. 8217651	-23. 7774784	-23. 7774784	C
0. 00003813	8853.	232216518.	13. 5481795	0. 0005165	-0. 0008560	1. 8695414	-24. 6242814	-24. 6242814	C
0. 00003938	9116.	231522453.	13. 5140628	0. 0005321	-0. 0008854	1. 9168399	-25. 4705920	-25. 4705920	C
0. 00004063	9379.	230862400.	13. 4820440	0. 0005477	-0. 0009148	1. 9636072	-26. 3169043	-26. 3169043	C
0. 00004188	9641.	230233537.	13. 4520361	0. 0005633	-0. 0009442	2. 0098561	-27. 1630961	-27. 1630961	C
0. 00004313	9903.	229633817.	13. 4241748	0. 0005789	-0. 0009736	2. 0556256	-28. 0087788	-28. 0087788	C



Lpile Run 3 ft shaft.lp9o

0.00004438	10165.	229060741.	13.3982810	0.0005945	-0.0010030	2.1009143	-28.8539495	-28.8539495 C
0.00004563	10426.	228512084.	13.3741953	0.0006102	-0.0010323	2.1457206	-29.6986053	-29.6986053 C
0.00004688	10687.	227985856.	13.3517753	0.0006259	-0.0010616	2.1900429	-30.5427428	-30.5427428 C
0.00004813	10947.	227480275.	13.3308934	0.0006415	-0.0010910	2.2338798	-31.3863592	-31.3863592 C
0.00004938	11208.	226993739.	13.3114351	0.0006573	-0.0011202	2.2772296	-32.2294513	-32.2294513 C
0.00005063	11468.	226524804.	13.2932969	0.0006730	-0.0011495	2.3200908	-33.0720158	-33.0720158 C
0.00005188	11727.	226072165.	13.2763857	0.0006887	-0.0011788	2.3624617	-33.9140496	-33.9140496 C
0.00005313	11987.	225634638.	13.2606168	0.0007045	-0.0012080	2.4043407	-34.7555495	-34.7555495 C
0.00005438	12246.	225211149.	13.2459137	0.0007202	-0.0012373	2.4457262	-35.5965122	-35.5965122 C
0.00005563	12490.	224534593.	13.2268102	0.0007357	-0.0012668	2.4858335	-36.4456392	-36.0000000 CY
0.00005688	12703.	223353788.	13.1980127	0.0007506	-0.0012969	2.5238733	-37.3121401	-36.0000000 CY
0.00005813	12899.	221916105.	13.1643464	0.0007652	-0.0013273	2.5605262	-38.1889359	-36.0000000 CY
0.00005938	13082.	220336773.	13.1277780	0.0007795	-0.0013580	2.5960739	-39.0731695	-36.0000000 CY
0.00006063	13255.	218631502.	13.0881364	0.0007935	-0.0013890	2.6304880	-39.9654575	-36.0000000 CY
0.00006188	13418.	216857522.	13.0472006	0.0008073	-0.0014202	2.6640359	-40.8629417	-36.0000000 CY
0.00006313	13574.	215037570.	13.0054113	0.0008210	-0.0014515	2.6967897	-41.7649562	-36.0000000 CY
0.00006438	13724.	213186180.	12.9630398	0.0008345	-0.0014830	2.7287976	-42.6710875	-36.0000000 CY
0.00006563	13867.	211310804.	12.9201986	0.0008479	-0.0015146	2.7600846	-43.5811844	-36.0000000 CY
0.00006688	14005.	209423131.	12.8771178	0.0008612	-0.0015463	2.7906947	-44.4948520	-36.0000000 CY
0.00006813	14138.	207535168.	12.8340540	0.0008743	-0.0015782	2.8206769	-45.4116094	-36.0000000 CY
0.00006938	14267.	205652763.	12.7911200	0.0008874	-0.0016101	2.8500583	-46.3312278	-36.0000000 CY
0.00007063	14392.	203776625.	12.7474900	0.0009003	-0.0016422	2.8787178	-47.2553843	-36.0000000 CY
0.00007188	14513.	201913231.	12.7038381	0.0009131	-0.0016744	2.9067703	-48.1827498	-36.0000000 CY
0.00007313	14630.	200067381.	12.6605584	0.0009258	-0.0017067	2.9342881	-49.1124906	-36.0000000 CY
0.00007438	14744.	198241892.	12.6177134	0.0009384	-0.0017391	2.9612912	-50.0444316	-36.0000000 CY
0.00007938	15174.	191163074.	12.4509704	0.0009883	-0.0018692	3.0643970	-53.7925848	-36.0000000 CY
0.00008438	15566.	184488214.	12.2893377	0.0010369	-0.0020006	3.1597131	-57.5765896	-36.0000000 CY
0.00008938	15931.	178246967.	12.1364776	0.0010847	-0.0021328	3.2483804	-60.0000000	-36.0000000 CY
0.00009438	16272.	172421173.	11.9909734	0.0011316	-0.0022659	3.3306583	-60.0000000	-36.0000000 CY
0.00009938	16595.	166993180.	11.8525960	0.0011779	-0.0023996	3.4069492	-60.0000000	-36.0000000 CY
0.0001044	16903.	161941341.	11.7231646	0.0012236	-0.0025339	3.4779360	-60.0000000	-36.0000000 CY
0.0001094	17188.	157147928.	11.5990969	0.0012687	-0.0026688	3.5433857	-60.0000000	-36.0000000 CY
0.0001144	17370.	151867758.	11.4701923	0.0013119	-0.0028056	3.6020575	-60.0000000	-36.0000000 CY
0.0001194	17512.	146698216.	11.3484115	0.0013547	-0.0029428	3.6561511	-60.0000000	-36.0000000 CY
0.0001244	17639.	141824795.	11.2333649	0.0013971	-0.0030804	3.7058574	-60.0000000	-36.0000000 CY
0.0001294	17756.	137247705.	11.1285332	0.0014398	-0.0032177	3.7518662	-60.0000000	-36.0000000 CY
0.0001344	17865.	132946871.	11.0317047	0.0014824	-0.0033551	3.7939903	-60.0000000	-36.0000000 CY
0.0001394	17966.	128900619.	10.9403029	0.0015248	-0.0034927	3.8320146	-60.0000000	-36.0000000 CY
0.0001444	18059.	125083344.	10.8538468	0.0015670	-0.0036305	3.8660078	-60.0000000	-36.0000000 CY
0.0001494	18147.	121485510.	10.7735345	0.0016093	-0.0037682	3.8961985	-60.0000000	-36.0000000 CY
0.0001544	18230.	118091148.	10.6985467	0.0016516	-0.0039059	3.9225517	-60.0000000	-36.0000000 CY
0.0001594	18309.	114880487.	10.6291208	0.0016940	-0.0040435	3.9451206	-60.0000000	-36.0000000 CY
0.0001644	18383.	111838238.	10.5611535	0.0017360	-0.0041815	3.9636283	-60.0000000	-36.0000000 CY
0.0001694	18454.	108952890.	10.4975695	0.0017780	-0.0043195	3.9783624	-60.0000000	-36.0000000 CY
0.0001744	18521.	106212895.	10.4376096	0.0018201	-0.0044574	3.9892909	-60.0000000	-36.0000000 CY
0.0001794	18585.	103611417.	10.3813988	0.0018622	-0.0045953	3.9964245	-60.0000000	-36.0000000 CY
0.0001844	18647.	101136104.	10.3293730	0.0019045	-0.0047330	3.9997477	-60.0000000	-36.0000000 CY
0.0001894	18706.	98778277.	10.2799336	0.0019468	-0.0048707	3.9980384	-60.0000000	-36.0000000 CY
0.0001944	18762.	96527071.	10.2323782	0.0019889	-0.0050086	3.9999940	-60.0000000	-36.0000000 CY
0.0001994	18816.	94375995.	10.1871430	0.0020311	-0.0051464	3.9986505	-60.0000000	-36.0000000 CY
0.0002044	18868.	92319492.	10.1439889	0.0020732	-0.0052843	3.9990690	-60.0000000	-36.0000000 CY
0.0002094	18918.	90353826.	10.1040839	0.0021155	-0.0054220	3.9986587	-60.0000000	-36.0000000 CY
0.0002144	18965.	88467625.	10.0664778	0.0021580	-0.0055595	3.9994928	-60.0000000	-36.0000000 CY
0.0002194	19012.	86662335.	10.0315320	0.0022007	-0.0056968	3.9981110	-60.0000000	-36.0000000 CY

Lpile Run 3 ft shaft.l p9o								
0.0002244	19056.	84929816.	9.9980065	0.0022433	-0.0058342	3.9999531	60.0000000	36.0000000 CY
0.0002294	19099.	83265979.	9.9672608	0.0022862	-0.0059713	3.9966983	60.0000000	36.0000000 CY
0.0002344	19141.	81667008.	9.9384445	0.0023293	-0.0061082	3.9995037	60.0000000	36.0000000 CY
0.0002394	19181.	80129188.	9.9110770	0.0023725	-0.0062450	3.9961654	60.0000000	36.0000000 CY
0.0002444	19218.	78642741.	9.8835360	0.0024153	-0.0063822	3.9979388	60.0000000	36.0000000 CY
0.0002494	19253.	77203591.	9.8554698	0.0024577	-0.0065198	3.9998354	60.0000000	36.0000000 CY
0.0002544	19278.	75785775.	9.8249738	0.0024992	-0.0066583	3.9944446	60.0000000	36.0000000 CY
0.0002594	19301.	74412126.	9.7948422	0.0025405	-0.0067970	3.9976164	60.0000000	36.0000000 CY
0.0002644	19315.	73060467.	9.7611988	0.0025806	-0.0069369	3.9995740	60.0000000	36.0000000 CY
0.0002694	19329.	71755864.	9.7289784	0.0026207	-0.0070768	3.9977551	60.0000000	36.0000000 CY
0.0002744	19341.	70492752.	9.6977532	0.0026608	-0.0072167	3.9952447	60.0000000	36.0000000 CY
0.0003044	19400.	63735996.	9.5342437	0.0029020	-0.0080555	3.9992834	60.0000000	36.0000000 CY
0.0003344	19439.	58135908.	9.3944162	0.0031413	-0.0088962	3.9999099	60.0000000	36.0000000 CY
0.0003644	19467.	53425678.	9.2817339	0.0033820	-0.0097355	3.9998172	60.0000000	36.0000000 CY
0.0003944	19487.	49411341.	9.1907618	0.0036246	-0.0105729	3.9985144	60.0000000	36.0000000 CY
0.0004244	19499.	45947023.	9.1082869	0.0038653	-0.0114122	3.9921796	60.0000000	36.0000000 CY

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Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1  
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Moment values interpolated at maximum compressive strain = 0.003  
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain
1	-8.000	18171.479	0.00300000
2	75.000	19015.100	0.00300000
3	90.000	19162.459	0.00300000
4	101.000	19269.992	0.00300000
5	104.000	19299.187	0.00300000
6	116.000	19415.845	0.00300000

Note that the values of moment capacity in the table above are not factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.70).

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to ACI 318, Section 9.3.2.2 or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding bending stiffnesses computed for common resistance factor values used for reinforced concrete sections.

Axial Load No.	Resist. Factor for Moment	Nominal Moment Cap in-kips	Ult. (Fac) Ax. Thrust kips	Ult. (Fac) Moment Cap in-kips	Bend. Stiff. at Ult Mom kip-in^2
1	0.65	18171.	-5.200000	11811.	209491180.

Lpile Run 3 ft shaft. l p9o					
2	0.65	19015.	48.750000	12360.	219283521.
3	0.65	19162.	58.500000	12456.	220965779.
4	0.65	19270.	65.650000	12525.	222183889.
5	0.65	19299.	67.600000	12544.	222516294.
6	0.65	19416.	75.400000	12620.	223812524.
1	0.70	18171.	-5.600000	12720.	199722415.
2	0.70	19015.	52.500000	13311.	209952912.
3	0.70	19162.	63.000000	13414.	211759026.
4	0.70	19270.	70.700000	13489.	213069620.
5	0.70	19299.	72.800000	13509.	213427523.
6	0.70	19416.	81.200000	13591.	214829123.
1	0.75	18171.	-6.000000	13629.	186361752.
2	0.75	19015.	56.250000	14261.	196320140.
3	0.75	19162.	67.500000	14372.	198093387.
4	0.75	19270.	75.750000	14452.	199378717.
5	0.75	19299.	78.000000	14474.	199730436.
6	0.75	19416.	87.000000	14562.	201137086.

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Layering Correction Equivalent Depths of Soil & Rock Layers  
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Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N. A.	No	0.00	26764.
2	4.0000	4.0000	Yes	No	26764.	70114.
3	8.0000	8.0000	Yes	No	96879.	645913.
4	21.0000	21.0000	Yes	No	742792.	650456.
5	27.0000	27.0000	Yes	No	1393249.	2299745.
6	37.0000	37.0000	Yes	No	3692994.	N. A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 1  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Lpile Run 3 ft shaft.lp9o

Shear force at pile head = 0.0 lbs  
 Applied moment at pile head = 5014935.0 in-lbs  
 Axial thrust load on pile head = 104000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.9667	5014935.	-9.88E-08	-0.00673	0.00	2.46E+11	0.00	0.00	791.7000
0.4000	0.9347	5027388.	3602.	-0.00663	0.00	2.46E+11	-82.7553	424.9919	791.7000
0.8000	0.9031	5056126.	6792.	-0.00653	0.00	2.46E+11	-171.1397	909.6211	791.7000
1.2000	0.8720	5099113.	9550.	-0.00643	0.00	2.46E+11	-263.1942	1449.	791.7000
1.6000	0.8414	5154227.	11862.	-0.00633	0.00	2.45E+11	-357.0896	2037.	791.7000
2.0000	0.8112	5219304.	13721.	-0.00623	0.00	2.45E+11	-451.3930	2671.	791.7000
2.4000	0.7816	5292170.	15132.	-0.00612	0.00	2.44E+11	-544.3361	3343.	791.7000
2.8000	0.7524	5370684.	16103.	-0.00602	0.00	2.44E+11	-634.3545	4047.	791.7000
3.2000	0.7238	5452770.	16650.	-0.00591	0.00	2.43E+11	-721.1545	4783.	791.7000
3.6000	0.6957	5536428.	16790.	-0.00580	0.00	2.43E+11	-803.9735	5547.	791.7000
4.0000	0.6681	5619749.	16688.	-0.00569	0.00	2.42E+11	-821.7126	5904.	791.7000
4.4000	0.6410	5702322.	16536.	-0.00558	0.00	2.42E+11	-825.3702	6181.	791.7000
4.8000	0.6145	5784063.	16234.	-0.00547	0.00	2.41E+11	-883.6657	6903.	791.7000
5.2000	0.5885	5863628.	15663.	-0.00535	0.00	2.41E+11	-937.7632	7649.	791.7000
5.6000	0.5631	5939769.	14850.	-0.00523	0.00	2.41E+11	-984.4402	8392.	791.7000
6.0000	0.5383	6011411.	13832.	-0.00511	0.00	2.40E+11	-1023.	9121.	791.7000
6.4000	0.5140	6077667.	12631.	-0.00499	0.00	2.40E+11	-1061.	9909.	791.7000
6.8000	0.4903	6137656.	11266.	-0.00487	0.00	2.40E+11	-1091.	10683.	791.7000
7.2000	0.4672	6190682.	9776.	-0.00475	0.00	2.39E+11	-1113.	11434.	791.7000
7.6000	0.4447	6236243.	8196.	-0.00462	0.00	2.39E+11	-1129.	12180.	791.7000
8.0000	0.4228	6273982.	6542.	-0.00450	0.00	2.39E+11	-1144.	12990.	791.7000
8.4000	0.4016	6303533.	4833.	-0.00437	0.00	2.39E+11	-1151.	13758.	791.7000
8.8000	0.3809	6324743.	3116.	-0.00424	0.00	2.39E+11	-1148.	14468.	791.7000
9.2000	0.3608	6337680.	1405.	-0.00412	0.00	2.39E+11	-1148.	15273.	791.7000
9.6000	0.3413	6342342.	-316.8476	-0.00399	0.00	2.39E+11	-1153.	16211.	791.7000
10.0000	0.3225	6338621.	-2042.	-0.00386	0.00	2.39E+11	-1149.	17106.	791.7000
10.4000	0.3043	6326597.	-3730.	-0.00373	0.00	2.39E+11	-1137.	17941.	791.7000
10.8000	0.2867	6306546.	-5339.	-0.00361	0.00	2.39E+11	-1117.	18697.	791.7000
11.2000	0.2696	6278948.	-6827.	-0.00348	0.00	2.39E+11	-1087.	19349.	791.7000
11.6000	0.2532	6244485.	-8151.	-0.00336	0.00	2.39E+11	-1048.	19873.	791.7000
12.0000	0.2374	6204045.	-9270.	-0.00323	0.00	2.39E+11	-1001.	20242.	791.7000
12.4000	0.2222	6158715.	-10290.	-0.00311	0.00	2.39E+11	-1007.	21756.	791.7000
12.8000	0.2076	6108359.	-11330.	-0.00298	0.00	2.40E+11	-1009.	23341.	791.7000
13.2000	0.1936	6052924.	-12372.	-0.00286	0.00	2.40E+11	-1008.	24998.	791.7000
13.6000	0.1801	5992442.	-13399.	-0.00274	0.00	2.40E+11	-1003.	26729.	791.7000
14.0000	0.1673	5927031.	-14392.	-0.00262	0.00	2.41E+11	-994.2111	28533.	791.7000
14.4000	0.1549	5856895.	-15334.	-0.00251	0.00	2.41E+11	-981.7013	30411.	791.7000
14.8000	0.1432	5782324.	-16207.	-0.00239	0.00	2.41E+11	-965.5485	32364.	791.7000
15.2000	0.1320	5703689.	-17016.	-0.00228	0.00	2.42E+11	-954.6936	34714.	791.7000
15.6000	0.1214	5621243.	-17787.	-0.00216	0.00	2.42E+11	-949.8521	37569.	791.7000
16.0000	0.1112	5535098.	-18528.	-0.00205	0.00	2.43E+11	-942.3692	40662.	791.7000
16.4000	0.1017	5445426.	-19227.	-0.00194	0.00	2.43E+11	-932.2345	44019.	791.7000
16.8000	0.09258	5352463.	-19871.	-0.00184	0.00	2.44E+11	-919.4453	47671.	791.7000
17.2000	0.08401	5256504.	-20447.	-0.00173	0.00	2.45E+11	-904.0075	51652.	791.7000
17.6000	0.07594	5157905.	-20942.	-0.00163	0.00	2.45E+11	-885.9352	56001.	791.7000

Lpile Run 3 ft shaft. l p90									
18. 0000	0. 06835	5057086.	-21345.	-0. 00153	0. 00	2. 46E+11	-865. 2515	60767.	791. 7000
18. 4000	0. 06123	4954522.	-21568.	-0. 00143	0. 00	2. 47E+11	-811. 1946	63590.	791. 7000
18. 8000	0. 05458	4851461.	-21488.	-0. 00134	0. 00	2. 47E+11	-738. 7790	64973.	791. 7000
19. 2000	0. 04838	4749573.	-21066.	-0. 00125	0. 00	2. 48E+11	-668. 7755	66355.	791. 7000
19. 6000	0. 04262	4650470.	-20314.	-0. 00116	0. 00	2. 49E+11	-601. 4200	67738.	791. 7000
20. 0000	0. 03729	4555708.	-20196.	-0. 00107	0. 00	2. 50E+11	-536. 9400	69120.	395. 8500
20. 4000	0. 03238	4457650.	-21676.	-9. 80E-04	0. 00	2. 51E+11	-475. 5577	70502.	0. 00
20. 8000	0. 02788	4348594.	-23820.	-8. 96E-04	0. 00	2. 52E+11	-417. 4787	71885.	0. 00
21. 2000	0. 02377	4229877.	-25402.	-8. 15E-04	0. 00	2. 53E+11	-241. 9189	48845.	0. 00
21. 6000	0. 02006	4105546.	-26482.	-7. 36E-04	0. 00	2. 54E+11	-207. 9352	49766.	0. 00
22. 0000	0. 01671	3976386.	-27404.	-6. 60E-04	0. 00	2. 56E+11	-176. 4492	50688.	0. 00
22. 4000	0. 01372	3843123.	-28182.	-5. 87E-04	0. 00	2. 58E+11	-147. 5267	51610.	0. 00
22. 8000	0. 01108	3706426.	-28827.	-5. 17E-04	0. 00	2. 59E+11	-121. 2182	52531.	0. 00
23. 2000	0. 00876	3566901.	-29352.	-4. 50E-04	0. 00	2. 62E+11	-97. 5593	53453.	0. 00
23. 6000	0. 00676	3425096.	-29770.	-3. 99E-04	0. 00	4. 64E+11	-76. 5636	54374.	0. 00
24. 0000	0. 00493	3281510.	-30090.	-3. 65E-04	0. 00	4. 65E+11	-56. 7565	55296.	0. 00
24. 4000	0. 00326	3136598.	-30318.	-3. 32E-04	0. 00	4. 65E+11	-38. 1511	56218.	0. 00
24. 8000	0. 00174	2990792.	-30459.	-3. 00E-04	0. 00	4. 65E+11	-20. 7543	57139.	0. 00
25. 2000	3. 78E-04	2844492.	-30520.	-2. 70E-04	0. 00	4. 66E+11	-4. 5671	58061.	0. 00
25. 6000	-8. 48E-04	2698072.	-30506.	-2. 41E-04	0. 00	4. 66E+11	10. 4153	58982.	0. 00
26. 0000	-0. 00194	2551878.	-30423.	-2. 14E-04	0. 00	4. 66E+11	24. 2033	59904.	0. 00
26. 4000	-0. 00291	2406229.	-30276.	-1. 89E-04	0. 00	4. 67E+11	36. 8129	60826.	0. 00
26. 8000	-0. 00375	2261416.	-30072.	-1. 65E-04	0. 00	4. 67E+11	48. 2648	61747.	0. 00
27. 2000	-0. 00449	2117703.	-29640.	-1. 42E-04	0. 00	4. 67E+11	131. 8159	141005.	0. 00
27. 6000	-0. 00512	1977016.	-28957.	-1. 21E-04	0. 00	4. 67E+11	152. 5582	143078.	0. 00
28. 0000	-0. 00565	1839834.	-28181.	-1. 02E-04	0. 00	4. 68E+11	170. 8986	145152.	0. 00
28. 4000	-0. 00609	1706580.	-27322.	-8. 35E-05	0. 00	4. 68E+11	186. 9198	147226.	0. 00
28. 8000	-0. 00645	1577624.	-26392.	-6. 66E-05	0. 00	4. 68E+11	200. 7099	149299.	0. 00
29. 2000	-0. 00673	1453284.	-25401.	-5. 11E-05	0. 00	4. 68E+11	212. 3612	151373.	0. 00
29. 6000	-0. 00694	1333829.	-24358.	-3. 68E-05	0. 00	4. 69E+11	221. 9699	153446.	0. 00
30. 0000	-0. 00709	1219482.	-23274.	-2. 38E-05	0. 00	4. 69E+11	229. 6344	155520.	0. 00
30. 4000	-0. 00717	1110420.	-22158.	-1. 18E-05	0. 00	4. 69E+11	235. 4551	157594.	0. 00
30. 8000	-0. 00720	1006777.	-21018.	-9. 84E-07	0. 00	4. 69E+11	239. 5330	159667.	0. 00
31. 2000	-0. 00718	908647.	-19863.	8. 82E-06	0. 00	4. 69E+11	241. 9695	161741.	0. 00
31. 6000	-0. 00712	816088.	-18699.	1. 76E-05	0. 00	4. 69E+11	242. 8654	163814.	0. 00
32. 0000	-0. 00701	729120.	-17534.	2. 55E-05	0. 00	4. 69E+11	242. 3200	165888.	0. 00
32. 4000	-0. 00687	647731.	-16376.	3. 26E-05	0. 00	4. 69E+11	240. 4311	167962.	0. 00
32. 8000	-0. 00670	571879.	-15229.	3. 88E-05	0. 00	4. 69E+11	237. 2938	170035.	0. 00
33. 2000	-0. 00650	501491.	-14101.	4. 43E-05	0. 00	4. 69E+11	233. 0005	172109.	0. 00
33. 6000	-0. 00627	436469.	-12995.	4. 91E-05	0. 00	4. 69E+11	227. 6404	174182.	0. 00
34. 0000	-0. 00603	376690.	-11918.	5. 33E-05	0. 00	4. 69E+11	221. 2987	176256.	0. 00
34. 4000	-0. 00576	322007.	-10873.	5. 69E-05	0. 00	4. 69E+11	214. 0568	178330.	0. 00
34. 8000	-0. 00548	272254.	-9865.	5. 99E-05	0. 00	4. 69E+11	205. 9915	180403.	0. 00
35. 2000	-0. 00519	227246.	-8897.	6. 25E-05	0. 00	4. 69E+11	197. 1754	182477.	0. 00
35. 6000	-0. 00488	186780.	-7973.	6. 46E-05	0. 00	4. 69E+11	187. 6759	184550.	0. 00
36. 0000	-0. 00457	150637.	-7097.	6. 63E-05	0. 00	4. 69E+11	177. 5561	186624.	0. 00
36. 4000	-0. 00424	118584.	-6270.	6. 77E-05	0. 00	4. 69E+11	166. 8736	188698.	0. 00
36. 8000	-0. 00392	90376.	-5496.	6. 87E-05	0. 00	4. 69E+11	155. 6816	190771.	0. 00
37. 2000	-0. 00358	65753.	-4642.	6. 95E-05	0. 00	4. 69E+11	200. 0390	267840.	0. 00
37. 6000	-0. 00325	45740.	-3722.	7. 01E-05	0. 00	4. 69E+11	183. 2728	270720.	0. 00
38. 0000	-0. 00291	29948.	-2884.	7. 05E-05	0. 00	4. 69E+11	165. 9761	273600.	0. 00
38. 4000	-0. 00257	17981.	-2130.	7. 07E-05	0. 00	4. 69E+11	148. 1894	276480.	0. 00
38. 8000	-0. 00223	9428.	-1463.	7. 09E-05	0. 00	4. 69E+11	129. 9445	279360.	0. 00
39. 2000	-0. 00189	3868.	-883. 7890	7. 10E-05	0. 00	4. 69E+11	111. 2643	282240.	0. 00

Lpile Run 3 ft shaft.lp9o									
39.6000	-0.00155	872.3933	-395.5607	7.10E-05	0.00	4.69E+11	92.1642	285120.	0.00
40.0000	-0.00121	0.00	0.00	7.10E-05	0.00	4.69E+11	72.6528	144000.	0.00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.96671165 inches
Computed slope at pile head	=	-0.00672505 radians
Maximum bending moment	=	6342342. inch-lbs
Maximum shear force	=	-30520. lbs
Depth of maximum bending moment	=	9.60000000 feet below pile head
Depth of maximum shear force	=	25.20000000 feet below pile head
Number of iterations	=	27
Number of zero deflection points	=	1

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Pile-head Deflection vs. Pile Length for Load Case 1  
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Boundary Condition Type 1, Shear and Moment

Shear	=	0. lbs
Moment	=	5014935. in-lbs
Axial Load	=	104000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment ln-lbs	Maximum Shear lbs
40.00000	0.96671165	6342342.	-30520.
38.00000	0.96650080	6341950.	-31051.
36.00000	0.96387742	6330440.	-32556.
34.00000	0.96840157	6343052.	-35117.
32.00000	0.97022307	6328956.	-38655.
30.00000	0.98200472	6302358.	-42164.
28.00000	1.01816271	6246034.	-44341.
26.00000	1.10866460	6138467.	-45248.
24.00000	1.22300243	6033526.	-52220.
22.00000	1.37154884	5912737.	-58047.
20.00000	1.59772059	5802661.	-61823.
18.00000	2.25279591	5750728.	-69037.

Lpile Run 3 ft shaft.lp9o

Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = -1300.0 lbs  
Applied moment at pile head = 5497571.0 in-lbs  
Axial thrust load on pile head = 116000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.9888	5497571.	-1300.	-0.00699	0.00	2.46E+11	0.00	0.00	791.7000
0.4000	0.9555	5504314.	2300.	-0.00688	0.00	2.46E+11	-83.4165	419.0540	791.7000
0.8000	0.9227	5527316.	5486.	-0.00678	0.00	2.46E+11	-172.4729	897.2234	791.7000
1.2000	0.8904	5564525.	8236.	-0.00667	0.00	2.46E+11	-265.1940	1430.	791.7000
1.6000	0.8587	5613804.	10536.	-0.00656	0.00	2.46E+11	-359.7255	2011.	791.7000
2.0000	0.8275	5672975.	12382.	-0.00645	0.00	2.45E+11	-454.5874	2637.	791.7000
2.4000	0.7968	5739851.	13776.	-0.00634	0.00	2.45E+11	-548.0262	3301.	791.7000
2.8000	0.7666	5812278.	14728.	-0.00622	0.00	2.44E+11	-638.4710	3997.	791.7000
3.2000	0.7371	5888173.	15255.	-0.00611	0.00	2.44E+11	-725.6239	4726.	791.7000
3.6000	0.7080	5965525.	15372.	-0.00599	0.00	2.44E+11	-808.7198	5483.	791.7000
4.0000	0.6795	6042420.	15248.	-0.00587	0.00	2.43E+11	-826.3290	5837.	791.7000
4.4000	0.6516	6118451.	15074.	-0.00575	0.00	2.43E+11	-829.7785	6112.	791.7000
4.8000	0.6243	6193537.	14751.	-0.00563	0.00	2.42E+11	-888.1495	6829.	791.7000
5.2000	0.5976	6266332.	14158.	-0.00551	0.00	2.42E+11	-942.3154	7569.	791.7000
5.6000	0.5714	6335588.	13323.	-0.00538	0.00	2.42E+11	-989.1106	8308.	791.7000
6.0000	0.5459	6400225.	12283.	-0.00526	0.00	2.41E+11	-1028.	9035.	791.7000
6.4000	0.5210	6459357.	11059.	-0.00513	0.00	2.41E+11	-1066.	9820.	791.7000
6.8000	0.4967	6512102.	9671.	-0.00500	0.00	2.41E+11	-1096.	10592.	791.7000
7.2000	0.4730	6557763.	8158.	-0.00487	0.00	2.40E+11	-1118.	11341.	791.7000
7.6000	0.4500	6595841.	6557.	-0.00474	0.00	2.40E+11	-1133.	12088.	791.7000
8.0000	0.4275	6625980.	4880.	-0.00460	0.00	2.40E+11	-1149.	12899.	791.7000
8.4000	0.4058	6647816.	3150.	-0.00447	0.00	2.40E+11	-1155.	13669.	791.7000
8.8000	0.3846	6661197.	1411.	-0.00434	0.00	2.40E+11	-1152.	14382.	791.7000
9.2000	0.3641	6666195.	-319.7184	-0.00421	0.00	2.40E+11	-1152.	15191.	791.7000
9.6000	0.3442	6662811.	-2062.	-0.00407	0.00	2.40E+11	-1157.	16132.	791.7000
10.0000	0.3250	6650938.	-3806.	-0.00394	0.00	2.40E+11	-1153.	17032.	791.7000
10.4000	0.3064	6630662.	-5512.	-0.00381	0.00	2.40E+11	-1141.	17873.	791.7000
10.8000	0.2885	6602263.	-7138.	-0.00367	0.00	2.40E+11	-1120.	18635.	791.7000
11.2000	0.2712	6566229.	-8642.	-0.00354	0.00	2.40E+11	-1090.	19295.	791.7000
11.6000	0.2545	6523248.	-9980.	-0.00341	0.00	2.41E+11	-1051.	19827.	791.7000
12.0000	0.2384	6474218.	-11111.	-0.00328	0.00	2.41E+11	-1004.	20205.	791.7000
12.4000	0.2230	6420235.	-12141.	-0.00315	0.00	2.41E+11	-1009.	21724.	791.7000
12.8000	0.2081	6361173.	-13189.	-0.00303	0.00	2.41E+11	-1011.	23315.	791.7000
13.2000	0.1939	6296988.	-14237.	-0.00290	0.00	2.42E+11	-1009.	24980.	791.7000
13.6000	0.1803	6227723.	-15268.	-0.00278	0.00	2.42E+11	-1004.	26719.	791.7000
14.0000	0.1673	6153508.	-16262.	-0.00265	0.00	2.42E+11	-994.2325	28533.	791.7000
14.4000	0.1548	6074560.	-17203.	-0.00253	0.00	2.43E+11	-981.1944	30422.	791.7000
14.8000	0.1429	5991178.	-18073.	-0.00241	0.00	2.43E+11	-964.4981	32387.	791.7000
15.2000	0.1316	5903750.	-18875.	-0.00230	0.00	2.44E+11	-953.0828	34752.	791.7000
15.6000	0.1209	5812538.	-19636.	-0.00218	0.00	2.44E+11	-947.6596	37625.	791.7000

Lpile Run 3 ft shaft. l p90									
16. 0000	0. 1107	5717670.	-20366.	-0. 00207	0. 00	2. 45E+11	-939. 5786	40740.	791. 7000
16. 4000	0. 1010	5619332.	-21050.	-0. 00196	0. 00	2. 46E+11	-928. 8301	44123.	791. 7000
16. 8000	0. 09191	5517773.	-21676.	-0. 00185	0. 00	2. 46E+11	-915. 4125	47806.	791. 7000
17. 2000	0. 08330	5413305.	-22231.	-0. 00174	0. 00	2. 47E+11	-899. 3316	51825.	791. 7000
17. 6000	0. 07519	5306298.	-22703.	-0. 00164	0. 00	2. 48E+11	-880. 6014	56219.	791. 7000
18. 0000	0. 06757	5197185.	-23078.	-0. 00154	0. 00	2. 49E+11	-859. 2438	61040.	791. 7000
18. 4000	0. 06043	5086460.	-23261.	-0. 00144	0. 00	2. 50E+11	-800. 6047	63590.	791. 7000
18. 8000	0. 05377	4975476.	-23129.	-0. 00134	0. 00	2. 50E+11	-727. 7748	64973.	791. 7000
19. 2000	0. 04756	4865912.	-22654.	-0. 00125	0. 00	2. 51E+11	-657. 4327	66355.	791. 7000
19. 6000	0. 04179	4759389.	-21847.	-0. 00116	0. 00	2. 52E+11	-589. 8079	67738.	791. 7000
20. 0000	0. 03647	4657467.	-21673.	-0. 00107	0. 00	2. 53E+11	-525. 1211	69120.	395. 8500
20. 4000	0. 03156	4552518.	-23096.	-9. 79E-04	0. 00	2. 54E+11	-463. 5872	70502.	0. 00
20. 8000	0. 02707	4436840.	-25181.	-8. 94E-04	0. 00	2. 56E+11	-405. 4038	71885.	0. 00
21. 2000	0. 02298	4311775.	-26715.	-8. 12E-04	0. 00	2. 57E+11	-233. 8253	48845.	0. 00
21. 6000	0. 01927	4181278.	-27756.	-7. 33E-04	0. 00	2. 59E+11	-199. 8180	49766.	0. 00
22. 0000	0. 01594	4046134.	-28640.	-6. 57E-04	0. 00	2. 60E+11	-168. 3229	50688.	0. 00
22. 4000	0. 01296	3907070.	-29378.	-5. 84E-04	0. 00	2. 62E+11	-139. 3993	51610.	0. 00
22. 8000	0. 01033	3764755.	-29984.	-5. 14E-04	0. 00	2. 64E+11	-113. 0913	52531.	0. 00
23. 2000	0. 00803	3619796.	-30470.	-4. 47E-04	0. 00	2. 67E+11	-89. 4279	53453.	0. 00
23. 6000	0. 00604	3472740.	-30849.	-3. 97E-04	0. 00	4. 64E+11	-68. 4234	54374.	0. 00
24. 0000	0. 00422	3324088.	-31130.	-3. 62E-04	0. 00	4. 65E+11	-48. 6400	55296.	0. 00
24. 4000	0. 00257	3174296.	-31319.	-3. 28E-04	0. 00	4. 65E+11	-30. 0893	56218.	0. 00
24. 8000	0. 00107	3023792.	-31422.	-2. 96E-04	0. 00	4. 65E+11	-12. 7766	57139.	0. 00
25. 2000	-2. 73E-04	2872977.	-31444.	-2. 66E-04	0. 00	4. 66E+11	3. 2989	58061.	0. 00
25. 6000	-0. 00148	2722221.	-31393.	-2. 37E-04	0. 00	4. 66E+11	18. 1441	58982.	0. 00
26. 0000	-0. 00255	2571868.	-31273.	-2. 10E-04	0. 00	4. 66E+11	31. 7711	59904.	0. 00
26. 4000	-0. 00349	2422231.	-31091.	-1. 84E-04	0. 00	4. 66E+11	44. 1977	60826.	0. 00
26. 8000	-0. 00431	2273600.	-30852.	-1. 60E-04	0. 00	4. 67E+11	55. 4468	61747.	0. 00
27. 2000	-0. 00502	2126232.	-30365.	-1. 37E-04	0. 00	4. 67E+11	147. 4789	141005.	0. 00
27. 6000	-0. 00563	1982251.	-29608.	-1. 16E-04	0. 00	4. 67E+11	167. 6890	143078.	0. 00
28. 0000	-0. 00613	1842122.	-28761.	-9. 63E-05	0. 00	4. 67E+11	185. 4661	145152.	0. 00
28. 4000	-0. 00655	1706255.	-27833.	-7. 81E-05	0. 00	4. 68E+11	200. 8969	147226.	0. 00
28. 8000	-0. 00688	1575007.	-26838.	-6. 12E-05	0. 00	4. 68E+11	214. 0733	149299.	0. 00
29. 2000	-0. 00714	1448683.	-25784.	-4. 57E-05	0. 00	4. 68E+11	225. 0913	151373.	0. 00
29. 6000	-0. 00732	1327536.	-24682.	-3. 15E-05	0. 00	4. 68E+11	234. 0503	153446.	0. 00
30. 0000	-0. 00744	1211775.	-23541.	-1. 85E-05	0. 00	4. 68E+11	241. 0516	155520.	0. 00
30. 4000	-0. 00750	1101560.	-22372.	-6. 62E-06	0. 00	4. 68E+11	246. 1983	157594.	0. 00
30. 8000	-0. 00750	997011.	-21182.	4. 13E-06	0. 00	4. 69E+11	249. 5938	159667.	0. 00
31. 2000	-0. 00746	898207.	-19980.	1. 38E-05	0. 00	4. 69E+11	251. 3415	161741.	0. 00
31. 6000	-0. 00737	805189.	-18773.	2. 26E-05	0. 00	4. 69E+11	251. 5439	163814.	0. 00
32. 0000	-0. 00724	717962.	-17568.	3. 04E-05	0. 00	4. 69E+11	250. 3020	165888.	0. 00
32. 4000	-0. 00708	636498.	-16373.	3. 73E-05	0. 00	4. 69E+11	247. 7144	167962.	0. 00
32. 8000	-0. 00688	560738.	-15193.	4. 34E-05	0. 00	4. 69E+11	243. 8775	170035.	0. 00
33. 2000	-0. 00666	490593.	-14035.	4. 88E-05	0. 00	4. 69E+11	238. 8840	172109.	0. 00
33. 6000	-0. 00642	425950.	-12903.	5. 35E-05	0. 00	4. 69E+11	232. 8236	174182.	0. 00
34. 0000	-0. 00615	366668.	-11802.	5. 76E-05	0. 00	4. 69E+11	225. 7815	176256.	0. 00
34. 4000	-0. 00586	312586.	-10737.	6. 10E-05	0. 00	4. 69E+11	217. 8389	178330.	0. 00
34. 8000	-0. 00556	263522.	-9713.	6. 40E-05	0. 00	4. 69E+11	209. 0723	180403.	0. 00
35. 2000	-0. 00525	219273.	-8732.	6. 65E-05	0. 00	4. 69E+11	199. 5536	182477.	0. 00
35. 6000	-0. 00492	179620.	-7799.	6. 85E-05	0. 00	4. 69E+11	189. 3496	184550.	0. 00
36. 0000	-0. 00459	144329.	-6916.	7. 02E-05	0. 00	4. 69E+11	178. 5220	186624.	0. 00
36. 4000	-0. 00425	113150.	-6086.	7. 15E-05	0. 00	4. 69E+11	167. 1276	188698.	0. 00
36. 8000	-0. 00391	85822.	-5313.	7. 25E-05	0. 00	4. 69E+11	155. 2182	190771.	0. 00
37. 2000	-0. 00356	62069.	-4464.	7. 33E-05	0. 00	4. 69E+11	198. 3896	267840.	0. 00



Lpile Run 3 ft shaft.lp9o									
37.6000	-0.00320	42886.	-3554.	7.38E-05	0.00	4.69E+11	180.6061	270720.	0.00
38.0000	-0.00285	27865.	-2731.	7.42E-05	0.00	4.69E+11	162.2788	273600.	0.00
38.4000	-0.00249	16582.	-1998.	7.44E-05	0.00	4.69E+11	143.4462	276480.	0.00
38.8000	-0.00213	8604.	-1355.	7.45E-05	0.00	4.69E+11	124.1383	279360.	0.00
39.2000	-0.00178	3486.	-807.0463	7.46E-05	0.00	4.69E+11	104.3766	282240.	0.00
39.6000	-0.00142	773.5397	-354.5218	7.46E-05	0.00	4.69E+11	84.1753	285120.	0.00
40.0000	-0.00106	0.00	0.00	7.46E-05	0.00	4.69E+11	63.5421	144000.	0.00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 2:

Pile-head deflection = 0.98878019 inches  
 Computed slope at pile head = -0.00699027 radians  
 Maximum bending moment = 6666195. inch-lbs  
 Maximum shear force = -31444. lbs  
 Depth of maximum bending moment = 9.20000000 feet below pile head  
 Depth of maximum shear force = 25.20000000 feet below pile head  
 Number of iterations = 20  
 Number of zero deflection points = 1

#### Pile-head Deflection vs. Pile Length for Load Case 2

#### Boundary Condition Type 1, Shear and Moment

Shear = -1300. lbs  
 Moment = 5497571. in-lbs  
 Axial Load = 116000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.98878019	6666195.	-31444.
38.00000	0.98858788	6665776.	-31930.
36.00000	0.98594961	6654645.	-33388.
34.00000	0.99053399	6667249.	-35928.
32.00000	0.99257267	6653675.	-39469.
30.00000	1.00442568	6630337.	-43123.
28.00000	1.04252266	6578308.	-45422.
26.00000	1.13544145	6479480.	-46913.
24.00000	1.25292984	6383718.	-54453.
22.00000	1.40729665	6272594.	-60588.

Lpile Run 3 ft shaft.lp9o

20.00000 1.65013082 6176758. -64837.  
18.00000 2.38893818 6158330. -73476.

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Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 3  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 1300.0 lbs  
Applied moment at pile head = 449695.0 in-lbs  
Axial thrust load on pile head = -8000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5920	449695.	1300.	-0.00287	0.00	4.72E+11	0.00	0.00	791.7000
0.4000	0.5782	464945.	4929.	-0.00287	0.00	4.72E+11	-71.4255	592.9276	791.7000
0.8000	0.5645	496791.	8202.	-0.00286	0.00	4.71E+11	-148.0672	1259.	791.7000
1.2000	0.5507	543465.	11099.	-0.00286	0.00	4.71E+11	-228.2070	1989.	791.7000
1.6000	0.5370	603124.	13609.	-0.00285	0.00	4.71E+11	-309.3221	2765.	791.7000
2.0000	0.5233	673896.	15763.	-0.00285	0.00	4.71E+11	-376.8038	3456.	791.7000
2.4000	0.5097	754227.	17602.	-0.00284	0.00	4.71E+11	-440.3745	4147.	791.7000
2.8000	0.4961	842654.	19145.	-0.00283	0.00	4.71E+11	-500.0523	4838.	791.7000
3.2000	0.4825	937800.	20411.	-0.00282	0.00	4.71E+11	-555.8583	5530.	791.7000
3.6000	0.4690	1038381.	21418.	-0.00281	0.00	4.70E+11	-607.8162	6221.	791.7000
4.0000	0.4555	1143199.	22185.	-0.00280	0.00	4.70E+11	-655.9531	6912.	791.7000
4.4000	0.4421	1251144.	22730.	-0.00279	0.00	4.70E+11	-700.2990	7603.	791.7000
4.8000	0.4288	1361197.	23072.	-0.00278	0.00	4.70E+11	-740.8875	8294.	791.7000
5.2000	0.4155	1472420.	23227.	-0.00276	0.00	4.69E+11	-777.7551	8986.	791.7000
5.6000	0.4023	1583965.	23214.	-0.00274	0.00	4.69E+11	-810.9418	9677.	791.7000
6.0000	0.3891	1695068.	23051.	-0.00273	0.00	4.69E+11	-840.4907	10368.	791.7000
6.4000	0.3761	1805047.	22755.	-0.00271	0.00	4.69E+11	-866.4482	11059.	791.7000
6.8000	0.3631	1913304.	22342.	-0.00269	0.00	4.68E+11	-888.8635	11750.	791.7000
7.2000	0.3502	2019324.	21830.	-0.00267	0.00	4.68E+11	-907.7888	12442.	791.7000
7.6000	0.3375	2122670.	21236.	-0.00265	0.00	4.68E+11	-923.2793	13133.	791.7000
8.0000	0.3248	2222985.	20322.	-0.00263	0.00	4.68E+11	-1041.	15384.	791.7000
8.4000	0.3122	2317558.	19108.	-0.00260	0.00	4.67E+11	-1048.	16113.	791.7000
8.8000	0.2998	2406223.	17881.	-0.00258	0.00	4.67E+11	-1047.	16756.	791.7000
9.2000	0.2875	2489018.	16655.	-0.00255	0.00	4.67E+11	-1048.	17494.	791.7000
9.6000	0.2753	2565917.	15413.	-0.00253	0.00	4.67E+11	-1053.	18365.	791.7000
10.0000	0.2632	2636792.	14163.	-0.00250	0.00	4.67E+11	-1051.	19172.	791.7000
10.4000	0.2512	2701690.	12941.	-0.00247	0.00	4.67E+11	-1042.	19899.	791.7000
10.8000	0.2394	2760832.	11784.	-0.00245	0.00	4.66E+11	-1024.	20527.	791.7000
11.2000	0.2278	2814625.	10731.	-0.00242	0.00	4.66E+11	-998.1297	21036.	791.7000
11.6000	0.2162	2863662.	9822.	-0.00239	0.00	4.66E+11	-964.1186	21403.	791.7000
12.0000	0.2048	2908728.	9095.	-0.00235	0.00	3.18E+11	-921.9431	21605.	791.7000
12.4000	0.1936	2950796.	8446.	-0.00230	0.00	2.14E+11	-931.8484	23099.	791.7000
12.8000	0.1828	2989636.	7757.	-0.00223	0.00	2.14E+11	-938.6719	24651.	791.7000
13.2000	0.1722	3025093.	7043.	-0.00216	0.00	2.14E+11	-942.3439	26262.	791.7000
13.6000	0.1620	3057082.	6319.	-0.00209	0.00	2.14E+11	-942.8139	27933.	791.7000

Lpile Run 3 ft shaft. lp90									
14. 0000	0. 1521	3085592.	5600.	-0. 00203	0. 00	2. 14E+11	-940. 0514	29661.	791. 7000
14. 4000	0. 1426	3110686.	4902.	-0. 00196	0. 00	2. 14E+11	-934. 0479	31447.	791. 7000
14. 8000	0. 1333	3132504.	4241.	-0. 00189	0. 00	2. 14E+11	-924. 8171	33289.	791. 7000
15. 2000	0. 1245	3151257.	3611.	-0. 00182	0. 00	2. 14E+11	-921. 1364	35524.	791. 7000
15. 6000	0. 1159	3167031.	2984.	-0. 00174	0. 00	2. 14E+11	-923. 7356	38250.	791. 7000
16. 0000	0. 1077	3179765.	2349.	-0. 00167	0. 00	2. 14E+11	-924. 0868	41178.	791. 7000
16. 4000	0. 09986	3189452.	1718.	-0. 00160	0. 00	2. 14E+11	-922. 1725	44328.	791. 7000
16. 8000	0. 09234	3196135.	1102.	-0. 00153	0. 00	2. 14E+11	-917. 9873	47719.	791. 7000
17. 2000	0. 08516	3199912.	511. 1206	-0. 00146	0. 00	2. 14E+11	-911. 5384	51375.	791. 7000
17. 6000	0. 07834	3200930.	-43. 2476	-0. 00139	0. 00	2. 14E+11	-902. 8483	55322.	791. 7000
18. 0000	0. 07185	3199390.	-550. 6177	-0. 00132	0. 00	2. 14E+11	-891. 9558	59587.	791. 7000
18. 4000	0. 06571	3195543.	-980. 4549	-0. 00124	0. 00	2. 14E+11	-870. 5430	63590.	791. 7000
18. 8000	0. 05992	3189882.	-1216.	-0. 00117	0. 00	2. 14E+11	-811. 0135	64973.	791. 7000
19. 2000	0. 05446	3183779.	-1169.	-0. 00110	0. 00	2. 14E+11	-752. 8934	66355.	791. 7000
19. 6000	0. 04935	3178573.	-847. 5594	-0. 00103	0. 00	2. 14E+11	-696. 4701	67738.	791. 7000
20. 0000	0. 04459	3175563.	-1210.	-9. 58E-04	0. 00	2. 14E+11	-642. 0319	69120.	395. 8500
20. 4000	0. 04016	3166885.	-3216.	-8. 86E-04	0. 00	2. 14E+11	-589. 8697	70502.	0. 00
20. 8000	0. 03608	3144618.	-5929.	-8. 16E-04	0. 00	2. 14E+11	-540. 2652	71885.	0. 00
21. 2000	0. 03233	3109907.	-8015.	-7. 46E-04	0. 00	2. 14E+11	-328. 9844	48845.	0. 00
21. 6000	0. 02892	3067618.	-9524.	-6. 76E-04	0. 00	2. 14E+11	-299. 8259	49766.	0. 00
22. 0000	0. 02584	3018424.	-10898.	-6. 08E-04	0. 00	2. 14E+11	-272. 8468	50688.	0. 00
22. 4000	0. 02308	2962946.	-12149.	-5. 41E-04	0. 00	2. 14E+11	-248. 1808	51610.	0. 00
22. 8000	0. 02065	2901753.	-13287.	-4. 92E-04	0. 00	4. 37E+11	-225. 9505	52531.	0. 00
23. 2000	0. 01836	2835355.	-14320.	-4. 61E-04	0. 00	4. 66E+11	-204. 4890	53453.	0. 00
23. 6000	0. 01622	2764247.	-15252.	-4. 32E-04	0. 00	4. 66E+11	-183. 7377	54374.	0. 00
24. 0000	0. 01421	2688906.	-16086.	-4. 04E-04	0. 00	4. 67E+11	-163. 7364	55296.	0. 00
24. 4000	0. 01234	2609794.	-16825.	-3. 77E-04	0. 00	4. 67E+11	-144. 5194	56218.	0. 00
24. 8000	0. 01059	2527353.	-17475.	-3. 51E-04	0. 00	4. 67E+11	-126. 1162	57139.	0. 00
25. 2000	0. 00897	2442008.	-18038.	-3. 25E-04	0. 00	4. 67E+11	-108. 5511	58061.	0. 00
25. 6000	0. 00747	2354163.	-18519.	-3. 00E-04	0. 00	4. 67E+11	-91. 8437	58982.	0. 00
26. 0000	0. 00609	2264202.	-18922.	-2. 77E-04	0. 00	4. 68E+11	-76. 0085	59904.	0. 00
26. 4000	0. 00482	2172491.	-19251.	-2. 54E-04	0. 00	4. 68E+11	-61. 0557	60826.	0. 00
26. 8000	0. 00365	2079374.	-19510.	-2. 32E-04	0. 00	4. 68E+11	-46. 9907	61747.	0. 00
27. 2000	0. 00259	1985176.	-19806.	-2. 11E-04	0. 00	4. 68E+11	-76. 0831	141005.	0. 00
27. 6000	0. 00162	1889225.	-20104.	-1. 91E-04	0. 00	4. 68E+11	-48. 4305	143078.	0. 00
28. 0000	7. 52E-04	1792159.	-20275.	-1. 73E-04	0. 00	4. 69E+11	-22. 7538	145152.	0. 00
28. 4000	-3. 18E-05	1694569.	-20327.	-1. 55E-04	0. 00	4. 69E+11	0. 9743	147226.	0. 00
28. 8000	-7. 33E-04	1597003.	-20270.	-1. 38E-04	0. 00	4. 69E+11	22. 7900	149299.	0. 00
29. 2000	-0. 00136	1499963.	-20113.	-1. 22E-04	0. 00	4. 69E+11	42. 7376	151373.	0. 00
29. 6000	-0. 00190	1403907.	-19865.	-1. 07E-04	0. 00	4. 70E+11	60. 8692	153446.	0. 00
30. 0000	-0. 00238	1309255.	-19533.	-9. 33E-05	0. 00	4. 70E+11	77. 2430	155520.	0. 00
30. 4000	-0. 00280	1216383.	-19127.	-8. 04E-05	0. 00	4. 70E+11	91. 9232	157594.	0. 00
30. 8000	-0. 00316	1125629.	-18654.	-6. 84E-05	0. 00	4. 70E+11	104. 9788	159667.	0. 00
31. 2000	-0. 00346	1037294.	-18123.	-5. 74E-05	0. 00	4. 70E+11	116. 4835	161741.	0. 00
31. 6000	-0. 00371	951644.	-17540.	-4. 73E-05	0. 00	4. 71E+11	126. 5141	163814.	0. 00
32. 0000	-0. 00391	868908.	-16912.	-3. 80E-05	0. 00	4. 71E+11	135. 1504	165888.	0. 00
32. 4000	-0. 00407	789287.	-16246.	-2. 95E-05	0. 00	4. 71E+11	142. 4745	167962.	0. 00
32. 8000	-0. 00419	712949.	-15547.	-2. 19E-05	0. 00	4. 71E+11	148. 5696	170035.	0. 00
33. 2000	-0. 00428	640035.	-14822.	-1. 50E-05	0. 00	4. 71E+11	153. 5201	172109.	0. 00
33. 6000	-0. 00434	570657.	-14076.	-8. 81E-06	0. 00	4. 71E+11	157. 4107	174182.	0. 00
34. 0000	-0. 00437	504907.	-13313.	-3. 34E-06	0. 00	4. 71E+11	160. 3257	176256.	0. 00
34. 4000	-0. 00437	442850.	-12539.	1. 49E-06	0. 00	4. 72E+11	162. 3485	178330.	0. 00
34. 8000	-0. 00435	384535.	-11757.	5. 70E-06	0. 00	4. 72E+11	163. 5613	180403.	0. 00
35. 2000	-0. 00432	329988.	-10970.	9. 33E-06	0. 00	4. 72E+11	164. 0446	182477.	0. 00

Lpile Run 3 ft shaft.lp9o									
35.6000	-0.00426	279220.	-10183.	1.24E-05	0.00	4.72E+11	163.8767	184550.	0.00
36.0000	-0.00420	232229.	-9398.	1.50E-05	0.00	4.72E+11	163.1332	186624.	0.00
36.4000	-0.00412	188996.	-8618.	1.72E-05	0.00	4.72E+11	161.8867	188698.	0.00
36.8000	-0.00403	149493.	-7845.	1.89E-05	0.00	4.72E+11	160.2063	190771.	0.00
37.2000	-0.00394	113682.	-6934.	2.02E-05	0.00	4.72E+11	219.6633	267840.	0.00
37.6000	-0.00384	82931.	-5887.	2.12E-05	0.00	4.72E+11	216.3916	270720.	0.00
38.0000	-0.00373	57166.	-4857.	2.19E-05	0.00	4.72E+11	212.7693	273600.	0.00
38.4000	-0.00363	36303.	-3845.	2.24E-05	0.00	4.72E+11	208.8616	276480.	0.00
38.8000	-0.00352	20253.	-2853.	2.27E-05	0.00	4.72E+11	204.7226	279360.	0.00
39.2000	-0.00341	8919.	-1880.	2.29E-05	0.00	4.72E+11	200.3954	282240.	0.00
39.6000	-0.00330	2203.	-929.2773	2.29E-05	0.00	4.72E+11	195.9109	285120.	0.00
40.0000	-0.00319	0.00	0.00	2.29E-05	0.00	4.72E+11	191.2880	144000.	0.00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 3:

Pile-head deflection = 0.59200198 inches  
 Computed slope at pile head = -0.00287352 radians  
 Maximum bending moment = 3200930. inch-lbs  
 Maximum shear force = 23227. lbs  
 Depth of maximum bending moment = 17.60000000 feet below pile head  
 Depth of maximum shear force = 5.20000000 feet below pile head  
 Number of iterations = 61  
 Number of zero deflection points = 1

#### Pile-head Deflection vs. Pile Length for Load Case 3

#### Boundary Condition Type 1, Shear and Moment

Shear = 1300. lbs  
 Moment = 449695. in-lbs  
 Axial Load = -8000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.59200198	3200930.	23227.
38.00000	0.59430297	3205380.	23137.
36.00000	0.59318315	3197538.	-23723.
34.00000	0.59137039	3175317.	-26064.
32.00000	0.58917595	3131708.	-28806.

Lpile Run 3 ft shaft.lp9o

30.00000	0.58911093	3062340.	-31205.
28.00000	0.58660502	2929775.	-31206.
26.00000	0.62429008	2487350.	-26113.
24.00000	0.67844375	2196371.	-22578.
22.00000	0.74868601	2010432.	-24251.
20.00000	0.82308184	1900346.	-24468.
18.00000	1.00268665	1686752.	-23530.
16.00000	1.26662764	1465611.	-23155.
14.00000	1.69342184	1256563.	-23575.
12.00000	3.02510214	1165360.	-26733.
10.00000	46.18313650	938909.	-32924.

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Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 4  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs  
Applied moment at pile head = 4948283.0 in-lbs  
Axial thrust load on pile head = 101000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.9613	4948283.	7.71E-08	-0.00668	0.00	2.46E+11	0.00	0.00	791.7000
0.4000	0.9295	4960617.	3602.	-0.00658	0.00	2.46E+11	-82.5922	426.4974	791.7000
0.8000	0.8982	4989242.	6794.	-0.00648	0.00	2.45E+11	-170.8058	912.8104	791.7000
1.2000	0.8673	5032124.	9554.	-0.00638	0.00	2.45E+11	-262.6855	1454.	791.7000
1.6000	0.8369	5087148.	11868.	-0.00629	0.00	2.45E+11	-356.4080	2044.	791.7000
2.0000	0.8070	5152152.	13732.	-0.00619	0.00	2.44E+11	-450.5532	2680.	791.7000
2.4000	0.7775	5224967.	15146.	-0.00608	0.00	2.44E+11	-543.3489	3354.	791.7000
2.8000	0.7486	5303455.	16123.	-0.00598	0.00	2.43E+11	-633.2330	4060.	791.7000
3.2000	0.7201	5385543.	16675.	-0.00587	0.00	2.43E+11	-719.9138	4799.	791.7000
3.6000	0.6922	5469233.	16821.	-0.00577	0.00	2.42E+11	-802.6297	5566.	791.7000
4.0000	0.6648	5552619.	16726.	-0.00566	0.00	2.42E+11	-820.3785	5924.	791.7000
4.4000	0.6379	5635290.	16580.	-0.00555	0.00	2.41E+11	-824.0685	6201.	791.7000
4.8000	0.6115	5717162.	16285.	-0.00543	0.00	2.41E+11	-882.3113	6926.	791.7000
5.2000	0.5857	5796890.	15720.	-0.00532	0.00	2.41E+11	-936.3452	7674.	791.7000
5.6000	0.5605	5873230.	14914.	-0.00520	0.00	2.40E+11	-982.9487	8418.	791.7000
6.0000	0.5358	5945107.	13904.	-0.00508	0.00	2.40E+11	-1021.	9150.	791.7000
6.4000	0.5117	6011637.	12710.	-0.00496	0.00	2.39E+11	-1059.	9939.	791.7000
6.8000	0.4881	6071939.	11353.	-0.00484	0.00	2.39E+11	-1090.	10715.	791.7000
7.2000	0.4652	6125317.	9871.	-0.00472	0.00	2.39E+11	-1111.	11467.	791.7000
7.6000	0.4428	6171272.	8299.	-0.00460	0.00	2.39E+11	-1127.	12215.	791.7000
8.0000	0.4210	6209446.	6653.	-0.00447	0.00	2.38E+11	-1143.	13026.	791.7000
8.4000	0.3999	6239475.	4953.	-0.00435	0.00	2.38E+11	-1149.	13795.	791.7000
8.8000	0.3793	6261207.	3244.	-0.00422	0.00	2.38E+11	-1146.	14504.	791.7000
9.2000	0.3594	6274710.	1542.	-0.00409	0.00	2.38E+11	-1146.	15310.	791.7000
9.6000	0.3400	6279984.	-170.4928	-0.00397	0.00	2.38E+11	-1151.	16248.	791.7000
10.0000	0.3213	6276921.	-1886.	-0.00384	0.00	2.38E+11	-1147.	17143.	791.7000

Lpile Run 3 ft shaft. lp90									
10. 4000	0. 3031	6265601.	-3565.	-0. 00371	0. 00	2. 38E+11	-1135.	17978.	791. 7000
10. 8000	0. 2856	6246303.	-5164.	-0. 00359	0. 00	2. 38E+11	-1115.	18732.	791. 7000
11. 2000	0. 2687	6219504.	-6643.	-0. 00346	0. 00	2. 38E+11	-1085.	19383.	791. 7000
11. 6000	0. 2524	6185889.	-7958.	-0. 00334	0. 00	2. 39E+11	-1046.	19905.	791. 7000
12. 0000	0. 2366	6146343.	-9068.	-0. 00321	0. 00	2. 39E+11	-999. 3326	20272.	791. 7000
12. 4000	0. 2215	6101953.	-10079.	-0. 00309	0. 00	2. 39E+11	-1005.	21787.	791. 7000
12. 8000	0. 2069	6052582.	-11110.	-0. 00297	0. 00	2. 39E+11	-1008.	23373.	791. 7000
13. 2000	0. 1930	5998176.	-12144.	-0. 00285	0. 00	2. 39E+11	-1006.	25031.	791. 7000
13. 6000	0. 1796	5938766.	-13162.	-0. 00273	0. 00	2. 40E+11	-1001.	26761.	791. 7000
14. 0000	0. 1668	5874469.	-14147.	-0. 00261	0. 00	2. 40E+11	-992. 5601	28566.	791. 7000
14. 4000	0. 1545	5805488.	-15081.	-0. 00249	0. 00	2. 40E+11	-980. 1266	30444.	791. 7000
14. 8000	0. 1428	5732109.	-15947.	-0. 00238	0. 00	2. 41E+11	-964. 0589	32397.	791. 7000
15. 2000	0. 1317	5654703.	-16749.	-0. 00227	0. 00	2. 41E+11	-953. 2926	34747.	791. 7000
15. 6000	0. 1211	5573520.	-17513.	-0. 00215	0. 00	2. 42E+11	-948. 5423	37602.	791. 7000
16. 0000	0. 1110	5488670.	-18248.	-0. 00204	0. 00	2. 42E+11	-941. 1580	40696.	791. 7000
16. 4000	0. 1015	5400323.	-18941.	-0. 00194	0. 00	2. 43E+11	-931. 1289	44053.	791. 7000
16. 8000	0. 09241	5308712.	-19580.	-0. 00183	0. 00	2. 43E+11	-918. 4525	47704.	791. 7000
17. 2000	0. 08388	5214130.	-20152.	-0. 00173	0. 00	2. 44E+11	-903. 1344	51684.	791. 7000
17. 6000	0. 07583	5116931.	-20644.	-0. 00163	0. 00	2. 45E+11	-885. 1889	56031.	791. 7000
18. 0000	0. 06827	5017529.	-21043.	-0. 00153	0. 00	2. 45E+11	-864. 6392	60794.	791. 7000
18. 4000	0. 06118	4916399.	-21263.	-0. 00143	0. 00	2. 46E+11	-810. 4496	63590.	791. 7000
18. 8000	0. 05454	4814790.	-21180.	-0. 00133	0. 00	2. 47E+11	-738. 3014	64973.	791. 7000
19. 2000	0. 04836	4714366.	-20756.	-0. 00124	0. 00	2. 48E+11	-668. 5481	66355.	791. 7000
19. 6000	0. 04262	4616736.	-20004.	-0. 00115	0. 00	2. 48E+11	-601. 4259	67738.	791. 7000
20. 0000	0. 03730	4523446.	-19886.	-0. 00106	0. 00	2. 49E+11	-537. 1632	69120.	395. 8500
20. 4000	0. 03241	4426858.	-21368.	-9. 78E-04	0. 00	2. 50E+11	-475. 9829	70502.	0. 00
20. 8000	0. 02792	4319262.	-23514.	-8. 94E-04	0. 00	2. 51E+11	-418. 0914	71885.	0. 00
21. 2000	0. 02383	4201993.	-25099.	-8. 13E-04	0. 00	2. 52E+11	-242. 4434	48845.	0. 00
21. 6000	0. 02012	4079100.	-26181.	-7. 34E-04	0. 00	2. 54E+11	-208. 5677	49766.	0. 00
22. 0000	0. 01678	3951364.	-27107.	-6. 58E-04	0. 00	2. 55E+11	-177. 1826	50688.	0. 00
22. 4000	0. 01380	3819509.	-27888.	-5. 85E-04	0. 00	2. 57E+11	-148. 3550	51610.	0. 00
22. 8000	0. 01116	3684202.	-28538.	-5. 15E-04	0. 00	2. 58E+11	-122. 1363	52531.	0. 00
23. 2000	0. 00885	3546047.	-29067.	-4. 49E-04	0. 00	2. 62E+11	-98. 5634	53453.	0. 00
23. 6000	0. 00685	3405590.	-29490.	-3. 98E-04	0. 00	4. 65E+11	-77. 6417	54374.	0. 00
24. 0000	0. 00503	3263327.	-29816.	-3. 64E-04	0. 00	4. 65E+11	-57. 8991	55296.	0. 00
24. 4000	0. 00336	3119714.	-30049.	-3. 31E-04	0. 00	4. 65E+11	-39. 3489	56218.	0. 00
24. 8000	0. 00185	2975179.	-30196.	-3. 00E-04	0. 00	4. 65E+11	-21. 9983	57139.	0. 00
25. 2000	4. 84E-04	2830121.	-30263.	-2. 70E-04	0. 00	4. 66E+11	-5. 8486	58061.	0. 00
25. 6000	-7. 41E-04	2684915.	-30255.	-2. 41E-04	0. 00	4. 66E+11	9. 1048	58982.	0. 00
26. 0000	-0. 00183	2539906.	-30178.	-2. 14E-04	0. 00	4. 66E+11	22. 8719	59904.	0. 00
26. 4000	-0. 00280	2395410.	-30038.	-1. 89E-04	0. 00	4. 67E+11	35. 4682	60826.	0. 00
26. 8000	-0. 00365	2251720.	-29841.	-1. 65E-04	0. 00	4. 67E+11	46. 9141	61747.	0. 00
27. 2000	-0. 00438	2109100.	-29419.	-1. 43E-04	0. 00	4. 67E+11	128. 7790	141005.	0. 00
27. 6000	-0. 00502	1969436.	-28751.	-1. 22E-04	0. 00	4. 67E+11	149. 5377	143078.	0. 00
28. 0000	-0. 00555	1833207.	-27989.	-1. 02E-04	0. 00	4. 68E+11	167. 9080	145152.	0. 00
28. 4000	-0. 00600	1700839.	-27145.	-8. 41E-05	0. 00	4. 68E+11	183. 9716	147226.	0. 00
28. 8000	-0. 00636	1572700.	-26228.	-6. 73E-05	0. 00	4. 68E+11	197. 8156	149299.	0. 00
29. 2000	-0. 00664	1449111.	-25251.	-5. 18E-05	0. 00	4. 68E+11	209. 5315	151373.	0. 00
29. 6000	-0. 00686	1330343.	-24222.	-3. 76E-05	0. 00	4. 69E+11	219. 2145	153446.	0. 00
30. 0000	-0. 00701	1216619.	-23151.	-2. 45E-05	0. 00	4. 69E+11	226. 9622	155520.	0. 00
30. 4000	-0. 00709	1108117.	-22047.	-1. 26E-05	0. 00	4. 69E+11	232. 8742	157594.	0. 00
30. 8000	-0. 00713	1004976.	-20920.	-1. 83E-06	0. 00	4. 69E+11	237. 0509	159667.	0. 00
31. 2000	-0. 00711	907292.	-19776.	7. 96E-06	0. 00	4. 69E+11	239. 5929	161741.	0. 00
31. 6000	-0. 00705	815123.	-18623.	1. 68E-05	0. 00	4. 69E+11	240. 6003	163814.	0. 00

Lpile Run 3 ft shaft.lp9o										
32.0000	-0.00695	728494.	-17469.	2.47E-05	0.00	4.69E+11	240.1720	165888.	0.00	
32.4000	-0.00681	647394.	-16321.	3.17E-05	0.00	4.69E+11	238.4051	167962.	0.00	
32.8000	-0.00665	571784.	-15184.	3.79E-05	0.00	4.69E+11	235.3943	170035.	0.00	
33.2000	-0.00645	501595.	-14064.	4.34E-05	0.00	4.69E+11	231.2317	172109.	0.00	
33.6000	-0.00623	436731.	-12966.	4.82E-05	0.00	4.69E+11	226.0059	174182.	0.00	
34.0000	-0.00599	377072.	-11896.	5.24E-05	0.00	4.69E+11	219.8020	176256.	0.00	
34.4000	-0.00573	322475.	-10858.	5.60E-05	0.00	4.69E+11	212.7009	178330.	0.00	
34.8000	-0.00545	272778.	-9856.	5.90E-05	0.00	4.69E+11	204.7795	180403.	0.00	
35.2000	-0.00516	227797.	-8894.	6.16E-05	0.00	4.69E+11	196.1100	182477.	0.00	
35.6000	-0.00486	187333.	-7975.	6.37E-05	0.00	4.69E+11	186.7599	184550.	0.00	
36.0000	-0.00455	151172.	-7103.	6.54E-05	0.00	4.69E+11	176.7921	186624.	0.00	
36.4000	-0.00423	119082.	-6280.	6.68E-05	0.00	4.69E+11	166.2643	188698.	0.00	
36.8000	-0.00391	90824.	-5508.	6.79E-05	0.00	4.69E+11	155.2295	190771.	0.00	
37.2000	-0.00358	66141.	-4656.	6.87E-05	0.00	4.69E+11	199.6334	267840.	0.00	
37.6000	-0.00325	46057.	-3738.	6.93E-05	0.00	4.69E+11	183.0933	270720.	0.00	
38.0000	-0.00291	30192.	-2900.	6.97E-05	0.00	4.69E+11	166.0268	273600.	0.00	
38.4000	-0.00258	18151.	-2145.	6.99E-05	0.00	4.69E+11	148.4746	276480.	0.00	
38.8000	-0.00224	9532.	-1476.	7.00E-05	0.00	4.69E+11	130.4685	279360.	0.00	
39.2000	-0.00191	3918.	-893.5490	7.01E-05	0.00	4.69E+11	112.0316	282240.	0.00	
39.6000	-0.00157	885.5745	-401.0419	7.01E-05	0.00	4.69E+11	93.1797	285120.	0.00	
40.0000	-0.00123	0.00	0.00	7.01E-05	0.00	4.69E+11	73.9211	144000.	0.00	

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 4:

Pile-head deflection = 0.96134725 inches  
 Computed slope at pile head = -0.00667673 radians  
 Maximum bending moment = 6279984. inch-lbs  
 Maximum shear force = -30263. lbs  
 Depth of maximum bending moment = 9.60000000 feet below pile head  
 Depth of maximum shear force = 25.20000000 feet below pile head  
 Number of iterations = 32  
 Number of zero deflection points = 1

#### Pile-head Deflection vs. Pile Length for Load Case 4

#### Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs  
 Moment = 4948283. in-lbs  
 Axial Load = 101000. lbs

Lpile Run 3 ft shaft.lp9o

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.96134725	6279984.	-30263.
38.00000	0.96112996	6279437.	-30803.
36.00000	0.95850629	6268320.	-32309.
34.00000	0.96265779	6281151.	-34902.
32.00000	0.96479793	6266701.	-38388.
30.00000	0.97601150	6240419.	-41922.
28.00000	1.01208406	6183775.	-44019.
26.00000	1.10202910	6075846.	-44851.
24.00000	1.21532793	5970584.	-51720.
22.00000	1.36225818	5850015.	-57493.
20.00000	1.58441182	5738549.	-61193.
18.00000	2.22112864	5679943.	-68132.
16.00000	7.43402014	5934655.	-101294.

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 Computed Values of Pile Loading and Deflection  
 for Lateral Loading for Load Case Number 5  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = -800.0 lbs  
 Applied moment at pile head = 3567496.0 in-lbs  
 Axial thrust load on pile head = 75000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.8210	3567496.	-800.0000	-0.00543	0.00	2.48E+11	0.00	0.00	791.7000
0.4000	0.7951	3574718.	2812.	-0.00536	0.00	2.48E+11	-78.3223	472.8504	791.7000
0.8000	0.7695	3598352.	6035.	-0.00529	0.00	2.47E+11	-162.0604	1011.	791.7000
1.2000	0.7443	3636467.	8848.	-0.00522	0.00	2.47E+11	-249.3542	1608.	791.7000
1.6000	0.7194	3687053.	11237.	-0.00515	0.00	2.47E+11	-338.5399	2259.	791.7000
2.0000	0.6949	3748053.	13197.	-0.00508	0.00	2.46E+11	-428.5233	2960.	791.7000
2.4000	0.6707	3817395.	14726.	-0.00500	0.00	2.45E+11	-517.4413	3703.	791.7000
2.8000	0.6468	3893028.	15836.	-0.00493	0.00	2.45E+11	-603.7902	4481.	791.7000
3.2000	0.6234	3972964.	16537.	-0.00485	0.00	2.44E+11	-687.3247	5292.	791.7000
3.6000	0.6003	4055276.	16846.	-0.00477	0.00	2.43E+11	-767.3193	6136.	791.7000
4.0000	0.5776	4138122.	16920.	-0.00469	0.00	2.43E+11	-785.1879	6525.	791.7000
4.4000	0.5553	4221088.	16942.	-0.00461	0.00	2.42E+11	-789.3365	6823.	791.7000
4.8000	0.5334	4304078.	16818.	-0.00452	0.00	2.41E+11	-845.4432	7609.	791.7000
5.2000	0.5119	4385799.	16436.	-0.00444	0.00	2.41E+11	-897.2365	8414.	791.7000
5.6000	0.4908	4465057.	15822.	-0.00435	0.00	2.40E+11	-941.8426	9211.	791.7000
6.0000	0.4701	4540824.	15014.	-0.00426	0.00	2.40E+11	-978.4674	9990.	791.7000
6.4000	0.4499	4612255.	14029.	-0.00417	0.00	2.39E+11	-1015.	10831.	791.7000
6.8000	0.4301	4678501.	12886.	-0.00407	0.00	2.39E+11	-1044.	11654.	791.7000
7.2000	0.4108	4738893.	11624.	-0.00398	0.00	2.39E+11	-1065.	12442.	791.7000
7.6000	0.3920	4792956.	10295.	-0.00388	0.00	2.38E+11	-1072.	13133.	791.7000



Lpile Run 3 ft shaft. lp9o									
8. 0000	0. 3736	4840517.	8894.	-0. 00378	0. 00	2. 38E+11	-1095.	14064.	791. 7000
8. 4000	0. 3556	4881065.	7427.	-0. 00369	0. 00	2. 38E+11	-1100.	14849.	791. 7000
8. 8000	0. 3382	4914471.	5955.	-0. 00359	0. 00	2. 38E+11	-1096.	15563.	791. 7000
9. 2000	0. 3212	4940820.	4495.	-0. 00349	0. 00	2. 38E+11	-1096.	16372.	791. 7000
9. 6000	0. 3047	4960133.	3028.	-0. 00339	0. 00	2. 38E+11	-1099.	17315.	791. 7000
10. 0000	0. 2887	4972328.	1563.	-0. 00329	0. 00	2. 37E+11	-1095.	18204.	791. 7000
10. 4000	0. 2731	4977505.	138. 3677	-0. 00319	0. 00	2. 37E+11	-1082.	19021.	791. 7000
10. 8000	0. 2581	4975951.	-1207.	-0. 00309	0. 00	2. 37E+11	-1062.	19744.	791. 7000
11. 2000	0. 2435	4968144.	-2432.	-0. 00299	0. 00	2. 37E+11	-1032.	20352.	791. 7000
11. 6000	0. 2294	4954757.	-3497.	-0. 00289	0. 00	2. 38E+11	-994. 8503	20817.	791. 7000
12. 0000	0. 2158	4936653.	-4362.	-0. 00279	0. 00	2. 38E+11	-949. 1717	21114.	791. 7000
12. 4000	0. 2026	4914885.	-5135.	-0. 00269	0. 00	2. 38E+11	-956. 0868	22646.	791. 7000
12. 8000	0. 1900	4889294.	-5932.	-0. 00259	0. 00	2. 38E+11	-959. 6615	24245.	791. 7000
13. 2000	0. 1778	4859797.	-6739.	-0. 00249	0. 00	2. 38E+11	-959. 8458	25912.	791. 7000
13. 6000	0. 1661	4826391.	-7538.	-0. 00239	0. 00	2. 38E+11	-956. 6113	27646.	791. 7000
14. 0000	0. 1548	4789150.	-8314.	-0. 00229	0. 00	2. 38E+11	-949. 9514	29447.	791. 7000
14. 4000	0. 1441	4748229.	-9049.	-0. 00220	0. 00	2. 39E+11	-939. 8830	31316.	791. 7000
14. 8000	0. 1337	4703859.	-9728.	-0. 00210	0. 00	2. 39E+11	-926. 4464	33252.	791. 7000
15. 2000	0. 1239	4656351.	-10356.	-0. 00201	0. 00	2. 39E+11	-918. 4364	35591.	791. 7000
15. 6000	0. 1144	4605889.	-10960.	-0. 00192	0. 00	2. 40E+11	-916. 5536	38443.	791. 7000
16. 0000	0. 1055	4552517.	-11549.	-0. 00183	0. 00	2. 40E+11	-912. 2722	41522.	791. 7000
16. 4000	0. 09692	4496334.	-12112.	-0. 00173	0. 00	2. 40E+11	-905. 5802	44850.	791. 7000
16. 8000	0. 08881	4437495.	-12636.	-0. 00165	0. 00	2. 41E+11	-896. 4744	48455.	791. 7000
17. 2000	0. 08112	4376210.	-13112.	-0. 00156	0. 00	2. 41E+11	-884. 9612	52366.	791. 7000
17. 6000	0. 07385	4312745.	-13526.	-0. 00147	0. 00	2. 41E+11	-871. 0574	56616.	791. 7000
18. 0000	0. 06699	4247421.	-13868.	-0. 00139	0. 00	2. 42E+11	-854. 7909	61245.	791. 7000
18. 4000	0. 06054	4180613.	-14044.	-0. 00130	0. 00	2. 42E+11	-802. 0459	63590.	791. 7000
18. 8000	0. 05449	4113537.	-13939.	-0. 00122	0. 00	2. 43E+11	-737. 5238	64973.	791. 7000
19. 2000	0. 04882	4047680.	-13528.	-0. 00114	0. 00	2. 43E+11	-674. 9092	66355.	791. 7000
19. 6000	0. 04354	3984484.	-12823.	-0. 00106	0. 00	2. 44E+11	-614. 4395	67738.	791. 7000
20. 0000	0. 03864	3925345.	-12783.	-9. 83E-04	0. 00	2. 44E+11	-556. 3486	69120.	395. 8500
20. 4000	0. 03410	3862480.	-14370.	-9. 07E-04	0. 00	2. 45E+11	-500. 8686	70502.	0. 00
20. 8000	0. 02993	3788048.	-16648.	-8. 32E-04	0. 00	2. 46E+11	-448. 2187	71885.	0. 00
21. 2000	0. 02611	3703262.	-18361.	-7. 59E-04	0. 00	2. 46E+11	-265. 7274	48845.	0. 00
21. 6000	0. 02264	3612328.	-19562.	-6. 88E-04	0. 00	2. 47E+11	-234. 7680	49766.	0. 00
22. 0000	0. 01951	3515959.	-20620.	-6. 19E-04	0. 00	2. 48E+11	-206. 0311	50688.	0. 00
22. 4000	0. 01670	3414819.	-21546.	-5. 52E-04	0. 00	2. 49E+11	-179. 6000	51610.	0. 00
22. 8000	0. 01421	3309517.	-22350.	-4. 87E-04	0. 00	2. 51E+11	-155. 5446	52531.	0. 00
23. 2000	0. 01203	3200609.	-23045.	-4. 36E-04	0. 00	3. 89E+11	-133. 9214	53453.	0. 00
23. 6000	0. 01003	3088601.	-23639.	-4. 00E-04	0. 00	4. 65E+11	-113. 6046	54374.	0. 00
24. 0000	0. 00818	2973964.	-24138.	-3. 69E-04	0. 00	4. 66E+11	-94. 2820	55296.	0. 00
24. 4000	0. 00649	2857144.	-24546.	-3. 39E-04	0. 00	4. 66E+11	-75. 9744	56218.	0. 00
24. 8000	0. 00493	2738563.	-24870.	-3. 10E-04	0. 00	4. 66E+11	-58. 6967	57139.	0. 00
25. 2000	0. 00351	2618619.	-25112.	-2. 83E-04	0. 00	4. 66E+11	-42. 4586	58061.	0. 00
25. 6000	0. 00222	2497688.	-25280.	-2. 56E-04	0. 00	4. 67E+11	-27. 2642	58982.	0. 00
26. 0000	0. 00105	2376119.	-25377.	-2. 31E-04	0. 00	4. 67E+11	-13. 1127	59904.	0. 00
26. 4000	-1. 40E-07	2254239.	-25408.	-2. 07E-04	0. 00	4. 67E+11	0. 00177	60826.	0. 00
26. 8000	-9. 40E-04	2132350.	-25379.	-1. 85E-04	0. 00	4. 67E+11	12. 0899	61747.	0. 00
27. 2000	-0. 00177	2010733.	-25225.	-1. 64E-04	0. 00	4. 68E+11	52. 1252	141005.	0. 00
27. 6000	-0. 00251	1890309.	-24920.	-1. 44E-04	0. 00	4. 68E+11	74. 8170	143078.	0. 00
28. 0000	-0. 00315	1771601.	-24512.	-1. 25E-04	0. 00	4. 68E+11	95. 3302	145152.	0. 00
28. 4000	-0. 00371	1655084.	-24010.	-1. 07E-04	0. 00	4. 68E+11	113. 7248	147226.	0. 00
28. 8000	-0. 00418	1541181.	-23425.	-9. 08E-05	0. 00	4. 69E+11	130. 0673	149299.	0. 00
29. 2000	-0. 00458	1430269.	-22766.	-7. 56E-05	0. 00	4. 69E+11	144. 4300	151373.	0. 00

Lpile Run 3 ft shaft.lp9o										
29.6000	-0.00491	1322679.	-22043.	-6.15E-05	0.00	4.69E+11	156.8901	153446.	0.00	
30.0000	-0.00517	1218699.	-21265.	-4.85E-05	0.00	4.69E+11	167.5285	155520.	0.00	
30.4000	-0.00537	1118574.	-20439.	-3.66E-05	0.00	4.69E+11	176.4297	157594.	0.00	
30.8000	-0.00552	1022510.	-19575.	-2.56E-05	0.00	4.70E+11	183.6801	159667.	0.00	
31.2000	-0.00562	930675.	-18679.	-1.57E-05	0.00	4.70E+11	189.3680	161741.	0.00	
31.6000	-0.00567	843199.	-17760.	-6.60E-06	0.00	4.70E+11	193.5827	163814.	0.00	
32.0000	-0.00568	760180.	-16824.	1.59E-06	0.00	4.70E+11	196.4136	165888.	0.00	
32.4000	-0.00566	681684.	-15878.	8.95E-06	0.00	4.70E+11	197.9498	167962.	0.00	
32.8000	-0.00560	607746.	-14927.	1.55E-05	0.00	4.70E+11	198.2795	170035.	0.00	
33.2000	-0.00551	538374.	-13977.	2.14E-05	0.00	4.70E+11	197.4896	172109.	0.00	
33.6000	-0.00539	473550.	-13034.	2.66E-05	0.00	4.70E+11	195.6649	174182.	0.00	
34.0000	-0.00525	413233.	-12101.	3.11E-05	0.00	4.70E+11	192.8878	176256.	0.00	
34.4000	-0.00509	357358.	-11184.	3.50E-05	0.00	4.70E+11	189.2383	178330.	0.00	
34.8000	-0.00492	305842.	-10286.	3.84E-05	0.00	4.70E+11	184.7929	180403.	0.00	
35.2000	-0.00472	258582.	-9412.	4.13E-05	0.00	4.70E+11	179.6249	182477.	0.00	
35.6000	-0.00452	215461.	-8563.	4.37E-05	0.00	4.70E+11	173.8039	184550.	0.00	
36.0000	-0.00431	176342.	-7745.	4.57E-05	0.00	4.70E+11	167.3958	186624.	0.00	
36.4000	-0.00408	141080.	-6958.	4.73E-05	0.00	4.70E+11	160.4621	188698.	0.00	
36.8000	-0.00385	109515.	-6205.	4.86E-05	0.00	4.70E+11	153.0604	190771.	0.00	
37.2000	-0.00362	81475.	-5354.	4.96E-05	0.00	4.70E+11	201.7275	267840.	0.00	
37.6000	-0.00338	58083.	-4413.	5.03E-05	0.00	4.70E+11	190.3628	270720.	0.00	
38.0000	-0.00313	39077.	-3527.	5.08E-05	0.00	4.70E+11	178.5478	273600.	0.00	
38.4000	-0.00289	24184.	-2700.	5.11E-05	0.00	4.70E+11	166.3312	276480.	0.00	
38.8000	-0.00264	13124.	-1931.	5.13E-05	0.00	4.70E+11	153.7520	279360.	0.00	
39.2000	-0.00240	5606.	-1224.	5.14E-05	0.00	4.70E+11	140.8399	282240.	0.00	
39.6000	-0.00215	1333.	-580.0959	5.14E-05	0.00	4.70E+11	127.6155	285120.	0.00	
40.0000	-0.00190	0.00	0.00	5.14E-05	0.00	4.70E+11	114.0911	144000.	0.00	

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 5:

Pile-head deflection = 0.82095688 inches  
 Computed slope at pile head = -0.00542860 radians  
 Maximum bending moment = 4977505. inch-lbs  
 Maximum shear force = -25408. lbs  
 Depth of maximum bending moment = 10.40000000 feet below pile head  
 Depth of maximum shear force = 26.40000000 feet below pile head  
 Number of iterations = 19  
 Number of zero deflection points = 1

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 Pile-head Deflection vs. Pile Length for Load Case 5  
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Boundary Condition Type 1, Shear and Moment

Lpile Run 3 ft shaft.lp9o

Shear = -800. lbs  
 Moment = 3567496. in-lbs  
 Axial Load = 75000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.82095688	4977505.	-25408.
38.00000	0.82120211	4978772.	-26163.
36.00000	0.81904438	4968989.	-27836.
34.00000	0.82212635	4978017.	-30379.
32.00000	0.82357473	4960140.	-33481.
30.00000	0.83251824	4931803.	-36342.
28.00000	0.86275700	4868726.	-37356.
26.00000	0.93724830	4753717.	-36891.
24.00000	1.02985345	4647218.	-41316.
22.00000	1.14516029	4528672.	-45954.
20.00000	1.30179763	4417232.	-48413.
18.00000	1.67820340	4247310.	-51378.
16.00000	2.74375689	4237472.	-60318.

Computed Values of Pile Loading and Deflection  
 for Lateral Loading for Load Case Number 6

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 600.0 lbs  
 Applied moment at pile head = 4355711.0 in-lbs  
 Axial thrust load on pile head = 90000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.9178	4355711.	600.0000	-0.00624	0.00	2.47E+11	0.00	0.00	791.7000
0.4000	0.8880	4370388.	4205.	-0.00615	0.00	2.47E+11	-81.2739	439.3112	791.7000
0.8000	0.8587	4401397.	7407.	-0.00607	0.00	2.46E+11	-168.1214	939.7924	791.7000
1.2000	0.8298	4446735.	10183.	-0.00598	0.00	2.46E+11	-258.6178	1496.	791.7000
1.6000	0.8013	4504319.	12520.	-0.00589	0.00	2.45E+11	-350.9895	2103.	791.7000
2.0000	0.7732	4572018.	14412.	-0.00581	0.00	2.45E+11	-443.9148	2756.	791.7000
2.4000	0.7455	4647692.	15862.	-0.00572	0.00	2.44E+11	-535.5930	3448.	791.7000
2.8000	0.7183	4729227.	16878.	-0.00562	0.00	2.44E+11	-624.4782	4173.	791.7000
3.2000	0.6915	4814574.	17474.	-0.00553	0.00	2.43E+11	-710.2912	4930.	791.7000
3.6000	0.6652	4901756.	17668.	-0.00543	0.00	2.43E+11	-792.2793	5717.	791.7000
4.0000	0.6394	4988883.	17622.	-0.00533	0.00	2.42E+11	-810.1759	6082.	791.7000
4.4000	0.6140	5075541.	17524.	-0.00523	0.00	2.41E+11	-814.1881	6365.	791.7000
4.8000	0.5891	5161638.	17277.	-0.00513	0.00	2.41E+11	-872.0811	7105.	791.7000
5.2000	0.5647	5245838.	16763.	-0.00503	0.00	2.40E+11	-925.6059	7867.	791.7000

Lpile Run 3 ft shaft. l p90									
5. 6000	0. 5409	5326908.	16009.	-0. 00492	0. 00	2. 40E+11	-971. 7553	8624.	791. 7000
6. 0000	0. 5175	5403783.	15054.	-0. 00482	0. 00	2. 40E+11	-1010.	9366.	791. 7000
6. 4000	0. 4946	5475589.	13917.	-0. 00471	0. 00	2. 39E+11	-1048.	10167.	791. 7000
6. 8000	0. 4723	5541450.	12616.	-0. 00460	0. 00	2. 39E+11	-1078.	10953.	791. 7000
7. 2000	0. 4505	5600674.	11192.	-0. 00448	0. 00	2. 39E+11	-1099.	11712.	791. 7000
7. 6000	0. 4292	5652764.	9678.	-0. 00437	0. 00	2. 38E+11	-1115.	12466.	791. 7000
8. 0000	0. 4085	5697363.	8090.	-0. 00426	0. 00	2. 38E+11	-1130.	13280.	791. 7000
8. 4000	0. 3884	5734110.	6450.	-0. 00414	0. 00	2. 38E+11	-1137.	14050.	791. 7000
8. 8000	0. 3688	5762857.	4800.	-0. 00403	0. 00	2. 38E+11	-1134.	14757.	791. 7000
9. 2000	0. 3497	5783672.	3159.	-0. 00391	0. 00	2. 38E+11	-1134.	15560.	791. 7000
9. 6000	0. 3313	5796556.	1506.	-0. 00379	0. 00	2. 38E+11	-1138.	16495.	791. 7000
10. 0000	0. 3133	5801402.	-149. 9454	-0. 00367	0. 00	2. 38E+11	-1135.	17385.	791. 7000
10. 4000	0. 2960	5798292.	-1769.	-0. 00356	0. 00	2. 38E+11	-1123.	18212.	791. 7000
10. 8000	0. 2792	5787498.	-3309.	-0. 00344	0. 00	2. 38E+11	-1102.	18955.	791. 7000
11. 2000	0. 2629	5769495.	-4731.	-0. 00332	0. 00	2. 38E+11	-1073.	19591.	791. 7000
11. 6000	0. 2473	5744955.	-5991.	-0. 00321	0. 00	2. 38E+11	-1035.	20096.	791. 7000
12. 0000	0. 2321	5714755.	-7048.	-0. 00309	0. 00	2. 38E+11	-988. 7265	20444.	791. 7000
12. 4000	0. 2176	5679965.	-8010.	-0. 00298	0. 00	2. 38E+11	-995. 2600	21956.	791. 7000
12. 8000	0. 2036	5640435.	-8994.	-0. 00286	0. 00	2. 38E+11	-998. 2395	23538.	791. 7000
13. 2000	0. 1901	5596098.	-9984.	-0. 00275	0. 00	2. 39E+11	-997. 6132	25191.	791. 7000
13. 6000	0. 1772	5546968.	-10962.	-0. 00264	0. 00	2. 39E+11	-993. 3515	26914.	791. 7000
14. 0000	0. 1648	5493144.	-11911.	-0. 00253	0. 00	2. 39E+11	-985. 4487	28708.	791. 7000
14. 4000	0. 1529	5434808.	-12813.	-0. 00242	0. 00	2. 39E+11	-973. 9233	30575.	791. 7000
14. 8000	0. 1416	5372226.	-13652.	-0. 00231	0. 00	2. 40E+11	-958. 8193	32513.	791. 7000
15. 2000	0. 1307	5305748.	-14430.	-0. 00220	0. 00	2. 40E+11	-949. 0489	34847.	791. 7000
15. 6000	0. 1204	5235599.	-15177.	-0. 00210	0. 00	2. 41E+11	-945. 3256	37685.	791. 7000
16. 0000	0. 1106	5161865.	-15899.	-0. 00199	0. 00	2. 41E+11	-939. 0115	40756.	791. 7000
16. 4000	0. 1013	5084692.	-16585.	-0. 00189	0. 00	2. 41E+11	-930. 0903	44085.	791. 7000
16. 8000	0. 09243	5004287.	-17221.	-0. 00179	0. 00	2. 42E+11	-918. 5537	47701.	791. 7000
17. 2000	0. 08407	4920917.	-17796.	-0. 00169	0. 00	2. 42E+11	-904. 4009	51637.	791. 7000
17. 6000	0. 07618	4834908.	-18297.	-0. 00160	0. 00	2. 43E+11	-887. 6390	55932.	791. 7000
18. 0000	0. 06874	4746647.	-18711.	-0. 00150	0. 00	2. 44E+11	-868. 2836	60630.	791. 7000
18. 4000	0. 06176	4656582.	-18958.	-0. 00141	0. 00	2. 44E+11	-818. 1307	63590.	791. 7000
18. 8000	0. 05521	4565867.	-18915.	-0. 00132	0. 00	2. 45E+11	-747. 2975	64973.	791. 7000
19. 2000	0. 04909	4476138.	-18537.	-0. 00123	0. 00	2. 46E+11	-678. 6313	66355.	791. 7000
19. 6000	0. 04339	4388975.	-17835.	-0. 00114	0. 00	2. 46E+11	-612. 3675	67738.	791. 7000
20. 0000	0. 03811	4305907.	-17772.	-0. 00106	0. 00	2. 47E+11	-548. 7343	69120.	395. 8500
20. 4000	0. 03322	4219281.	-19310.	-9. 77E-04	0. 00	2. 48E+11	-487. 9556	70502.	0. 00
20. 8000	0. 02873	4121377.	-21513.	-8. 96E-04	0. 00	2. 49E+11	-430. 2395	71885.	0. 00
21. 2000	0. 02462	4013526.	-23147.	-8. 18E-04	0. 00	2. 50E+11	-250. 5101	48845.	0. 00
21. 6000	0. 02088	3899870.	-24268.	-7. 42E-04	0. 00	2. 51E+11	-216. 4553	49766.	0. 00
22. 0000	0. 01749	3781194.	-25231.	-6. 69E-04	0. 00	2. 52E+11	-184. 7468	50688.	0. 00
22. 4000	0. 01446	3658231.	-26047.	-5. 98E-04	0. 00	2. 54E+11	-155. 4546	51610.	0. 00
22. 8000	0. 01175	3531656.	-26729.	-5. 30E-04	0. 00	2. 55E+11	-128. 6342	52531.	0. 00
23. 2000	0. 00937	3402089.	-27288.	-4. 65E-04	0. 00	2. 57E+11	-104. 3266	53453.	0. 00
23. 6000	0. 00729	3270091.	-27737.	-4. 03E-04	0. 00	2. 59E+11	-82. 5590	54374.	0. 00
24. 0000	0. 00550	3136164.	-28087.	-3. 57E-04	0. 00	4. 65E+11	-63. 3452	55296.	0. 00
24. 4000	0. 00386	3000764.	-28348.	-3. 25E-04	0. 00	4. 66E+11	-45. 2634	56218.	0. 00
24. 8000	0. 00238	2864307.	-28524.	-2. 95E-04	0. 00	4. 66E+11	-28. 3222	57139.	0. 00
25. 2000	0. 00104	2727185.	-28622.	-2. 66E-04	0. 00	4. 66E+11	-12. 5242	58061.	0. 00
25. 6000	-1. 74E-04	2589763.	-28647.	-2. 39E-04	0. 00	4. 66E+11	2. 1333	58982.	0. 00
26. 0000	-0. 00125	2452378.	-28605.	-2. 13E-04	0. 00	4. 67E+11	15. 6584	59904.	0. 00
26. 4000	-0. 00221	2315343.	-28500.	-1. 88E-04	0. 00	4. 67E+11	28. 0644	60826.	0. 00
26. 8000	-0. 00306	2178945.	-28338.	-1. 65E-04	0. 00	4. 67E+11	39. 3694	61747.	0. 00

Lpile Run 3 ft shaft.lp9o										
27. 2000	-0. 00380	2043443.	-27975.	-1. 43E-04	0. 00	4. 68E+11	111. 5917	141005.		0. 00
27. 6000	-0. 00444	1910504.	-27390.	-1. 23E-04	0. 00	4. 68E+11	132. 2385	143078.		0. 00
28. 0000	-0. 00498	1780603.	-26711.	-1. 04E-04	0. 00	4. 68E+11	150. 5904	145152.		0. 00
28. 4000	-0. 00544	1654164.	-25950.	-8. 65E-05	0. 00	4. 68E+11	166. 7233	147226.		0. 00
28. 8000	-0. 00581	1531559.	-25116.	-7. 02E-05	0. 00	4. 68E+11	180. 7185	149299.		0. 00
29. 2000	-0. 00611	1413111.	-24220.	-5. 51E-05	0. 00	4. 69E+11	192. 6616	151373.		0. 00
29. 6000	-0. 00634	1299095.	-23271.	-4. 12E-05	0. 00	4. 69E+11	202. 6425	153446.		0. 00
30. 0000	-0. 00650	1189743.	-22279.	-2. 85E-05	0. 00	4. 69E+11	210. 7534	155520.		0. 00
30. 4000	-0. 00661	1085241.	-21252.	-1. 68E-05	0. 00	4. 69E+11	217. 0888	157594.		0. 00
30. 8000	-0. 00667	985736.	-20199.	-6. 23E-06	0. 00	4. 69E+11	221. 7442	159667.		0. 00
31. 2000	-0. 00667	891336.	-19127.	3. 37E-06	0. 00	4. 69E+11	224. 8156	161741.		0. 00
31. 6000	-0. 00663	802111.	-18044.	1. 20E-05	0. 00	4. 69E+11	226. 3989	163814.		0. 00
32. 0000	-0. 00656	718099.	-16957.	1. 98E-05	0. 00	4. 70E+11	226. 5888	165888.		0. 00
32. 4000	-0. 00644	639305.	-15872.	2. 67E-05	0. 00	4. 70E+11	225. 4788	167962.		0. 00
32. 8000	-0. 00630	565703.	-14796.	3. 29E-05	0. 00	4. 70E+11	223. 1604	170035.		0. 00
33. 2000	-0. 00613	497240.	-13733.	3. 83E-05	0. 00	4. 70E+11	219. 7223	172109.		0. 00
33. 6000	-0. 00593	433837.	-12689.	4. 31E-05	0. 00	4. 70E+11	215. 2506	174182.		0. 00
34. 0000	-0. 00571	375391.	-11668.	4. 72E-05	0. 00	4. 70E+11	209. 8278	176256.		0. 00
34. 4000	-0. 00548	321779.	-10676.	5. 08E-05	0. 00	4. 70E+11	203. 5330	178330.		0. 00
34. 8000	-0. 00523	272854.	-9716.	5. 38E-05	0. 00	4. 70E+11	196. 4410	180403.		0. 00
35. 2000	-0. 00496	228454.	-8792.	5. 64E-05	0. 00	4. 70E+11	188. 6227	182477.		0. 00
35. 6000	-0. 00469	188399.	-7907.	5. 85E-05	0. 00	4. 70E+11	180. 1444	184550.		0. 00
36. 0000	-0. 00440	152494.	-7064.	6. 03E-05	0. 00	4. 70E+11	171. 0681	186624.		0. 00
36. 4000	-0. 00411	120529.	-6266.	6. 17E-05	0. 00	4. 70E+11	161. 4511	188698.		0. 00
36. 8000	-0. 00381	92284.	-5516.	6. 27E-05	0. 00	4. 70E+11	151. 3458	190771.		0. 00
37. 2000	-0. 00350	67525.	-4683.	6. 36E-05	0. 00	4. 70E+11	195. 5562	267840.		0. 00
37. 6000	-0. 00320	47272.	-3781.	6. 41E-05	0. 00	4. 70E+11	180. 3589	270720.		0. 00
38. 0000	-0. 00289	31174.	-2953.	6. 45E-05	0. 00	4. 70E+11	164. 6614	273600.		0. 00
38. 4000	-0. 00258	18869.	-2201.	6. 48E-05	0. 00	4. 70E+11	148. 5048	276480.		0. 00
38. 8000	-0. 00227	9987.	-1528.	6. 49E-05	0. 00	4. 70E+11	131. 9217	279360.		0. 00
39. 2000	-0. 00195	4143.	-935. 7066	6. 50E-05	0. 00	4. 70E+11	114. 9360	282240.		0. 00
39. 6000	-0. 00164	947. 5618	-425. 7071	6. 50E-05	0. 00	4. 70E+11	97. 5638	285120.		0. 00
40. 0000	-0. 00133	0. 00	0. 00	6. 51E-05	0. 00	4. 70E+11	79. 8142	144000.		0. 00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 6:

Pile-head deflection = 0. 91775642 inches  
 Computed slope at pile head = -0. 00623854 radians  
 Maximum bending moment = 5801402. inch-lbs  
 Maximum shear force = -28647. lbs  
 Depth of maximum bending moment = 10. 00000000 feet below pile head  
 Depth of maximum shear force = 25. 60000000 feet below pile head  
 Number of iterations = 27  
 Number of zero deflection points = 1

Pile-head Deflection vs. Pile Length for Load Case 6

Boundary Condition Type 1, Shear and Moment

Shear = 600. lbs  
 Moment = 4355711. in-lbs  
 Axial Load = 90000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs
40.00000	0.91775642	5801402.	-28647.
38.00000	0.91747307	5800972.	-29201.
36.00000	0.91485036	5789682.	-30708.
34.00000	0.91915813	5801813.	-33238.
32.00000	0.92094591	5787000.	-36612.
30.00000	0.93116219	5759655.	-39986.
28.00000	0.96624653	5697551.	-41666.
26.00000	1.05164247	5582492.	-42062.
24.00000	1.15761657	5472900.	-48069.
22.00000	1.29415367	5347815.	-53425.
20.00000	1.49132301	5226212.	-56566.
18.00000	2.01702713	5118088.	-61713.
16.00000	4.54278155	5224694.	-81294.

Summary of Pile-head Responses for Conventional Analyses

Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs  
 Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians  
 Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.  
 Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs  
 Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

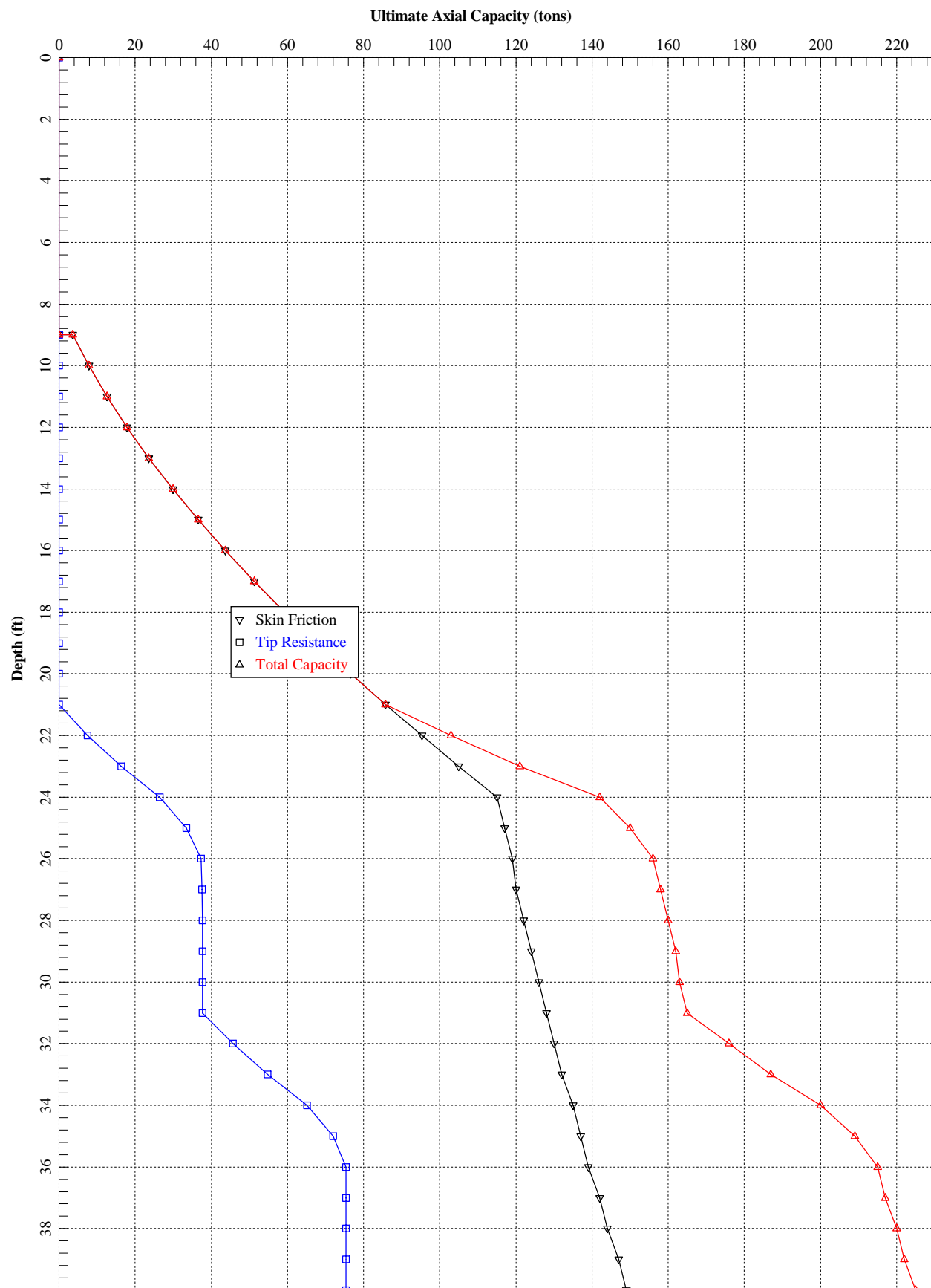
Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	5014935.	104000.	0.9667	-0.00673	-30520.	6342342.
2	V, lb	-1300.	M, in-lb	5497571.	116000.	0.9888	-0.00699	-31444.	6666195.
3	V, lb	1300.	M, in-lb	449695.	-8000.	0.5920	-0.00287	23227.	3200930.
4	V, lb	0.00	M, in-lb	4948283.	101000.	0.9613	-0.00668	-30263.	6279984.
5	V, lb	-800.0000	M, in-lb	3567496.	75000.	0.8210	-0.00543	-25408.	4977505.
6	V, lb	600.0000	M, in-lb	4355711.	90000.	0.9178	-0.00624	-28647.	5801402.

Lpile Run 3 ft shaft.lp9o

Maximum pile-head deflection = 0.9887801926 inches

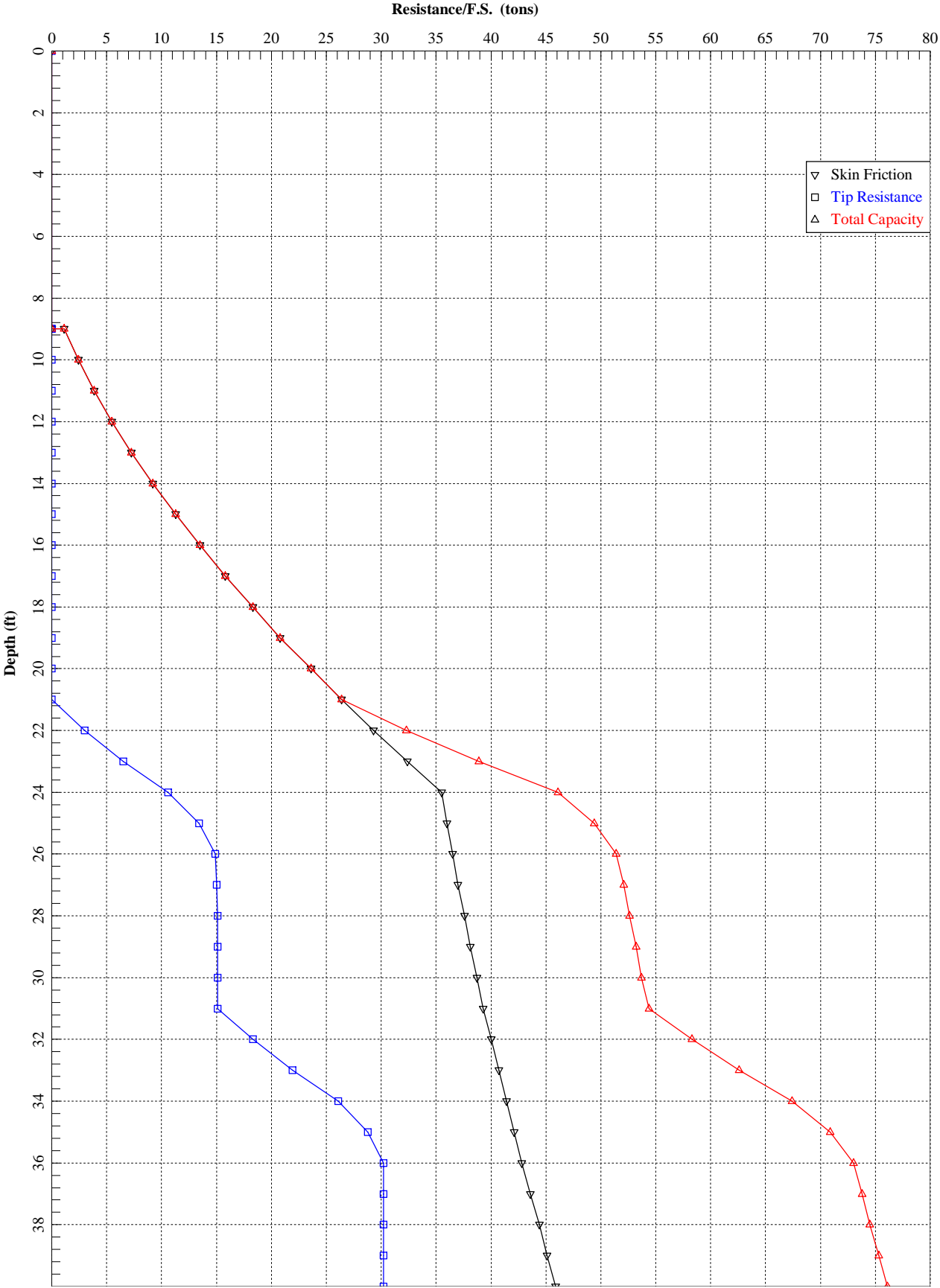
Maximum pile-head rotation = -0.0069902665 radians = -0.400513 deg.

The analysis ended normally.





Allowable Capacity- 3 ft. dia. shaft



=====

SHAFT for Windows, Version 2017.8.2

Serial Number : 161217426

VERTICALLY LOADED DRILLED SHAFT ANALYSIS  
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=====

Path to file locations : C:\Users\fsaramal\madrona\Desktop\FER\Rolling Road\  
Name of input data file : Shaft.sf8d  
Name of output file : Shaft.sf8o  
Name of plot output file : Shaft.sf8p  
Name of runtime file : Shaft.sf8r

-----

Time and Date of Analysis

-----

Date: February 05, 2018 Time: 16:25:59

Rolling Road Platform Extension

PROPOSED DEPTH = 40.0 FT  
-----

NUMBER OF LAYERS = 6  
-----

WATER TABLE DEPTH = 21.0 FT.  
-----

FACTOR OF SAFETY APPLIED TO THE ULTIMATE SIDE FRICTION CAPACITY = 3.25  
-----

FACTOR OF SAFETY APPLIED TO THE ULTIMATE BASE CAPACITY = 2.50  
-----

SOIL INFORMATION  
-----

LAYER NO 1---SAND

AT THE TOP

SIDE FRICTION PROCEDURE, BETA METHOD		
SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01	(*)
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02	
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00	
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03	
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11	
DEPTH, FT	= 0.000E+00	

AT THE BOTTOM

SIDE FRICTION PROCEDURE, BETA METHOD		
SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01	(*)
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02	
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00	
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03	
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11	
DEPTH, FT	= 0.400E+01	

LAYER NO 2----SAND

AT THE TOP

SIDE FRICTION PROCEDURE, BETA METHOD		
SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01	(*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02	
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00	
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03	
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11	
DEPTH, FT	= 0.400E+01	

AT THE BOTTOM

SIDE FRICTION PROCEDURE, BETA METHOD		
SKIN FRICTION COEFFICIENT- BETA	= 0.112E+01	(*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02	
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00	
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03	
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11	
DEPTH, FT	= 0.800E+01	

LAYER NO 3----SAND

AT THE TOP

SIDE FRICTION PROCEDURE, BETA METHOD		
SKIN FRICTION COEFFICIENT- BETA	= 0.112E+01	(*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02	
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00	
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03	
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11	
DEPTH, FT	= 0.800E+01	

AT THE BOTTOM

SIDE FRICTION PROCEDURE, BETA METHOD		
SKIN FRICTION COEFFICIENT- BETA	= 0.881E+00	(*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02	
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00	
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03	
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11	
DEPTH, FT	= 0.210E+02	

## LAYER NO 4----SAND

## AT THE TOP

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.210E+02

## AT THE BOTTOM

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.270E+02

## LAYER NO 5----SAND

## AT THE TOP

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.270E+02

## AT THE BOTTOM

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.370E+02

## LAYER NO 6----SAND

AT THE TOP

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.370E+02

AT THE BOTTOM

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.530E+02

(\*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS

## INPUT DRILLED SHAFT INFORMATION

-----

MINIMUM SHAFT DIAMETER	=	3.000	FT.
MAXIMUM SHAFT DIAMETER	=	3.000	FT.
RATIO BASE/SHAFT DIAMETER	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	3.000	FT.
ELASTIC MODULUS, Ec	=	0.290E+08	LB/SQ IN

## VARY SHAFT LENGTH FOR INITIAL DIAMETER

-----

MAXIMUM SHAFT LENGTH	=	40.000	FT.
MINIMUM SHAFT LENGTH	=	26.000	FT.
SHAFT LENGTH INCREMENT	=	5.000	FT.

## COMPUTATION RESULTS

-----

- CASE ANALYZED : 1  
 VARIATION LENGTH : 1  
 VARIATION DIAMETER : 1

#### DRILLED SHAFT INFORMATION

-----

DIAMETER OF STEM = 3.000 FT.  
 DIAMETER OF BASE = 3.000 FT.  
 END OF STEM TO BASE = 0.000 FT.  
 ANGLE OF BELL = 0.000 DEG.  
 IGNORED TOP PORTION = 5.000 FT.  
 IGNORED BOTTOM PORTION = 3.000 FT.  
 AREA OF ONE PERCENT STEEL = 10.180 SQ. IN.  
 ELASTIC MODULUS,  $E_c$  = 0.290E+08 LB/SQ IN  
 VOLUME OF UNDERREAM = 0.000 CU. YDS.  
 SHAFT LENGTH = 40.000 FT.

#### PREDICTED RESULTS

-----

QS = ULTIMATE SIDE RESISTANCE;  
 QB = ULTIMATE BASE RESISTANCE;  
 WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);  
 QU = TOTAL ULTIMATE RESISTANCE;  
 QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY  
 APPLIED TO THE ULTIMATE BASE RESISTANCE;  
 QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY  
 APPLIED TO THE ULTIMATE SIDE RESISTANCE AND  
 THE ULTIMATE BASE RESISTANCE.

LENGTH (FT)	VOLUME (CU. YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU. YDS)
9.0	2.36	3.64	0.00	3.64	3.64	1.12	1.54
10.0	2.62	7.84	0.00	7.84	7.84	2.41	2.99
11.0	2.88	12.58	0.00	12.58	12.58	3.87	4.37
12.0	3.14	17.85	0.00	17.85	17.85	5.49	5.68
13.0	3.40	23.61	0.00	23.61	23.61	7.26	6.94
14.0	3.67	29.86	0.00	29.86	29.86	9.19	8.15
15.0	3.93	36.57	0.00	36.57	36.57	11.25	9.31
16.0	4.19	43.74	0.00	43.74	43.74	13.46	10.44
17.0	4.45	51.33	0.00	51.33	51.33	15.79	11.53
18.0	4.71	59.35	0.00	59.35	59.35	18.26	12.59
19.0	4.97	67.76	0.00	67.76	67.76	20.85	13.62
20.0	5.24	76.57	0.00	76.57	76.57	23.56	14.62
21.0	5.50	85.74	0.00	85.74	85.74	26.38	15.59

Shaft. sf8o							
22.0	5.76	95.28	7.47	102.75	98.27	32.30	17.84
23.0	6.02	105.16	16.26	121.43	111.67	38.86	20.16
24.0	6.28	115.38	26.43	141.82	125.96	46.08	22.57
25.0	6.55	117.00	33.48	150.48	130.39	49.39	22.99
26.0	6.81	118.65	37.25	155.90	133.55	51.41	22.90
27.0	7.07	120.34	37.59	157.93	135.37	52.06	22.34
28.0	7.33	122.06	37.71	159.77	137.14	52.64	21.79
29.0	7.59	123.82	37.71	161.53	138.90	53.18	21.27
30.0	7.85	125.61	37.71	163.32	140.70	53.73	20.79
31.0	8.12	127.77	37.71	165.48	142.85	54.40	20.39
32.0	8.38	129.97	45.71	175.68	148.26	58.27	20.97
33.0	8.64	132.22	54.85	187.07	154.16	62.62	21.65
34.0	8.90	134.52	65.13	199.65	160.57	67.44	22.43
35.0	9.16	136.86	71.99	208.85	165.65	70.91	22.79
36.0	9.43	139.24	75.42	214.66	169.41	73.01	22.77
37.0	9.69	141.68	75.42	217.09	171.84	73.76	22.41
38.0	9.95	144.15	75.42	219.57	174.32	74.52	22.07
39.0	10.21	146.68	75.42	222.10	176.85	75.30	21.75
40.0	10.47	149.25	75.42	224.67	179.42	76.09	21.45

#### AXIAL LOAD VS SETTLEMENT CURVES

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##### RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1560E-01	0.1027E-04	0.7332E-03	0.1000E-04
0.7802E-01	0.5134E-04	0.3666E-02	0.5000E-04
0.1560E+00	0.1027E-03	0.7332E-02	0.1000E-03
0.7802E+01	0.5134E-02	0.3666E+00	0.5000E-02
0.1170E+02	0.7702E-02	0.5499E+00	0.7500E-02
0.1560E+02	0.1027E-01	0.7332E+00	0.1000E-01
0.3902E+02	0.2567E-01	0.1833E+01	0.2500E-01
0.7233E+02	0.5125E-01	0.3666E+01	0.5000E-01
0.9973E+02	0.7673E-01	0.5499E+01	0.7500E-01
0.1171E+03	0.1020E+00	0.7332E+01	0.1000E+00
0.1658E+03	0.2530E+00	0.1818E+02	0.2500E+00
0.1871E+03	0.5036E+00	0.3423E+02	0.5000E+00
0.1918E+03	0.6288E+00	0.3934E+02	0.6250E+00
0.2006E+03	0.9041E+00	0.4827E+02	0.9000E+00
0.2284E+03	0.1805E+01	0.7655E+02	0.1800E+01

##### RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.2107E-01	0.1036E-04	0.1047E-02	0.1000E-04
0.1053E+00	0.5182E-04	0.5237E-02	0.5000E-04

Shaft. sf8o

0. 2107E+00	0. 1036E-03	0. 1047E-01	0. 1000E-03
0. 1053E+02	0. 5182E-02	0. 5237E+00	0. 5000E-02
0. 1580E+02	0. 7773E-02	0. 7856E+00	0. 7500E-02
0. 2107E+02	0. 1036E-01	0. 1047E+01	0. 1000E-01
0. 5269E+02	0. 2591E-01	0. 2619E+01	0. 2500E-01
0. 9642E+02	0. 5167E-01	0. 5237E+01	0. 5000E-01
0. 1308E+03	0. 7728E-01	0. 7856E+01	0. 7500E-01
0. 1489E+03	0. 1026E+00	0. 1047E+02	0. 1000E+00
0. 1844E+03	0. 2535E+00	0. 2560E+02	0. 2500E+00
0. 2062E+03	0. 5042E+00	0. 4735E+02	0. 5000E+00
0. 2109E+03	0. 6293E+00	0. 5213E+02	0. 6250E+00
0. 2161E+03	0. 9045E+00	0. 5732E+02	0. 9000E+00
0. 2403E+03	0. 1805E+01	0. 8145E+02	0. 1800E+01

#### RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0. 1016E-01	0. 1017E-04	0. 4190E-03	0. 1000E-04
0. 5081E-01	0. 5087E-04	0. 2095E-02	0. 5000E-04
0. 1016E+00	0. 1017E-03	0. 4190E-02	0. 1000E-03
0. 5081E+01	0. 5087E-02	0. 2095E+00	0. 5000E-02
0. 7622E+01	0. 7631E-02	0. 3142E+00	0. 7500E-02
0. 1016E+02	0. 1017E-01	0. 4190E+00	0. 1000E-01
0. 2541E+02	0. 2544E-01	0. 1047E+01	0. 2500E-01
0. 4831E+02	0. 5083E-01	0. 2095E+01	0. 5000E-01
0. 6870E+02	0. 7618E-01	0. 3142E+01	0. 7500E-01
0. 8523E+02	0. 1015E+00	0. 4190E+01	0. 1000E+00
0. 1471E+03	0. 2526E+00	0. 1077E+02	0. 2500E+00
0. 1681E+03	0. 5031E+00	0. 2112E+02	0. 5000E+00
0. 1726E+03	0. 6283E+00	0. 2654E+02	0. 6250E+00
0. 1850E+03	0. 9037E+00	0. 3922E+02	0. 9000E+00
0. 2165E+03	0. 1805E+01	0. 7165E+02	0. 1800E+01

- CASE ANALYZED : 2  
 VARIATION LENGTH : 2  
 VARIATION DIAMETER : 1

#### DRIILLED SHAFT INFORMATION

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DIAMETER OF STEM	=	3.000	FT.
DIAMETER OF BASE	=	3.000	FT.
END OF STEM TO BASE	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	3.000	FT.
AREA OF ONE PERCENT STEEL	=	10.180	SQ. IN.



Shaft. sf8o

ELASTIC MODULUS,  $E_c$  = 0.290E+08 LB/SQ IN  
 VOLUME OF UNDERREAM = 0.000 CU. YDS.  
 SHAFT LENGTH = 35.000 FT.

# PREDICTED RESULTS

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QS = ULTIMATE SIDE RESISTANCE;  
 QB = ULTIMATE BASE RESISTANCE;  
 WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);  
 QU = TOTAL ULTIMATE RESISTANCE;  
 QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY  
 APPLIED TO THE ULTIMATE BASE RESISTANCE;  
 QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY  
 APPLIED TO THE ULTIMATE SIDE RESISTANCE AND  
 THE ULTIMATE BASE RESISTANCE.

LENGTH (FT)	VOLUME (CU. YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU. YDS)
9.0	2.36	3.64	0.00	3.64	3.64	1.12	1.54
10.0	2.62	7.84	0.00	7.84	7.84	2.41	2.99
11.0	2.88	12.58	0.00	12.58	12.58	3.87	4.37
12.0	3.14	17.85	0.00	17.85	17.85	5.49	5.68
13.0	3.40	23.61	0.00	23.61	23.61	7.26	6.94
14.0	3.67	29.86	0.00	29.86	29.86	9.19	8.15
15.0	3.93	36.57	0.00	36.57	36.57	11.25	9.31
16.0	4.19	43.74	0.00	43.74	43.74	13.46	10.44
17.0	4.45	51.33	0.00	51.33	51.33	15.79	11.53
18.0	4.71	59.35	0.00	59.35	59.35	18.26	12.59
19.0	4.97	67.76	0.00	67.76	67.76	20.85	13.62
20.0	5.24	76.57	0.00	76.57	76.57	23.56	14.62
21.0	5.50	85.74	0.00	85.74	85.74	26.38	15.59
22.0	5.76	95.28	7.47	102.75	98.27	32.30	17.84
23.0	6.02	105.16	16.26	121.43	111.67	38.86	20.16
24.0	6.28	115.38	26.43	141.82	125.96	46.08	22.57
25.0	6.55	117.00	33.48	150.48	130.39	49.39	22.99
26.0	6.81	118.65	37.25	155.90	133.55	51.41	22.90
27.0	7.07	120.34	37.59	157.93	135.37	52.06	22.34
28.0	7.33	122.06	37.71	159.77	137.14	52.64	21.79
29.0	7.59	123.82	37.71	161.53	138.90	53.18	21.27
30.0	7.85	125.61	37.71	163.32	140.70	53.73	20.79
31.0	8.12	127.77	37.71	165.48	142.85	54.40	20.39
32.0	8.38	129.97	45.71	175.68	148.26	58.27	20.97
33.0	8.64	132.22	54.85	187.07	154.16	62.62	21.65
34.0	8.90	134.52	65.13	199.65	160.57	67.44	22.43
35.0	9.16	136.86	71.99	208.85	165.65	70.91	22.79

# AXIAL LOAD VS SETTLEMENT CURVES

## RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1448E-01	0.1023E-04	0.6999E-03	0.1000E-04
0.7240E-01	0.5116E-04	0.3499E-02	0.5000E-04
0.1448E+00	0.1023E-03	0.6999E-02	0.1000E-03
0.7240E+01	0.5116E-02	0.3499E+00	0.5000E-02
0.1086E+02	0.7674E-02	0.5249E+00	0.7500E-02
0.1448E+02	0.1023E-01	0.6999E+00	0.1000E-01
0.3621E+02	0.2558E-01	0.1750E+01	0.2500E-01
0.6716E+02	0.5108E-01	0.3499E+01	0.5000E-01
0.9265E+02	0.7649E-01	0.5249E+01	0.7500E-01
0.1088E+03	0.1018E+00	0.6999E+01	0.1000E+00
0.1543E+03	0.2526E+00	0.1736E+02	0.2500E+00
0.1746E+03	0.5031E+00	0.3268E+02	0.5000E+00
0.1790E+03	0.6282E+00	0.3755E+02	0.6250E+00
0.1874E+03	0.9035E+00	0.4607E+02	0.9000E+00
0.2140E+03	0.1804E+01	0.7307E+02	0.1800E+01

## RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1954E-01	0.1031E-04	0.9999E-03	0.1000E-04
0.9772E-01	0.5157E-04	0.4999E-02	0.5000E-04
0.1954E+00	0.1031E-03	0.9999E-02	0.1000E-03
0.9772E+01	0.5157E-02	0.4999E+00	0.5000E-02
0.1466E+02	0.7735E-02	0.7499E+00	0.7500E-02
0.1954E+02	0.1031E-01	0.9999E+00	0.1000E-01
0.4888E+02	0.2578E-01	0.2500E+01	0.2500E-01
0.8951E+02	0.5144E-01	0.4999E+01	0.5000E-01
0.1215E+03	0.7697E-01	0.7499E+01	0.7500E-01
0.1384E+03	0.1023E+00	0.9999E+01	0.1000E+00
0.1718E+03	0.2530E+00	0.2444E+02	0.2500E+00
0.1926E+03	0.5036E+00	0.4519E+02	0.5000E+00
0.1972E+03	0.6287E+00	0.4976E+02	0.6250E+00
0.2021E+03	0.9038E+00	0.5471E+02	0.9000E+00
0.2251E+03	0.1804E+01	0.7775E+02	0.1800E+01

## RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.9435E-02	0.1015E-04	0.3999E-03	0.1000E-04
0.4717E-01	0.5075E-04	0.2000E-02	0.5000E-04
0.9435E-01	0.1015E-03	0.3999E-02	0.1000E-03
0.4717E+01	0.5075E-02	0.2000E+00	0.5000E-02
0.7076E+01	0.7613E-02	0.3000E+00	0.7500E-02
0.9435E+01	0.1015E-01	0.3999E+00	0.1000E-01

Shaft. sf8o

0. 2359E+02	0. 2538E-01	0. 9999E+00	0. 2500E-01
0. 4486E+02	0. 5072E-01	0. 2000E+01	0. 5000E-01
0. 6381E+02	0. 7602E-01	0. 3000E+01	0. 7500E-01
0. 7917E+02	0. 1013E+00	0. 3999E+01	0. 1000E+00
0. 1368E+03	0. 2522E+00	0. 1028E+02	0. 2500E+00
0. 1565E+03	0. 5027E+00	0. 2016E+02	0. 5000E+00
0. 1609E+03	0. 6278E+00	0. 2534E+02	0. 6250E+00
0. 1727E+03	0. 9031E+00	0. 3743E+02	0. 9000E+00
0. 2028E+03	0. 1804E+01	0. 6839E+02	0. 1800E+01

- CASE ANALYZED : 3  
 VARIATION LENGTH : 3  
 VARIATION DIAMETER : 1

#### DRILLED SHAFT INFORMATION

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DIAMETER OF STEM	=	3. 000	FT.
DIAMETER OF BASE	=	3. 000	FT.
END OF STEM TO BASE	=	0. 000	FT.
ANGLE OF BELL	=	0. 000	DEG.
IGNORED TOP PORTION	=	5. 000	FT.
IGNORED BOTTOM PORTION	=	3. 000	FT.
AREA OF ONE PERCENT STEEL	=	10. 180	SQ. IN.
ELASTIC MODULUS, $E_c$	=	0. 290E+08	LB/SQ IN
VOLUME OF UNDERREAM	=	0. 000	CU. YDS.
SHAFT LENGTH	=	30. 000	FT.

#### PREDICTED RESULTS

-----

QS = ULTIMATE SIDE RESISTANCE;  
 QB = ULTIMATE BASE RESISTANCE;  
 WT = WEIGHT OF DRILLED SHAFT (FOR UPLIFT CAPACITY ONLY);  
 QU = TOTAL ULTIMATE RESISTANCE;  
 QBD = TOTAL ALLOWABLE LOAD USING A FACTOR OF SAFETY  
 APPLIED TO THE ULTIMATE BASE RESISTANCE;  
 QDN = TOTAL ALLOWABLE LOAD USING FACTORS OF SAFETY  
 APPLIED TO THE ULTIMATE SIDE RESISTANCE AND  
 THE ULTIMATE BASE RESISTANCE.

LENGTH (FT)	VOLUME (CU. YDS)	QS (TONS)	QB (TONS)	QU (TONS)	QBD (TONS)	QDN (TONS)	QU/VOLUME (TONS/CU. YDS)
9. 0	2. 36	3. 64	0. 00	3. 64	3. 64	1. 12	1. 54
10. 0	2. 62	7. 84	0. 00	7. 84	7. 84	2. 41	2. 99
11. 0	2. 88	12. 58	0. 00	12. 58	12. 58	3. 87	4. 37
12. 0	3. 14	17. 85	0. 00	17. 85	17. 85	5. 49	5. 68

Shaft. sf8o							
13.0	3.40	23.61	0.00	23.61	23.61	7.26	6.94
14.0	3.67	29.86	0.00	29.86	29.86	9.19	8.15
15.0	3.93	36.57	0.00	36.57	36.57	11.25	9.31
16.0	4.19	43.74	0.00	43.74	43.74	13.46	10.44
17.0	4.45	51.33	0.00	51.33	51.33	15.79	11.53
18.0	4.71	59.35	0.00	59.35	59.35	18.26	12.59
19.0	4.97	67.76	0.00	67.76	67.76	20.85	13.62
20.0	5.24	76.57	0.00	76.57	76.57	23.56	14.62
21.0	5.50	85.74	0.00	85.74	85.74	26.38	15.59
22.0	5.76	95.28	7.47	102.75	98.27	32.30	17.84
23.0	6.02	105.16	16.26	121.43	111.67	38.86	20.16
24.0	6.28	115.38	26.43	141.82	125.96	46.08	22.57
25.0	6.55	117.00	33.48	150.48	130.39	49.39	22.99
26.0	6.81	118.65	37.25	155.90	133.55	51.41	22.90
27.0	7.07	120.34	37.59	157.93	135.37	52.06	22.34
28.0	7.33	122.06	37.71	159.77	137.14	52.64	21.79
29.0	7.59	123.82	37.71	161.53	138.90	53.18	21.27
30.0	7.85	125.61	37.71	163.32	140.70	53.73	20.79

#### AXIAL LOAD VS SETTLEMENT CURVES

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#### RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1303E-01	0.1019E-04	0.3666E-03	0.1000E-04
0.6515E-01	0.5097E-04	0.1833E-02	0.5000E-04
0.1303E+00	0.1019E-03	0.3666E-02	0.1000E-03
0.6515E+01	0.5097E-02	0.1833E+00	0.5000E-02
0.9773E+01	0.7645E-02	0.2750E+00	0.7500E-02
0.1303E+02	0.1019E-01	0.3666E+00	0.1000E-01
0.3258E+02	0.2548E-01	0.9165E+00	0.2500E-01
0.6035E+02	0.5090E-01	0.1833E+01	0.5000E-01
0.8313E+02	0.7624E-01	0.2750E+01	0.7500E-01
0.9726E+02	0.1015E+00	0.3666E+01	0.1000E+00
0.1351E+03	0.2521E+00	0.9092E+01	0.2500E+00
0.1477E+03	0.5023E+00	0.1712E+02	0.5000E+00
0.1499E+03	0.6274E+00	0.1967E+02	0.6250E+00
0.1542E+03	0.9025E+00	0.2413E+02	0.9000E+00
0.1679E+03	0.1803E+01	0.3827E+02	0.1800E+01

#### RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1755E-01	0.1026E-04	0.5237E-03	0.1000E-04
0.8777E-01	0.5130E-04	0.2619E-02	0.5000E-04
0.1755E+00	0.1026E-03	0.5237E-02	0.1000E-03

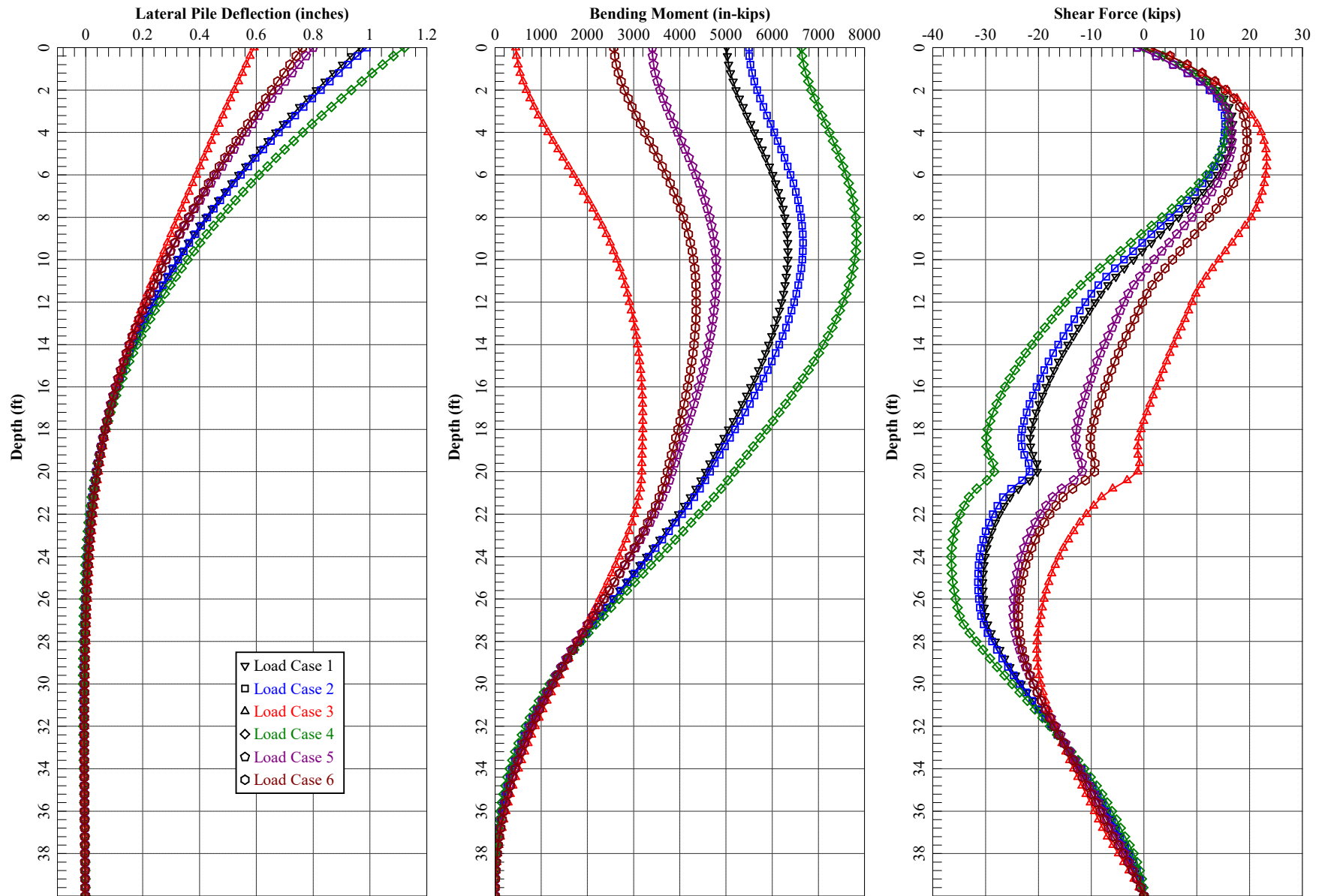
Shaft. sf8o

0. 8777E+01	0. 5130E-02	0. 2619E+00	0. 5000E-02
0. 1317E+02	0. 7695E-02	0. 3928E+00	0. 7500E-02
0. 1755E+02	0. 1026E-01	0. 5237E+00	0. 1000E-01
0. 4390E+02	0. 2565E-01	0. 1309E+01	0. 2500E-01
0. 8027E+02	0. 5119E-01	0. 2619E+01	0. 5000E-01
0. 1088E+03	0. 7662E-01	0. 3928E+01	0. 7500E-01
0. 1233E+03	0. 1018E+00	0. 5237E+01	0. 1000E+00
0. 1484E+03	0. 2523E+00	0. 1280E+02	0. 2500E+00
0. 1593E+03	0. 5026E+00	0. 2367E+02	0. 5000E+00
0. 1617E+03	0. 6276E+00	0. 2607E+02	0. 6250E+00
0. 1643E+03	0. 9027E+00	0. 2866E+02	0. 9000E+00
0. 1764E+03	0. 1803E+01	0. 4073E+02	0. 1800E+01

# RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0. 8516E-02	0. 1013E-04	0. 2095E-03	0. 1000E-04
0. 4258E-01	0. 5063E-04	0. 1047E-02	0. 5000E-04
0. 8516E-01	0. 1013E-03	0. 2095E-02	0. 1000E-03
0. 4258E+01	0. 5063E-02	0. 1047E+00	0. 5000E-02
0. 6387E+01	0. 7594E-02	0. 1571E+00	0. 7500E-02
0. 8516E+01	0. 1013E-01	0. 2095E+00	0. 1000E-01
0. 2129E+02	0. 2531E-01	0. 5237E+00	0. 2500E-01
0. 4046E+02	0. 5060E-01	0. 1047E+01	0. 5000E-01
0. 5750E+02	0. 7585E-01	0. 1571E+01	0. 7500E-01
0. 7123E+02	0. 1011E+00	0. 2095E+01	0. 1000E+00
0. 1218E+03	0. 2518E+00	0. 5384E+01	0. 2500E+00
0. 1361E+03	0. 5021E+00	0. 1056E+02	0. 5000E+00
0. 1380E+03	0. 6271E+00	0. 1327E+02	0. 6250E+00
0. 1441E+03	0. 9023E+00	0. 1961E+02	0. 9000E+00
0. 1595E+03	0. 1803E+01	0. 3582E+02	0. 1800E+01

VRE Rolling Road Station Platform Extension - 3-Foot Dia. Shaft with Casing



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LPile for Windows, Version 2016-09.008

Analysis of Individual Piles and Drilled Shafts  
Subjected to Lateral Loading Using the p-y Method  
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Files Used for Analysis

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Path to file locations:

\\dcmetrowest1\Data\Projects\2018\JD185036\Working Files\Calculations-Analyses\Rolling Road Shaft Analysis\

Name of input data file:

Lpile Run 3 ft shaft.lp9d

Name of output report file:

Lpile Run 3 ft shaft.lp9o

Name of plot output file:

Lpile Run 3 ft shaft.lp9p

Name of runtime message file:

Lpile Run 3 ft shaft.lp9r

-----

Date and Time of Analysis

-----

Date: February 6, 2018

Time: 7:20:19

-----  
Problem Title  
-----

Project Name: Rolling Road Platform

Job Number: JD185036

Client: Dewberry

Engineer: FM

Description: Drilled Shafts

-----  
Program Options and Settings  
-----

Computational Options:

- Use unfactored loads in computations (conventional analysis)

Engineering Units Used for Data Input and Computations:

- US Customary System Units (pounds, feet, inches)

Analysis Control Options:

- Maximum number of iterations allowed	=	500
- Deflection tolerance for convergence	=	1.0000E-05 in
- Maximum allowable deflection	=	100.0000 in
- Number of pile increments	=	100

Loading Type and Number of Cycles of Loading:

- Static loading specified

- Use of p-y modification factors for p-y curves not selected
- Analysis includes loading by one distributed lateral load acting on pile
- Loading by lateral soil movements acting on pile not selected
- Input of shear resistance at the pile tip not selected
- Computation of pile-head foundation stiffness matrix not selected
- Push-over analysis of pile not selected
- Buckling analysis of pile not selected

Output Options:

- Output files use decimal points to denote decimal symbols.
- Values of pile-head deflection, bending moment, shear force, and soil reaction are printed for full length of pile.
- Printing Increment (nodal spacing of output points) = 1
- No p-y curves to be computed and reported for user-specified depths
- Print using wide report formats



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 Pile Structural Properties and Geometry
 

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Number of pile sections defined = 1  
 Total length of pile = 40.000 ft  
 Depth of ground surface below top of pile = 0.0000 ft

Pile diameters used for p-y curve computations are defined using 2 points.

p-y curves are computed using pile diameter values interpolated with depth over the length of the pile. A summary of values of pile diameter vs. depth follows.

Point No.	Depth Below Pile Head feet	Pile Diameter inches
1	0.000	36.0000
2	40.000	36.0000

---

 Input Structural Properties for Pile Sections:
 

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Pile Section No. 1:

Section 1 is a drilled shaft with permanent casing  
 Length of section = 40.000000 ft  
 Casing outside diameter = 36.000000 in  
 Shear capacity of section = 0.0000 lbs

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 Ground Slope and Pile Batter Angles
 

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Ground Slope Angle = 0.000 degrees  
 = 0.000 radians  
 Pile Batter Angle = 0.000 degrees  
 = 0.000 radians

---

 Soil and Rock Layering Information
 

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The soil profile is modelled using 6 layers

Layer 1 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 0.0000 ft

		Lpile Run 3 ft shaft.lp9o
Distance from top of pile to bottom of layer	=	4.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	30.000000 deg.
Friction angle at bottom of layer	=	30.000000 deg.
Subgrade k at top of layer	=	30.000000 pci
Subgrade k at bottom of layer	=	30.000000 pci

Layer 2 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	4.000000 ft
Distance from top of pile to bottom of layer	=	8.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	28.000000 deg.
Friction angle at bottom of layer	=	28.000000 deg.
Subgrade k at top of layer	=	30.000000 pci
Subgrade k at bottom of layer	=	30.000000 pci

Layer 3 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	8.000000 ft
Distance from top of pile to bottom of layer	=	21.000000 ft
Effective unit weight at top of layer	=	120.000000 pcf
Effective unit weight at bottom of layer	=	120.000000 pcf
Friction angle at top of layer	=	28.000000 deg.
Friction angle at bottom of layer	=	28.000000 deg.
Subgrade k at top of layer	=	60.000000 pci
Subgrade k at bottom of layer	=	60.000000 pci

Layer 4 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	21.000000 ft
Distance from top of pile to bottom of layer	=	27.000000 ft
Effective unit weight at top of layer	=	57.600000 pcf
Effective unit weight at bottom of layer	=	57.600000 pcf
Friction angle at top of layer	=	28.000000 deg.
Friction angle at bottom of layer	=	28.000000 deg.
Subgrade k at top of layer	=	40.000000 pci
Subgrade k at bottom of layer	=	40.000000 pci

Layer 5 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer	=	27.000000 ft
Distance from top of pile to bottom of layer	=	37.000000 ft
Effective unit weight at top of layer	=	62.600000 pcf
Effective unit weight at bottom of layer	=	62.600000 pcf
Friction angle at top of layer	=	32.000000 deg.
Friction angle at bottom of layer	=	32.000000 deg.
Subgrade k at top of layer	=	90.000000 pci

Subgrade k at bottom of layer = Lpile Run 3 ft shaft.1p9o  
90.000000 pci

Layer 6 is sand, p-y criteria by Reese et al., 1974

Distance from top of pile to top of layer = 37.000000 ft  
Distance from top of pile to bottom of layer = 53.000000 ft  
Effective unit weight at top of layer = 67.600000 pcf  
Effective unit weight at bottom of layer = 67.600000 pcf  
Friction angle at top of layer = 34.000000 deg.  
Friction angle at bottom of layer = 34.000000 deg.  
Subgrade k at top of layer = 125.000000 pci  
Subgrade k at bottom of layer = 125.000000 pci

(Depth of the lowest soil layer extends 13.000 ft below the pile tip)

#### Summary of Input Soil Properties

Layer Layer Num.	Soil Type Name (p-y Curve Type)	Layer Depth ft	Effective Unit Wt. pcf	Angle of Friction deg.	kpy pci
1	Sand (Reese, et al.)	0.00 4.0000	120.0000 120.0000	30.0000 30.0000	30.0000 30.0000
2	Sand (Reese, et al.)	4.0000 8.0000	120.0000 120.0000	28.0000 28.0000	30.0000 30.0000
3	Sand (Reese, et al.)	8.0000 21.0000	120.0000 120.0000	28.0000 28.0000	60.0000 60.0000
4	Sand (Reese, et al.)	21.0000 27.0000	57.6000 57.6000	28.0000 28.0000	40.0000 40.0000
5	Sand (Reese, et al.)	27.0000 37.0000	62.6000 62.6000	32.0000 32.0000	90.0000 90.0000
6	Sand (Reese, et al.)	37.0000 53.0000	67.6000 67.6000	34.0000 34.0000	125.0000 125.0000

#### Static Loading Type

Static loading criteria were used when computing p-y curves for all analyses.

#### Distributed Lateral Loading Used For All Load Cases

Distributed lateral load intensity defined using 2 points

Lpile Run 3 ft shaft.lp9o

Point No.	Depth X in	Dist. Load lb/in
1	0.000	791.700
2	240.000	791.700

-----  
Pile-head Loading and Pile-head Fixity Conditions  
-----

Number of Loads specified = 6

Load No.	Load Type	Condition 1	Condition 2	Axial Thrust Force, lbs	Compute Top y vs. Pile Length
1	1	V = 0.0000 lbs	M = 5014935. in-lbs	104000.	Yes
2	1	V = -1300. lbs	M = 5497571. in-lbs	116000.	Yes
3	1	V = 1300. lbs	M = 449695. in-lbs	-8000.	Yes
4	1	V = 0.0000 lbs	M = 6634768. in-lbs	135000.	Yes
5	1	V = -1300. lbs	M = 3405399. in-lbs	71000.	Yes
6	1	V = 1300. lbs	M = 2571372. in-lbs	56000.	Yes

V = shear force applied normal to pile axis

M = bending moment applied to pile head

y = lateral deflection normal to pile axis

S = pile slope relative to original pile batter angle

R = rotational stiffness applied to pile head

Values of top y vs. pile lengths can be computed only for load types with specified shear loading (Load Types 1, 2, and 3).

Thrust force is assumed to be acting axially for all pile batter angles.

-----  
Computations of Nominal Moment Capacity and Nonlinear Bending Stiffness  
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Axial thrust force values were determined from pile-head loading conditions

Number of Pile Sections Analyzed = 1

Pile Section No. 1:

-----  
Dimensions and Properties of Drilled Shaft (Bored Pile) with Permanent Casing:  
-----

Length of Section	=	40.000000 ft
Outer Diameter of Casing	=	36.000000 in
Concrete Cover Thickness Inside Casing	=	3.000000 in

Lpile Run 3 ft shaft.lp9o

Casing Wall Thickness	=	0.250000 in
Moment of Inertia of Steel Casing	=	4486. in^4
Yield Stress of Casing	=	36000. psi
Elastic Modulus of Casing	=	29000000. psi
Number of Reinforcing Bars	=	6 bars
Area of Single Reinforcing Bar	=	0.790000 sq. in.
Edge-to-Edge Bar Spacing	=	13.250000 in
Maximum Concrete Aggregate Size	=	0.750000 in
Ratio of Bar Spacing to Aggregate Size	=	17.67
Offset of Center of Rebar Cage from Center of Pile	=	0.0000 in
Yield Stress of Reinforcing Bars	=	60000. psi
Modulus of Elasticity of Reinforcing Bars	=	29000000. psi
Gross Area of Pile	=	1018. sq. in.
Area of Concrete	=	985.058035 sq. in.
Cross-sectional Area of Steel Casing	=	28.077984 sq. in.
Area of All Steel (Casing and Bars)	=	32.817984 sq. in.
Area Ratio of All Steel to Gross Area of Pile	=	3.22 percent

#### Axial Structural Capacities:

-----

Nom. Axial Structural Capacity = $0.85 F_c A_c + F_y A_s$	=	4644.405 kips
Tensile Load for Cracking of Concrete	=	-519.495 kips
Nominal Axial Tensile Capacity	=	-1295.207 kips

#### Reinforcing Bar Dimensions and Positions Used in Computations:

Bar Number	Bar Diam. inches	Bar Area sq. in.	X inches	Y inches
1	1.000000	0.790000	14.250000	0.000000
2	1.000000	0.790000	7.125000	12.340862
3	1.000000	0.790000	-7.125000	12.340862
4	1.000000	0.790000	-14.250000	0.000000
5	1.000000	0.790000	-7.125000	-12.340862
6	1.000000	0.790000	7.125000	-12.340862

NOTE: The positions of the above rebars were computed by LPile

Minimum spacing between any two bars not equal to zero = 13.250 inches  
between bars 5 and 6.

#### Concrete Properties:

-----

Compressive Strength of Concrete	=	4000. psi
Modulus of Elasticity of Concrete	=	3604997. psi
Modulus of Rupture of Concrete	=	-474.341649 psi
Compression Strain at Peak Stress	=	0.001886
Tensile Strain at Fracture of Concrete	=	-0.0001154
Maximum Coarse Aggregate Size	=	0.0000 in

Lpile Run 3 ft shaft.lp9o

Number of Axial Thrust Force Values Determined from Pile-head Loadings = 6

Number	Axial Thrust Force kips
-----	-----
1	-8.000
2	56.000
3	71.000
4	104.000
5	116.000
6	135.000

Definitions of Run Messages and Notes:

-----

C = concrete in section has cracked in tension.  
Y = stress in reinforcing steel has reached yield stress.  
T = ACI 318 criteria for tension-controlled section met, tensile strain in reinforcement exceeds 0.005 while simultaneously compressive strain in concrete more than 0.003. See ACI 318, Section 10.3.4.  
Z = depth of tensile zone in concrete section is less than 10 percent of section depth.

Bending Stiffness (EI) = Computed Bending Moment / Curvature.  
Position of neutral axis is measured from edge of compression side of pile.  
Compressive stresses and strains are positive in sign.  
Tensile stresses and strains are negative in sign.

Axial Thrust Force = -8.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6.25000E-07	295.0122744	472019639.	15.4995453	0.00000969	-0.00001281	0.0405050	-0.3683082	-0.3683082	
0.00000125	589.2240656	471379252.	16.7472518	0.00002093	-0.00002407	0.0873486	-0.6913871	-0.6913871	
0.00000188	882.6156065	470728323.	17.1631415	0.00003218	-0.00003532	0.1339133	-1.0144667	-1.0144667	
0.00000250	1175.	470074738.	17.3710802	0.00004343	-0.00004657	0.1801993	-1.3375467	-1.3375467	
0.00000313	1467.	469420087.	17.4958387	0.00005467	-0.00005783	0.2262065	-1.6606271	-1.6606271	
0.00000375	1758.	468764904.	17.5790075	0.00006592	-0.00006908	0.2719348	-1.9837079	-1.9837079	
0.00000438	2048.	468109417.	17.6384107	0.00007717	-0.00008033	0.3173844	-2.3067891	-2.3067891	
0.00000500	2337.	467453739.	17.6829604	0.00008841	-0.00009159	0.3625551	-2.6298707	-2.6298707	
0.00000563	2626.	466797934.	17.7176078	0.00009966	-0.0001028	0.4074471	-2.9529527	-2.9529527	
0.00000625	2913.	466142040.	17.7453235	0.0001109	-0.0001141	0.4520603	-3.2760351	-3.2760351	
0.00000688	2913.	423765491.	11.4082407	0.00007843	-0.0001691	0.3206945	-4.8670946	-4.8670946	C
0.00000750	2913.	388451700.	11.4577789	0.00008593	-0.0001841	0.3506895	-5.2987831	-5.2987831	C
0.00000813	2913.	358570800.	11.5001905	0.00009344	-0.0001991	0.3805778	-5.7303551	-5.7303551	C
0.00000875	2913.	332958600.	11.5370040	0.0001009	-0.0002141	0.4103595	-6.1618102	-6.1618102	C
0.00000938	2913.	310761360.	11.5693401	0.0001085	-0.0002290	0.4400343	-6.5931481	-6.5931481	C
0.00001000	2913.	291338775.	11.5980397	0.0001160	-0.0002440	0.4696021	-7.0243685	-7.0243685	C

Lpile Run 3 ft shaft. lp9o									
0.00001063	2913.	274201200.	11.6237454	0.0001235	-0.0002590	0.4990627	-7.4554709	-7.4554709	C
0.00001125	2913.	258967800.	11.6469573	0.0001310	-0.0002740	0.5284160	-7.8864555	-7.8864555	C
0.00001188	2913.	245337916.	11.6680701	0.0001386	-0.0002889	0.5576618	-8.3173211	-8.3173211	C
0.00001250	2913.	233071020.	11.6873996	0.0001461	-0.0003039	0.5867999	-8.7480679	-8.7480679	C
0.00001313	2913.	221972400.	11.7050761	0.0001536	-0.0003189	0.6158239	-9.1787429	-9.1787429	C
0.00001375	2940.	213816605.	11.7211619	0.0001612	-0.0003338	0.6447247	-9.6094119	-9.6094119	C
0.00001438	3075.	213917137.	11.7361290	0.0001687	-0.0003488	0.6735172	-10.0399639	-10.0399639	C
0.00001500	3210.	214004783.	11.7501179	0.0001763	-0.0003637	0.7022012	-10.4703989	-10.4703989	C
0.00001563	3345.	214081078.	11.7632468	0.0001838	-0.0003787	0.7307764	-10.9007164	-10.9007164	C
0.00001625	3480.	214147322.	11.7756157	0.0001914	-0.0003936	0.7592429	-11.3309162	-11.3309162	C
0.00001688	3615.	214204621.	11.7873096	0.0001989	-0.0004086	0.7876003	-11.7609980	-11.7609980	C
0.00001750	3749.	214253925.	11.7984016	0.0002065	-0.0004235	0.8158486	-12.1909613	-12.1909613	C
0.00001813	3884.	214296051.	11.8089545	0.0002140	-0.0004385	0.8439876	-12.6208059	-12.6208059	C
0.00001875	4019.	214331708.	11.8190229	0.0002216	-0.0004534	0.8720170	-13.0505314	-13.0505314	C
0.00001938	4153.	214361514.	11.8286542	0.0002292	-0.0004683	0.8999369	-13.4801375	-13.4801375	C
0.00002000	4288.	214386008.	11.8378901	0.0002368	-0.0004832	0.9277469	-13.9096238	-13.9096238	C
0.00002063	4422.	214405665.	11.8467671	0.0002443	-0.0004982	0.9554469	-14.3389900	-14.3389900	C
0.00002125	4556.	214420904.	11.8553173	0.0002519	-0.0005131	0.9830368	-14.7682358	-14.7682358	C
0.00002188	4691.	214432095.	11.8635694	0.0002595	-0.0005280	1.0105164	-15.1973607	-15.1973607	C
0.00002250	4825.	214439569.	11.8715487	0.0002671	-0.0005429	1.0378855	-15.6263645	-15.6263645	C
0.00002313	4959.	214443618.	11.8792779	0.0002747	-0.0005578	1.0651440	-16.0552468	-16.0552468	C
0.00002375	5093.	214444507.	11.8867772	0.0002823	-0.0005727	1.0922916	-16.4840073	-16.4840073	C
0.00002438	5227.	214442471.	11.8940648	0.0002899	-0.0005876	1.1193283	-16.9126455	-16.9126455	C
0.00002563	5495.	214430444.	11.9080689	0.0003051	-0.0006174	1.1730680	-17.7695543	-17.7695543	C
0.00002688	5762.	214409017.	11.9214030	0.0003204	-0.0006471	1.2263619	-18.6259695	-18.6259695	C
0.00002813	6029.	214379386.	11.9341601	0.0003356	-0.0006769	1.2792084	-19.4818887	-19.4818887	C
0.00002938	6296.	214342548.	11.9464172	0.0003509	-0.0007066	1.3316062	-20.3373088	-20.3373088	C
0.00003063	6563.	214299337.	11.9582389	0.0003662	-0.0007363	1.3835540	-21.1922270	-21.1922270	C
0.00003188	6829.	214250458.	11.9696798	0.0003815	-0.0007660	1.4350502	-22.0466403	-22.0466403	C
0.00003313	7095.	214196506.	11.9807859	0.0003969	-0.0007956	1.4860935	-22.9005455	-22.9005455	C
0.00003438	7361.	214137992.	11.9915971	0.0004122	-0.0008253	1.5366825	-23.7539397	-23.7539397	C
0.00003563	7626.	214075351.	12.0021472	0.0004276	-0.0008549	1.5868156	-24.6068197	-24.6068197	C
0.00003688	7892.	214008963.	12.0124658	0.0004430	-0.0008845	1.6364916	-25.4591824	-25.4591824	C
0.00003813	8156.	213939155.	12.0225785	0.0004584	-0.0009141	1.6857087	-26.3110247	-26.3110247	C
0.00003938	8421.	213866212.	12.0325078	0.0004738	-0.0009437	1.7344657	-27.1623433	-27.1623433	C
0.00004063	8685.	213790386.	12.0422732	0.0004892	-0.0009733	1.7827610	-28.0131350	-28.0131350	C
0.00004188	8949.	213711894.	12.0518922	0.0005047	-0.0010028	1.8305930	-28.8633965	-28.8633965	C
0.00004313	9213.	213630963.	12.0613459	0.0005201	-0.0010324	1.8779558	-29.7131667	-29.7131667	C
0.00004438	9476.	213547856.	12.0704832	0.0005356	-0.0010619	1.9248250	-30.5626601	-30.5626601	C
0.00004563	9739.	213462623.	12.0795171	0.0005511	-0.0010914	1.9712256	-31.4116271	-31.4116271	C
0.00004688	10002.	213375392.	12.0884582	0.0005666	-0.0011209	2.0171561	-32.2600654	-32.2600654	C
0.00004813	10264.	213286285.	12.0973160	0.0005822	-0.0011503	2.0626148	-33.1079715	-33.1079715	C
0.00004938	10527.	213195410.	12.1060993	0.0005977	-0.0011798	2.1076002	-33.9553423	-33.9553423	C
0.00005063	10788.	213102865.	12.1148158	0.0006133	-0.0012092	2.1521108	-34.8021743	-34.8021743	C
0.00005188	11050.	213008739.	12.1234727	0.0006289	-0.0012386	2.1961449	-35.6484641	-35.6484641	C
0.00005313	11294.	212595617.	12.1253464	0.0006442	-0.0012683	2.2386950	-36.5045755	-36.0000000	CY
0.00005438	11506.	211604360.	12.1147397	0.0006587	-0.0012988	2.2788627	-37.3802321	-36.0000000	CY
0.00005563	11701.	210361812.	12.0984524	0.0006730	-0.0013295	2.3176252	-38.2658213	-36.0000000	CY
0.00005688	11883.	208927412.	12.0776380	0.0006869	-0.0013606	2.3551352	-39.1600581	-36.0000000	CY
0.00005813	12054.	207377317.	12.0537502	0.0007006	-0.0013919	2.3916021	-40.0609847	-36.0000000	CY
0.00005938	12216.	205747020.	12.0271691	0.0007141	-0.0014234	2.4270761	-40.9682805	-36.0000000	CY
0.00006063	12370.	204040513.	11.9983795	0.0007274	-0.0014551	2.4616277	-41.8813864	-36.0000000	CY
0.00006188	12517.	202297604.	11.9683178	0.0007405	-0.0014870	2.4954036	-42.7988621	-36.0000000	CY
0.00006313	12658.	200530053.	11.9372463	0.0007535	-0.0015190	2.5284473	-43.7203658	-36.0000000	CY

Lpile Run 3 ft shaft. lp9o									
0.00006438	12794.	198747464.	11.9053838	0.0007664	-0.0015511	2.5607970	-44.6455989	-36.0000000	CY
0.00006563	12925.	196957753.	11.8729152	0.0007792	-0.0015833	2.5924867	-45.5742955	-36.0000000	CY
0.00006688	13052.	195164926.	11.8399256	0.0007918	-0.0016157	2.6235350	-46.5063566	-36.0000000	CY
0.00006813	13174.	193377720.	11.8066409	0.0008043	-0.0016482	2.6539846	-47.4413924	-36.0000000	CY
0.00006938	13292.	191601813.	11.7732123	0.0008168	-0.0016807	2.6838670	-48.3791307	-36.0000000	CY
0.00007063	13408.	189840775.	11.7397379	0.0008291	-0.0017134	2.7132051	-49.3193866	-36.0000000	CY
0.00007188	13520.	188097599.	11.7063039	0.0008414	-0.0017461	2.7420204	-50.2619851	-36.0000000	CY
0.00007313	13628.	186368463.	11.6720360	0.0008535	-0.0017790	2.7701695	-51.2087759	-36.0000000	CY
0.00007438	13734.	184659702.	11.6377070	0.0008656	-0.0018119	2.7977903	-52.1581829	-36.0000000	CY
0.00007938	14134.	178070796.	11.5030255	0.0009131	-0.0019444	2.9036957	-55.9746354	-36.0000000	CY
0.00008438	14503.	171891706.	11.3735676	0.0009596	-0.0020779	3.0028011	-59.8173639	-36.0000000	CY
0.00008938	14847.	166115935.	11.2472400	0.0010052	-0.0022123	3.0951664	-60.0000000	-36.0000000	CY
0.00009438	15170.	160745368.	11.1268391	0.0010501	-0.0023474	3.1816938	-60.0000000	-36.0000000	CY
0.00009938	15478.	155749786.	11.0130974	0.0010944	-0.0024831	3.2628866	-60.0000000	-36.0000000	CY
0.0001044	15770.	151089157.	10.9031701	0.0011380	-0.0026195	3.3385639	-60.0000000	-36.0000000	CY
0.0001094	15981.	146113136.	10.7776354	0.0011788	-0.0027587	3.4055638	-60.0000000	-36.0000000	CY
0.0001144	16140.	141117268.	10.6472675	0.0012178	-0.0028997	3.4661889	-60.0000000	-36.0000000	CY
0.0001194	16289.	136451629.	10.5211009	0.0012560	-0.0030415	3.5223792	-60.0000000	-36.0000000	CY
0.0001244	16420.	132020895.	10.4097648	0.0012947	-0.0031828	3.5762505	-60.0000000	36.0000000	CY
0.0001294	16538.	127831842.	10.3102441	0.0013339	-0.0033236	3.6274369	-60.0000000	36.0000000	CY
0.0001344	16646.	123878696.	10.2180076	0.0013730	-0.0034645	3.6753098	-60.0000000	36.0000000	CY
0.0001394	16746.	120148287.	10.1316376	0.0014121	-0.0036054	3.7197744	-60.0000000	36.0000000	CY
0.0001444	16838.	116627804.	10.0526405	0.0014513	-0.0037462	3.7611743	-60.0000000	36.0000000	CY
0.0001494	16926.	113310389.	9.97789101	0.0014906	-0.0038869	3.7992637	-60.0000000	36.0000000	CY
0.0001544	17008.	110173229.	9.9110252	0.0015300	-0.0040275	3.8341889	-60.0000000	36.0000000	CY
0.0001594	17086.	107203332.	9.8449807	0.0015690	-0.0041685	3.8654791	-60.0000000	36.0000000	CY
0.0001644	17159.	104389600.	9.7831148	0.0016081	-0.0043094	3.8935188	-60.0000000	36.0000000	CY
0.0001694	17230.	101724732.	9.7251392	0.0016472	-0.0044503	3.9183094	-60.0000000	36.0000000	CY
0.0001744	17297.	99192418.	9.6711910	0.0016864	-0.0045911	3.9398834	-60.0000000	36.0000000	CY
0.0001794	17361.	96788660.	9.6198542	0.0017256	-0.0047319	3.9581252	-60.0000000	36.0000000	CY
0.0001844	17423.	94499213.	9.5728824	0.0017650	-0.0048725	3.9731791	-60.0000000	36.0000000	CY
0.0001894	17483.	92319636.	9.5275732	0.0018043	-0.0050132	3.9848531	-60.0000000	36.0000000	CY
0.0001944	17540.	90238418.	9.4830333	0.0018433	-0.0051542	3.9931613	-60.0000000	36.0000000	CY
0.0001994	17595.	88252259.	9.4420392	0.0018825	-0.0052950	3.9982324	-60.0000000	36.0000000	CY
0.0002044	17648.	86352799.	9.4025872	0.0019217	-0.0054358	3.9999978	-60.0000000	36.0000000	CY
0.0002094	17701.	84539865.	9.3658541	0.0019610	-0.0055765	3.9983459	-60.0000000	36.0000000	CY
0.0002144	17750.	82798556.	9.3314235	0.0020004	-0.0057171	3.9999971	-60.0000000	36.0000000	CY
0.0002194	17799.	81133071.	9.2994054	0.0020401	-0.0058574	3.9978579	-60.0000000	36.0000000	CY
0.0002244	17845.	79531913.	9.2682753	0.0020796	-0.0059979	3.9999161	-60.0000000	36.0000000	CY
0.0002294	17888.	77987246.	9.2387624	0.0021191	-0.0061384	3.9964565	60.0000000	36.0000000	CY
0.0002344	17924.	76473727.	9.2074126	0.0021580	-0.0062795	3.9993741	60.0000000	36.0000000	CY
0.0002394	17954.	75003077.	9.1751429	0.0021963	-0.0064212	3.9973612	60.0000000	36.0000000	CY
0.0002444	17973.	73546953.	9.1369243	0.0022328	-0.0065647	3.9972651	60.0000000	36.0000000	CY
0.0002494	17990.	72140532.	9.0991567	0.0022691	-0.0067084	3.9994968	60.0000000	36.0000000	CY
0.0002544	18005.	70781533.	9.0630911	0.0023054	-0.0068521	3.9977848	60.0000000	36.0000000	CY
0.0002594	18019.	69471217.	9.0288691	0.0023419	-0.0069956	3.9962220	60.0000000	36.0000000	CY
0.0002644	18032.	68206770.	8.9956190	0.0023782	-0.0071393	3.9988833	60.0000000	36.0000000	CY
0.0002694	18045.	66988414.	8.9639804	0.0024147	-0.0072828	3.9999723	60.0000000	36.0000000	CY
0.0002744	18057.	65811549.	8.9337033	0.0024512	-0.0074263	3.9933131	60.0000000	36.0000000	CY
0.0003044	18116.	59517286.	8.7727627	0.0026702	-0.0082873	3.9983874	60.0000000	36.0000000	CY
0.0003344	18156.	54299729.	8.6373214	0.0028881	-0.0091494	3.9994874	60.0000000	36.0000000	CY
0.0003644	18186.	49909909.	8.5288244	0.0031077	-0.0100098	3.9993117	60.0000000	36.0000000	CY
0.0003944	18207.	46166895.	8.4384024	0.0033279	-0.0108696	3.9972882	60.0000000	36.0000000	CY
0.0004244	18221.	42935872.	8.3576925	0.0035468	-0.0117307	3.9895553	60.0000000	36.0000000	CY



Lpile Run 3 ft shaft.lp9o

0.0004544	18231.	40122415.	8.2887929	0.0037662	-0.0125913	3.9999985	60.0000000	36.0000000	CY
0.0004844	18231.	37637414.	8.2375057	0.0039900	-0.0134475	3.9935207	60.0000000	36.0000000	CY

Axial Thrust Force = 56.000 kips

Bendi ng Curvature rad/in.	Bendi ng Moment in-kip	Bendi ng Sti ffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6.25000E-07	294.2480761	470796922.	35.5195780	0.00002220	-3.00264E-07	0.0931273	0.6405299	0.6405299	
0.00000125	588.2992479	470639398.	26.7737422	0.00003347	-0.00001153	0.1397435	0.9640232	0.9640232	
0.00000188	881.6543242	470215640.	23.8601903	0.00004474	-0.00002276	0.1860933	1.2876104	1.2876104	
0.00000250	1174.	469683976.	22.4037977	0.00005601	-0.00003399	0.2321671	1.6112253	1.6112253	
0.00000313	1466.	469104447.	21.5301047	0.00006728	-0.00004522	0.2779627	1.9348532	1.9348532	
0.00000375	1757.	468499994.	20.9477150	0.00007855	-0.00005645	0.3234794	2.2584890	2.2584890	
0.00000438	2047.	467881001.	20.5317671	0.00008983	-0.00006767	0.3687169	2.5821305	2.5821305	
0.00000500	2336.	467252814.	20.2198379	0.0001011	-0.00007890	0.4136750	2.9057765	2.9057765	
0.00000563	2625.	466618450.	19.9772506	0.0001124	-0.00009013	0.4583536	3.2294265	3.2294265	
0.00000625	2912.	465979741.	19.7832009	0.0001236	-0.0001014	0.5027526	3.5530802	3.5530802	
0.00000688	3199.	465337860.	19.6244501	0.0001349	-0.0001126	0.5468720	3.8767373	3.8767373	
0.00000750	3199.	426559705.	15.1426370	0.0001136	-0.0001564	0.4617858	-4.4973264	-4.4973264	C
0.00000813	3199.	393747420.	14.9245170	0.0001213	-0.0001712	0.4919544	-4.9234982	-4.9234982	C
0.00000875	3199.	365622604.	14.7342891	0.0001289	-0.0001861	0.5218808	-5.3504991	-5.3504991	C
0.00000938	3199.	341247764.	14.5695915	0.0001366	-0.0002009	0.5516851	-5.7774548	-5.7774548	C
0.00001000	3199.	319919779.	14.4229285	0.0001442	-0.0002158	0.5812611	-6.2051507	-6.2051507	C
0.00001063	3199.	301100968.	14.2938635	0.0001519	-0.0002306	0.6107239	-6.6327408	-6.6327408	C
0.00001125	3199.	284373137.	14.1785699	0.0001595	-0.0002455	0.6400344	-7.0605165	-7.0605165	C
0.00001188	3199.	269406129.	14.0742661	0.0001671	-0.0002604	0.6691649	-7.4886871	-7.4886871	C
0.00001250	3199.	255935823.	13.9806884	0.0001748	-0.0002752	0.6981828	-7.9167504	-7.9167504	C
0.00001313	3199.	243748403.	13.8963051	0.0001824	-0.0002901	0.7270879	-8.3447063	-8.3447063	C
0.00001375	3317.	241233288.	13.8189587	0.0001900	-0.0003050	0.7558327	-8.7729152	-8.7729152	C
0.00001438	3452.	240121865.	13.7478533	0.0001976	-0.0003199	0.7844242	-9.2013261	-9.2013261	C
0.00001500	3586.	239098350.	13.6829244	0.0002052	-0.0003348	0.8129034	-9.6296279	-9.6296279	C
0.00001563	3721.	238152185.	13.6234312	0.0002129	-0.0003496	0.8412701	-10.0578202	-10.0578202	C
0.00001625	3856.	237274435.	13.5687473	0.0002205	-0.0003645	0.8695242	-10.4859028	-10.4859028	C
0.00001688	3990.	236457488.	13.5183389	0.0002281	-0.0003794	0.8976656	-10.9138754	-10.9138754	C
0.00001750	4125.	235692876.	13.4710972	0.0002357	-0.0003943	0.9256517	-11.3420681	-11.3420681	C
0.00001813	4259.	234975916.	13.4269336	0.0002434	-0.0004091	0.9534989	-11.7703555	-11.7703555	C
0.00001875	4393.	234302973.	13.3859205	0.0002510	-0.0004240	0.9812336	-12.1985306	-12.1985306	C
0.00001938	4527.	233669781.	13.3477538	0.0002586	-0.0004389	1.0088558	-12.6265933	-12.6265933	C
0.00002000	4661.	233072605.	13.3121670	0.0002662	-0.0004538	1.0363652	-13.0545431	-13.0545431	C
0.00002063	4795.	232508161.	13.2789262	0.0002739	-0.0004686	1.0637617	-13.4823797	-13.4823797	C
0.00002125	4929.	231973555.	13.2478247	0.0002815	-0.0004835	1.0910451	-13.9101030	-13.9101030	C
0.00002188	5063.	231466221.	13.2186798	0.0002892	-0.0004983	1.1182153	-14.3377125	-14.3377125	C
0.00002250	5197.	230983879.	13.1913287	0.0002968	-0.0005132	1.1452721	-14.7652079	-14.7652079	C
0.00002313	5331.	230524495.	13.1656267	0.0003045	-0.0005280	1.1722154	-15.1925891	-15.1925891	C
0.00002375	5465.	230086250.	13.1414438	0.0003121	-0.0005429	1.1990449	-15.6198555	-15.6198555	C
0.00002438	5598.	229666504.	13.1181582	0.0003198	-0.0005577	1.2257170	-16.0473643	-16.0473643	C
0.00002563	5865.	228879879.	13.0754050	0.0003351	-0.0005874	1.2787152	-16.9020771	-16.9020771	C
0.00002688	6132.	228155665.	13.0372336	0.0003504	-0.0006171	1.3312586	-17.7563185	-17.7563185	C
0.00002813	6398.	227485490.	13.0030363	0.0003657	-0.0006468	1.3833459	-18.6100860	-18.6100860	C
0.00002938	6664.	226862408.	12.9723088	0.0003811	-0.0006764	1.4349756	-19.4633769	-19.4633769	C
0.00003063	6930.	226280606.	12.9446294	0.0003964	-0.0007061	1.4861465	-20.3161885	-20.3161885	C

Lpile Run 3 ft shaft. Ip9o

0.00003188	7195.	225735182.	12. 9196423	0.0004118	-0.0007357	1.5368571	-21.1685181	-21.1685181 C
0.00003313	7460.	225221974.	12. 8970456	0.0004272	-0.0007653	1.5871061	-22.0203630	-22.0203630 C
0.00003438	7725.	224737425.	12. 8765814	0.0004426	-0.0007949	1.6368920	-22.8717203	-22.8717203 C
0.00003563	7990.	224278477.	12. 8580278	0.0004581	-0.0008244	1.6862134	-23.7225874	-23.7225874 C
0.00003688	8254.	223842485.	12. 8411932	0.0004735	-0.0008540	1.7350690	-24.5729614	-24.5729614 C
0.00003813	8518.	223427152.	12. 8259111	0.0004890	-0.0008835	1.7834573	-25.4228394	-25.4228394 C
0.00003938	8782.	223030472.	12. 8120362	0.0005045	-0.0009130	1.8313768	-26.2722185	-26.2722185 C
0.00004063	9045.	222650686.	12. 7994410	0.0005200	-0.0009425	1.8788261	-27.1210959	-27.1210959 C
0.00004188	9308.	222286231.	12. 7880135	0.0005355	-0.0009720	1.9258035	-27.9694696	-27.9694696 C
0.00004313	9571.	221935729.	12. 7775961	0.0005510	-0.0010015	1.9723005	-28.8174063	-28.8174063 C
0.00004438	9833.	221597844.	12. 7679840	0.0005666	-0.0010309	2.0182990	-29.6650638	-29.6650638 C
0.00004563	10096.	221271671.	12. 7592956	0.0005821	-0.0010604	2.0638234	-30.5121951	-30.5121951 C
0.00004688	10357.	220956228.	12. 7514594	0.0005977	-0.0010898	2.1088720	-31.3587979	-31.3587979 C
0.00004813	10619.	220650644.	12. 7444113	0.0006133	-0.0011192	2.1534431	-32.2048689	-32.2048689 C
0.00004938	10880.	220354138.	12. 7380937	0.0006289	-0.0011486	2.1975352	-33.0504049	-33.0504049 C
0.00005063	11141.	220066002.	12. 7324549	0.0006446	-0.0011779	2.2411468	-33.8954024	-33.8954024 C
0.00005188	11401.	219785598.	12. 7274479	0.0006602	-0.0012073	2.2842761	-34.7398582	-34.7398582 C
0.00005313	11662.	219512349.	12. 7230305	0.0006759	-0.0012366	2.3269217	-35.5837688	-35.5837688 C
0.00005438	11907.	218978447.	12. 7135550	0.0006913	-0.0012662	2.3682556	-36.4359766	-36.0000000 CY
0.00005563	12121.	217904431.	12. 6929610	0.0007060	-0.0012965	2.4073547	-37.3068047	-36.0000000 CY
0.00005688	12317.	216559118.	12. 6667071	0.0007204	-0.0013271	2.4449923	-38.1884622	-36.0000000 CY
0.00005813	12500.	215055226.	12. 6370847	0.0007345	-0.0013580	2.4814968	-39.0777014	-36.0000000 CY
0.00005938	12672.	213420062.	12. 6045691	0.0007484	-0.0013891	2.5169328	-39.9740700	-36.0000000 CY
0.00006063	12835.	211713702.	12. 5704350	0.0007621	-0.0014204	2.5514927	-40.8756414	-36.0000000 CY
0.00006188	12991.	209955744.	12. 5350683	0.0007756	-0.0014519	2.5852375	-41.7818991	-36.0000000 CY
0.00006313	13140.	208151089.	12. 4985130	0.0007890	-0.0014835	2.6181772	-42.6928969	-36.0000000 CY
0.00006438	13282.	206322892.	12. 4612771	0.0008022	-0.0015153	2.6503959	-43.6078156	-36.0000000 CY
0.00006563	13419.	204483775.	12. 4236325	0.0008153	-0.0015472	2.6819426	-44.5262118	-36.0000000 CY
0.00006688	13551.	202637479.	12. 3847383	0.0008282	-0.0015793	2.7126888	-45.4497605	-36.0000000 CY
0.00006813	13679.	200793245.	12. 3456001	0.0008410	-0.0016115	2.7428014	-46.3766111	-36.0000000 CY
0.00006938	13803.	198956634.	12. 3064384	0.0008538	-0.0016437	2.7723239	-47.3063465	-36.0000000 CY
0.00007063	13922.	197131969.	12. 2673529	0.0008664	-0.0016761	2.8012809	-48.2387652	-36.0000000 CY
0.00007188	14039.	195322861.	12. 2284296	0.0008789	-0.0017086	2.8296948	-49.1736793	-36.0000000 CY
0.00007313	14152.	193532325.	12. 1897439	0.0008914	-0.0017411	2.8575868	-50.1109117	-36.0000000 CY
0.00007438	14262.	191762879.	12. 1513615	0.0009038	-0.0017737	2.8849763	-51.0502945	-36.0000000 CY
0.00007938	14678.	184914254.	11. 9997366	0.0009525	-0.0019050	2.9894887	-54.8312687	-36.0000000 CY
0.00008438	15058.	178468901.	11. 8525436	0.0010001	-0.0020374	3.0865454	-58.6453695	-36.0000000 CY
0.00008938	15413.	172451574.	11. 7134260	0.0010469	-0.0021706	3.1772604	-60.0000000	-36.0000000 CY
0.00009438	15745.	166837245.	11. 5787130	0.0010927	-0.0023048	3.2614558	-60.0000000	-36.0000000 CY
0.00009938	16061.	161615559.	11. 4518595	0.0011380	-0.0024395	3.3401327	-60.0000000	-36.0000000 CY
0.0001044	16361.	156756238.	11. 3325746	0.0011828	-0.0025747	3.4136027	-60.0000000	-36.0000000 CY
0.0001094	16621.	151965555.	11. 2087740	0.0012260	-0.0027115	3.4801620	-60.0000000	-36.0000000 CY
0.0001144	16790.	146794490.	11. 0707338	0.0012662	-0.0028513	3.5385929	-60.0000000	-36.0000000 CY
0.0001194	16933.	141850959.	10. 9487712	0.0013070	-0.0029905	3.5942694	-60.0000000	-36.0000000 CY
0.0001244	17061.	137171207.	10. 8367105	0.0013478	-0.0031297	3.6463825	-60.0000000	-36.0000000 CY
0.0001294	17177.	132772932.	10. 7350246	0.0013888	-0.0032687	3.6951745	-60.0000000	-36.0000000 CY
0.0001344	17285.	128634653.	10. 6413858	0.0014299	-0.0034076	3.7404155	-60.0000000	-36.0000000 CY
0.0001394	17385.	124736584.	10. 5519940	0.0014707	-0.0035468	3.7816832	-60.0000000	-36.0000000 CY
0.0001444	17478.	121058221.	10. 4691385	0.0015115	-0.0036860	3.8194255	-60.0000000	-36.0000000 CY
0.0001494	17565.	117592074.	10. 3919719	0.0015523	-0.0038252	3.8536059	-60.0000000	-36.0000000 CY
0.0001544	17648.	114319901.	10. 3201690	0.0015932	-0.0039643	3.8842440	-60.0000000	-36.0000000 CY
0.0001594	17726.	111224541.	10. 2532649	0.0016341	-0.0041034	3.9113287	-60.0000000	-36.0000000 CY
0.0001644	17800.	108290633.	10. 1877607	0.0016746	-0.0042429	3.9345712	-60.0000000	-36.0000000 CY
0.0001694	17871.	105509704.	10. 1268413	0.0017152	-0.0043823	3.9543429	-60.0000000	-36.0000000 CY

Lpile Run 3 ft shaft. l.p90								
0. 0001744	17938.	102868026.	10. 0694464	0. 0017559	-0. 0045216	3. 9705692	-60. 0000000	36. 0000000 CY
0. 0001794	18002.	100360306.	10. 0155183	0. 0017965	-0. 0046610	3. 9832603	-60. 0000000	36. 0000000 CY
0. 0001844	18064.	97973891.	9. 9657118	0. 0018374	-0. 0048001	3. 9924352	-60. 0000000	36. 0000000 CY
0. 0001894	18123.	95701330.	9. 9182835	0. 0018783	-0. 0049392	3. 9980090	-60. 0000000	36. 0000000 CY
0. 0001944	18180.	93531664.	9. 8725803	0. 0019190	-0. 0050785	3. 9999942	-60. 0000000	36. 0000000 CY
0. 0001994	18235.	91459515.	9. 8290349	0. 0019597	-0. 0052178	3. 9986797	-60. 0000000	36. 0000000 CY
0. 0002044	18287.	89478644.	9. 7874324	0. 0020003	-0. 0053572	3. 9988484	-60. 0000000	36. 0000000 CY
0. 0002094	18338.	87585371.	9. 7489455	0. 0020412	-0. 0054963	3. 9987366	-60. 0000000	36. 0000000 CY
0. 0002144	18387.	85768604.	9. 7126919	0. 0020822	-0. 0056353	3. 9990751	-60. 0000000	36. 0000000 CY
0. 0002194	18434.	84029885.	9. 6789197	0. 0021233	-0. 0057742	3. 9982574	60. 0000000	36. 0000000 CY
0. 0002244	18480.	82361429.	9. 6465392	0. 0021644	-0. 0059131	3. 9999768	60. 0000000	36. 0000000 CY
0. 0002294	18524.	80758379.	9. 6169314	0. 0022059	-0. 0060516	3. 9969631	60. 0000000	36. 0000000 CY
0. 0002344	18566.	79213327.	9. 5885003	0. 0022473	-0. 0061902	3. 9996088	60. 0000000	36. 0000000 CY
0. 0002394	18605.	77723118.	9. 5609095	0. 0022886	-0. 0063289	3. 9954275	60. 0000000	36. 0000000 CY
0. 0002444	18635.	76256089.	9. 5297410	0. 0023288	-0. 0064687	3. 9980822	60. 0000000	36. 0000000 CY
0. 0002494	18661.	74831172.	9. 4968795	0. 0023683	-0. 0066092	3. 9998448	60. 0000000	36. 0000000 CY
0. 0002544	18678.	73425590.	9. 4612530	0. 0024067	-0. 0067508	3. 9947413	60. 0000000	36. 0000000 CY
0. 0002594	18693.	72070393.	9. 4271333	0. 0024452	-0. 0068923	3. 9974049	60. 0000000	36. 0000000 CY
0. 0002644	18706.	70756452.	9. 3928644	0. 0024832	-0. 0070343	3. 9994721	60. 0000000	36. 0000000 CY
0. 0002694	18719.	69490222.	9. 3603163	0. 0025214	-0. 0071761	3. 9984867	60. 0000000	36. 0000000 CY
0. 0002744	18731.	68268372.	9. 3295036	0. 0025598	-0. 0073177	3. 9949080	60. 0000000	36. 0000000 CY
0. 0003044	18790.	61731665.	9. 1675827	0. 0027904	-0. 0081671	3. 9991636	60. 0000000	36. 0000000 CY
0. 0003344	18830.	56313287.	9. 0294380	0. 0030192	-0. 0090183	3. 9998733	60. 0000000	36. 0000000 CY
0. 0003644	18858.	51755189.	8. 9181190	0. 0032495	-0. 0098680	3. 9997775	60. 0000000	36. 0000000 CY
0. 0003944	18879.	47870034.	8. 8281485	0. 0034816	-0. 0107159	3. 9984290	60. 0000000	36. 0000000 CY
0. 0004244	18892.	44516665.	8. 7463622	0. 0037117	-0. 0115658	3. 9920257	60. 0000000	36. 0000000 CY
0. 0004544	18893.	41579701.	8. 6814797	0. 0039446	-0. 0124129	3. 9957082	60. 0000000	36. 0000000 CY

Axial Thrust Force = 71.000 kips

Bendi ng Curvature rad/in.	Bendi ng Moment in-kip	Bendi ng Sti ffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6. 25000E-07	293. 9273954	470283833.	40. 2236021	0. 00002514	0. 00000264	0. 1054407	0. 7257903	0. 7257903	
0. 00000125	587. 7812348	470224988.	29. 1271128	0. 00003641	-0. 00000859	0. 1519902	1. 0493328	1. 0493328	
0. 00000188	881. 0843122	469911633.	25. 4313641	0. 00004768	-0. 00001982	0. 1982837	1. 3730429	1. 3730429	
0. 00000250	1174.	469447754.	23. 5842251	0. 00005896	-0. 00003104	0. 2443046	1. 6968063	1. 6968063	
0. 00000313	1465.	468911954.	22. 4762068	0. 00007024	-0. 00004226	0. 2900487	2. 0205938	2. 0205938	
0. 00000375	1756.	468337670.	21. 7376555	0. 00008152	-0. 00005348	0. 3355144	2. 3443951	2. 3443951	
0. 00000438	2046.	467740642.	21. 2101933	0. 00009279	-0. 00006471	0. 3807011	2. 6682058	2. 6682058	
0. 00000500	2336.	467129120.	20. 8146465	0. 0001041	-0. 00007593	0. 4256085	2. 9920238	2. 9920238	
0. 00000563	2624.	466507818.	20. 5070359	0. 0001154	-0. 00008715	0. 4702363	3. 3158477	3. 3158477	
0. 00000625	2912.	465879613.	20. 2609765	0. 0001266	-0. 00009837	0. 5145845	3. 6396770	3. 6396770	
0. 00000688	3199.	465246356.	20. 0596791	0. 0001379	-0. 0001096	0. 5586530	3. 9635110	3. 9635110	
0. 00000750	3199.	426475826.	15. 9036224	0. 0001193	-0. 0001507	0. 4845151	-4. 3318121	-4. 3318121 C	
0. 00000813	3199.	393669993.	15. 6371003	0. 0001271	-0. 0001654	0. 5149125	-4. 7555957	-4. 7555957 C	
0. 00000875	3199.	365550708.	15. 4047896	0. 0001348	-0. 0001802	0. 5450446	-5. 1803596	-5. 1803596 C	
0. 00000938	3199.	341180661.	15. 2018321	0. 0001425	-0. 0001950	0. 5749863	-5. 6055644	-5. 6055644 C	
0. 00001000	3199.	319856870.	15. 0226932	0. 0001502	-0. 0002098	0. 6047370	-6. 0312189	-6. 0312189 C	
0. 00001063	3199.	301041760.	14. 8633738	0. 0001579	-0. 0002246	0. 6343060	-6. 4572604	-6. 4572604 C	
0. 00001125	3199.	284317217.	14. 7205163	0. 0001656	-0. 0002394	0. 6636917	-6. 8837065	-6. 8837065 C	
0. 00001188	3199.	269353153.	14. 5930059	0. 0001733	-0. 0002542	0. 6929627	-7. 3100461	-7. 3100461 C	

Lpile Run 3 ft shaft. Ip9o

0.00001250	3199.	255885496.	14. 4763328	0.0001810	-0.0002690	0.7220129	-7.7370793	-7.7370793 C
0.00001313	3269.	249036638.	14. 3707976	0.0001886	-0.0002839	0.7509363	-8.1641026	-8.1641026 C
0.00001375	3404.	247534671.	14. 2751262	0.0001963	-0.0002987	0.7797456	-8.5910184	-8.5910184 C
0.00001438	3538.	246154884.	14. 1873230	0.0002039	-0.0003136	0.8084020	-9.0181222	-9.0181222 C
0.00001500	3673.	244879957.	14. 1059658	0.0002116	-0.0003284	0.8368811	-9.4456048	-9.4456048 C
0.00001563	3808.	243702418.	14. 0313577	0.0002192	-0.0003433	0.8652467	-9.8729785	-9.8729785 C
0.00001625	3942.	242611021.	13. 9627204	0.0002269	-0.0003581	0.8934986	-10.3002429	-10.3002429 C
0.00001688	4077.	241596184.	13. 8993912	0.0002346	-0.0003729	0.9216367	-10.7273979	-10.7273979 C
0.00001750	4211.	240648042.	13. 8403661	0.0002422	-0.0003878	0.9496325	-11.1546641	-11.1546641 C
0.00001813	4346.	239758163.	13. 7847918	0.0002498	-0.0004027	0.9774590	-11.5822563	-11.5822563 C
0.00001875	4480.	238923778.	13. 7331271	0.0002575	-0.0004175	1.0051721	-12.0097371	-12.0097371 C
0.00001938	4614.	238139507.	13. 6849944	0.0002651	-0.0004324	1.0327716	-12.4371062	-12.4371062 C
0.00002000	4748.	237400645.	13. 6400630	0.0002728	-0.0004472	1.0602574	-12.8643634	-12.8643634 C
0.00002063	4882.	236703054.	13. 5980423	0.0002805	-0.0004620	1.0876293	-13.2915084	-13.2915084 C
0.00002125	5016.	236043085.	13. 5586759	0.0002881	-0.0004769	1.1148871	-13.7185409	-13.7185409 C
0.00002188	5150.	235417507.	13. 5217369	0.0002958	-0.0004917	1.1420308	-14.1454606	-14.1454606 C
0.00002250	5284.	234822592.	13. 4867216	0.0003035	-0.0005065	1.1690358	-14.5724641	-14.5724641 C
0.00002313	5417.	234255352.	13. 4532926	0.0003111	-0.0005214	1.1958875	-14.9996731	-14.9996731 C
0.00002375	5551.	233714917.	13. 4217903	0.0003188	-0.0005362	1.2226253	-15.4267668	-15.4267668 C
0.00002438	5684.	233199217.	13. 3920669	0.0003264	-0.0005511	1.2492490	-15.8537451	-15.8537451 C
0.00002563	5951.	232234758.	13. 3374379	0.0003418	-0.0005807	1.3021534	-16.7073539	-16.7073539 C
0.00002688	6218.	231349132.	13. 2884884	0.0003571	-0.0006104	1.3545996	-17.5604968	-17.5604968 C
0.00002813	6484.	230531779.	13. 2444641	0.0003725	-0.0006400	1.4065862	-18.4131714	-18.4131714 C
0.00002938	6750.	229773934.	13. 2047394	0.0003879	-0.0006696	1.4581117	-19.2653750	-19.2653750 C
0.00003063	7015.	229068264.	13. 1687907	0.0004033	-0.0006992	1.5091749	-20.1171052	-20.1171052 C
0.00003188	7281.	228408424.	13. 1360848	0.0004187	-0.0007288	1.5597647	-20.9684440	-20.9684440 C
0.00003313	7545.	227788250.	13. 1057170	0.0004341	-0.0007584	1.6098213	-21.8199080	-21.8199080 C
0.00003438	7810.	227204482.	13. 0780493	0.0004496	-0.0007879	1.6594140	-22.6708820	-22.6708820 C
0.00003563	8075.	226653243.	13. 0528003	0.0004650	-0.0008175	1.7085414	-23.5213631	-23.5213631 C
0.00003688	8339.	226131187.	13. 0297267	0.0004805	-0.0008470	1.7572020	-24.3713484	-24.3713484 C
0.00003813	8602.	225635402.	13. 0086171	0.0004960	-0.0008765	1.8053943	-25.2208352	-25.2208352 C
0.00003938	8866.	225163347.	12. 9892870	0.0005115	-0.0009060	1.8531170	-26.0698203	-26.0698203 C
0.00004063	9129.	224712793.	12. 9715746	0.0005270	-0.0009355	1.9003686	-26.9183010	-26.9183010 C
0.00004188	9392.	224281778.	12. 9553376	0.0005425	-0.0009650	1.9471475	-27.7662743	-27.7662743 C
0.00004313	9654.	223868567.	12. 9404501	0.0005581	-0.0009944	1.9934523	-28.6137370	-28.6137370 C
0.00004438	9917.	223471617.	12. 9268003	0.0005736	-0.0010239	2.0392815	-29.4606862	-29.4606862 C
0.00004563	10178.	223089558.	12. 9142889	0.0005892	-0.0010533	2.0846335	-30.3071189	-30.3071189 C
0.00004688	10440.	222721164.	12. 9028271	0.0006048	-0.0010827	2.1295069	-31.1530318	-31.1530318 C
0.00004813	10701.	222365325.	12. 8923353	0.0006204	-0.0011121	2.1738999	-31.9984231	-31.9984231 C
0.00004938	10962.	222021074.	12. 8827422	0.0006361	-0.0011414	2.2178112	-32.8432870	-32.8432870 C
0.00005063	11223.	221687511.	12. 8739833	0.0006517	-0.0011708	2.2612392	-33.6876216	-33.6876216 C
0.00005188	11483.	221363828.	12. 8660005	0.0006674	-0.0012001	2.3041822	-34.5314237	-34.5314237 C
0.00005313	11743.	221049297.	12. 8587411	0.0006831	-0.0012294	2.3466387	-35.3746901	-35.3746901 C
0.00005438	11996.	220607369.	12. 8493672	0.0006987	-0.0012588	2.3881984	-36.2218178	-36.0000000 CY
0.00005563	12216.	219612086.	12. 8289974	0.0007136	-0.0012889	2.4275410	-37.0873608	-36.0000000 CY
0.00005688	12415.	218293690.	12. 8021267	0.0007281	-0.0013194	2.4652925	-37.9651046	-36.0000000 CY
0.00005813	12601.	216798282.	12. 7714617	0.0007423	-0.0013502	2.5018386	-38.8511921	-36.0000000 CY
0.00005938	12777.	215184869.	12. 7377454	0.0007563	-0.0013812	2.5372831	-39.7447569	-36.0000000 CY
0.00006063	12942.	213469111.	12. 7017717	0.0007700	-0.0014125	2.5717428	-40.6447349	-36.0000000 CY
0.00006188	13099.	211700390.	12. 6646037	0.0007836	-0.0014439	2.6053816	-41.5494641	-36.0000000 CY
0.00006313	13250.	209894364.	12. 6265485	0.0007971	-0.0014754	2.6382510	-42.4585120	-36.0000000 CY
0.00006438	13394.	208063488.	12. 5878523	0.0008103	-0.0015072	2.6703949	-43.3715155	-36.0000000 CY
0.00006563	13533.	206211949.	12. 5485635	0.0008235	-0.0015390	2.7018271	-44.2884523	-36.0000000 CY
0.00006688	13666.	204354714.	12. 5090186	0.0008365	-0.0015710	2.7326081	-45.2087344	-36.0000000 CY

Lpile Run 3 ft shaft. lp9o

0. 00006813	13795.	202500084.	12. 4693996	0. 0008495	-0. 0016030	2. 7627746	-46. 1320297	-36. 0000000 CY
0. 00006938	13920.	200653282.	12. 4298179	0. 0008623	-0. 0016352	2. 7923530	-47. 0581225	-36. 0000000 CY
0. 00007063	14041.	198815090.	12. 3894899	0. 0008750	-0. 0016675	2. 8212244	-47. 9886132	-36. 0000000 CY
0. 00007188	14159.	196991296.	12. 3490796	0. 0008876	-0. 0016999	2. 8495038	-48. 9221994	-36. 0000000 CY
0. 00007313	14273.	195186100.	12. 3089502	0. 0009001	-0. 0017324	2. 8772589	-49. 8581198	-36. 0000000 CY
0. 00007438	14384.	193402046.	12. 2691661	0. 0009125	-0. 0017650	2. 9045095	-50. 7962047	-36. 0000000 CY
0. 00007938	14803.	186490842.	12. 1137412	0. 0009615	-0. 0018960	3. 0086866	-54. 5688443	-36. 0000000 CY
0. 00008438	15187.	179988320.	11. 9631349	0. 0010094	-0. 0020281	3. 1053593	-58. 3747669	-36. 0000000 CY
0. 00008938	15543.	173912026.	11. 8194695	0. 0010564	-0. 0021611	3. 1953895	-60. 0000000	-36. 0000000 CY
0. 00009438	15878.	168247495.	11. 6837164	0. 0011027	-0. 0022948	3. 2794049	-60. 0000000	-36. 0000000 CY
0. 00009938	16195.	162967990.	11. 5527699	0. 0011481	-0. 0024294	3. 3572938	-60. 0000000	-36. 0000000 CY
0. 0001044	16497.	158056606.	11. 4300338	0. 0011930	-0. 0025645	3. 4300049	-60. 0000000	-36. 0000000 CY
0. 0001094	16766.	153290615.	11. 3079567	0. 0012368	-0. 0027007	3. 4966157	-60. 0000000	-36. 0000000 CY
0. 0001144	16936.	148076590.	11. 1709062	0. 0012777	-0. 0028398	3. 5549488	-60. 0000000	36. 0000000 CY
0. 0001194	17079.	143073335.	11. 0489219	0. 0013190	-0. 0029785	3. 6102576	-60. 0000000	36. 0000000 CY
0. 0001244	17208.	138351965.	10. 9373231	0. 0013603	-0. 0031172	3. 6619865	-60. 0000000	36. 0000000 CY
0. 0001294	17324.	133906501.	10. 8332768	0. 0014016	-0. 0032559	3. 7098753	-60. 0000000	36. 0000000 CY
0. 0001344	17432.	129724580.	10. 7384413	0. 0014430	-0. 0033945	3. 7543151	-60. 0000000	36. 0000000 CY
0. 0001394	17532.	125789823.	10. 6504737	0. 0014844	-0. 0035331	3. 7950712	-60. 0000000	36. 0000000 CY
0. 0001444	17625.	122081347.	10. 5664858	0. 0015255	-0. 0036720	3. 8318683	-60. 0000000	36. 0000000 CY
0. 0001494	17712.	118576599.	10. 4880522	0. 0015667	-0. 0038108	3. 8650191	-60. 0000000	36. 0000000 CY
0. 0001544	17795.	115272798.	10. 4144123	0. 0016077	-0. 0039498	3. 8945028	-60. 0000000	36. 0000000 CY
0. 0001594	17873.	112146534.	10. 3464451	0. 0016490	-0. 0040885	3. 9204584	-60. 0000000	36. 0000000 CY
0. 0001644	17948.	109190758.	10. 2824665	0. 0016902	-0. 0042273	3. 9427428	-60. 0000000	36. 0000000 CY
0. 0001694	18018.	106380342.	10. 2211748	0. 0017312	-0. 0043663	3. 9612957	-60. 0000000	36. 0000000 CY
0. 0001744	18085.	103715410.	10. 1620866	0. 0017720	-0. 0045055	3. 9761526	-60. 0000000	36. 0000000 CY
0. 0001794	18149.	101181337.	10. 1075645	0. 0018130	-0. 0046445	3. 9874838	-60. 0000000	36. 0000000 CY
0. 0001844	18211.	98771949.	10. 0560345	0. 0018541	-0. 0047834	3. 9951949	-60. 0000000	36. 0000000 CY
0. 0001894	18270.	96476560.	10. 0073556	0. 0018951	-0. 0049224	3. 9992852	-60. 0000000	36. 0000000 CY
0. 0001944	18327.	94287931.	9. 9625167	0. 0019365	-0. 0050610	3. 9966277	-60. 0000000	36. 0000000 CY
0. 0001994	18382.	92197813.	9. 9197306	0. 0019777	-0. 0051998	3. 9997054	-60. 0000000	36. 0000000 CY
0. 0002044	18435.	90200358.	9. 8785724	0. 0020189	-0. 0053386	3. 9970443	-60. 0000000	36. 0000000 CY
0. 0002094	18485.	88284987.	9. 8392198	0. 0020601	-0. 0054774	3. 9997596	-60. 0000000	36. 0000000 CY
0. 0002144	18533.	86452369.	9. 8021778	0. 0021013	-0. 0056162	3. 9965941	-60. 0000000	36. 0000000 CY
0. 0002194	18580.	84695888.	9. 7669524	0. 0021426	-0. 0057549	3. 9995477	60. 0000000	36. 0000000 CY
0. 0002244	18626.	83010951.	9. 7345753	0. 0021842	-0. 0058933	3. 9952307	60. 0000000	36. 0000000 CY
0. 0002294	18669.	81390668.	9. 7039400	0. 0022258	-0. 0060317	3. 9988476	60. 0000000	36. 0000000 CY
0. 0002344	18711.	79835498.	9. 6750963	0. 0022676	-0. 0061699	3. 9994851	60. 0000000	36. 0000000 CY
0. 0002394	18750.	78330784.	9. 6466314	0. 0023092	-0. 0063083	3. 9970678	60. 0000000	36. 0000000 CY
0. 0002444	18784.	76865522.	9. 6175846	0. 0023503	-0. 0064472	3. 9995577	60. 0000000	36. 0000000 CY
0. 0002494	18812.	75435129.	9. 5878122	0. 0023910	-0. 0065865	3. 9965740	60. 0000000	36. 0000000 CY
0. 0002544	18832.	74030790.	9. 5553734	0. 0024306	-0. 0067269	3. 9970919	60. 0000000	36. 0000000 CY
0. 0002594	18848.	72666318.	9. 5215113	0. 0024696	-0. 0068679	3. 9993756	60. 0000000	36. 0000000 CY
0. 0002644	18862.	71344232.	9. 4869736	0. 0025081	-0. 0070094	3. 9989935	60. 0000000	36. 0000000 CY
0. 0002694	18874.	70065182.	9. 4533764	0. 0025465	-0. 0071510	3. 9949413	60. 0000000	36. 0000000 CY
0. 0002744	18886.	68831198.	9. 4218403	0. 0025851	-0. 0072924	3. 9980201	60. 0000000	36. 0000000 CY
0. 0003044	18944.	62237828.	9. 2567452	0. 0028175	-0. 0081400	4. 0000000	60. 0000000	36. 0000000 CY
0. 0003344	18984.	56775611.	9. 1229195	0. 0030505	-0. 0089870	3. 9935280	60. 0000000	36. 0000000 CY
0. 0003644	19013.	52178848.	9. 0084692	0. 0032825	-0. 0098350	3. 9940893	60. 0000000	36. 0000000 CY
0. 0003944	19032.	48259482.	8. 9158814	0. 0035162	-0. 0106813	3. 9999913	60. 0000000	36. 0000000 CY
0. 0004244	19046.	44879864.	8. 8385845	0. 0037509	-0. 0115266	3. 9977149	60. 0000000	36. 0000000 CY
0. 0004544	19046.	41917494.	8. 7753505	0. 0039873	-0. 0123702	3. 9870726	60. 0000000	36. 0000000 CY

Lpile Run 3 ft shaft.lp9o

Axial Thrust Force = 104.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in <sup>2</sup>	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6.25000E-07	293.2204506	469152721.	50.5936615	0.00003162	0.00000912	0.1325170	0.9137476	0.9137476	
0.00000125	586.4397749	469151820.	34.3129080	0.00004289	-0.00000211	0.1789079	1.2373179	1.2373179	
0.00000188	879.4703650	469050861.	28.8919062	0.00005417	-0.00001333	0.2250646	1.5612099	1.5612099	
0.00000250	1172.	468758181.	26.1834443	0.00006546	-0.00002454	0.2709616	1.8852497	1.8852497	
0.00000313	1464.	468342222.	24.5591106	0.00007675	-0.00003575	0.3165874	2.2093569	2.2093569	
0.00000375	1754.	467853669.	23.4765629	0.00008804	-0.00004696	0.3619376	2.5335012	2.5335012	
0.00000438	2045.	467320279.	22.7035010	0.00009933	-0.00005817	0.4070101	2.8576692	2.8576692	
0.00000500	2334.	466757614.	22.1238204	0.0001106	-0.00006938	0.4518039	3.1818540	3.1818540	
0.00000563	2622.	466174894.	21.6730373	0.0001219	-0.00008059	0.4963186	3.5060517	3.5060517	
0.00000625	2910.	465577878.	21.3124695	0.0001332	-0.00009180	0.5405537	3.8302601	3.8302601	
0.00000688	3197.	464970332.	21.0175055	0.0001445	-0.0001030	0.5845091	4.1544777	4.1544777	
0.00000750	3483.	464354813.	20.7717399	0.0001558	-0.0001142	0.6281845	4.4787034	4.4787034	
0.00000813	3483.	428635212.	17.1162679	0.0001391	-0.0001534	0.5623278	-4.4070669	-4.4070669	C
0.00000875	3483.	398018411.	16.8002810	0.0001470	-0.0001680	0.5930066	-4.8262537	-4.8262537	C
0.00000938	3483.	371483850.	16.5223896	0.0001549	-0.0001826	0.6234005	-5.2465378	-5.2465378	C
0.00001000	3483.	348266110.	16.2765628	0.0001628	-0.0001972	0.6535545	-5.6675968	-5.6675968	C
0.00001063	3483.	327779868.	16.0575103	0.0001706	-0.0002119	0.6834852	-6.0893171	-6.0893171	C
0.00001125	3483.	309569875.	15.8599434	0.0001784	-0.0002266	0.7131580	-6.5119684	-6.5119684	C
0.00001188	3483.	293276724.	15.6828074	0.0001862	-0.0002413	0.7426809	-6.9347457	-6.9347457	C
0.00001250	3483.	278612888.	15.5208599	0.0001940	-0.0002560	0.7719503	-7.3584383	-7.3584383	C
0.00001313	3483.	265345607.	15.3741939	0.0002018	-0.0002707	0.8010806	-7.7821849	-7.7821849	C
0.00001375	3591.	261145560.	15.2398899	0.0002095	-0.0002855	0.8300284	-8.2063189	-8.2063189	C
0.00001438	3726.	259191070.	15.1160952	0.0002173	-0.0003002	0.8587814	-8.6309403	-8.6309403	C
0.00001500	3861.	257394391.	15.0028671	0.0002250	-0.0003150	0.8874175	-9.0554528	-9.0554528	C
0.00001563	3996.	255730904.	14.8980525	0.0002328	-0.0003297	0.9158850	-9.4802574	-9.4802574	C
0.00001625	4130.	254182735.	14.8002827	0.0002405	-0.0003445	0.9441604	-9.9055417	-9.9055417	C
0.00001688	4265.	252744796.	14.7099790	0.0002482	-0.0003593	0.9723195	-10.3307165	-10.3307165	C
0.00001750	4400.	251405266.	14.6263421	0.0002560	-0.0003740	1.0003622	-10.7557814	-10.7557814	C
0.00001813	4534.	250150206.	14.5479929	0.0002637	-0.0003888	1.0282426	-11.1810987	-11.1810987	C
0.00001875	4668.	248969659.	14.4741192	0.0002714	-0.0004036	1.0559417	-11.6068227	-11.6068227	C
0.00001938	4802.	247861430.	14.4052090	0.0002791	-0.0004184	1.0835251	-12.0324357	-12.0324357	C
0.00002000	4936.	246818730.	14.3407975	0.0002868	-0.0004332	1.1109924	-12.4579374	-12.4579374	C
0.00002063	5070.	245835593.	14.2804762	0.0002945	-0.0004480	1.1383436	-12.8833276	-12.8833276	C
0.00002125	5204.	244906757.	14.2238846	0.0003023	-0.0004627	1.1655785	-13.3086061	-13.3086061	C
0.00002188	5338.	244022606.	14.1695924	0.0003100	-0.0004775	1.1926105	-13.7344772	-13.7344772	C
0.00002250	5472.	243183904.	14.1184073	0.0003177	-0.0004923	1.2195202	-14.1602892	-14.1602892	C
0.00002313	5605.	242387316.	14.0701581	0.0003254	-0.0005071	1.2463141	-14.5859877	-14.5859877	C
0.00002375	5739.	241629511.	14.0246134	0.0003331	-0.0005219	1.2729920	-15.0115725	-15.0115725	C
0.00002438	5872.	240907498.	13.9815655	0.0003408	-0.0005367	1.2995538	-15.4370433	-15.4370433	C
0.00002563	6139.	239560346.	13.9022313	0.0003562	-0.0005663	1.3523281	-16.2876418	-16.2876418	C
0.00002688	6405.	238324961.	13.8301935	0.0003717	-0.0005958	1.4045740	-17.1383054	-17.1383054	C
0.00002813	6671.	237185645.	13.7642445	0.0003871	-0.0006254	1.4562693	-17.9892255	-17.9892255	C
0.00002938	6936.	236133060.	13.7044592	0.0004026	-0.0006549	1.5074988	-18.8396762	-18.8396762	C
0.00003063	7202.	235156539.	13.6500858	0.0004180	-0.0006845	1.5582611	-19.6896550	-19.6896550	C
0.00003188	7467.	234247088.	13.6004902	0.0004335	-0.0007140	1.6085549	-20.5391593	-20.5391593	C
0.00003313	7731.	233397070.	13.5551344	0.0004490	-0.0007435	1.6583786	-21.3881864	-21.3881864	C
0.00003438	7996.	232599958.	13.5135585	0.0004645	-0.0007730	1.7077310	-22.2367338	-22.2367338	C
0.00003563	8260.	231848728.	13.4747799	0.0004800	-0.0008025	1.7565441	-23.0854054	-23.0854054	C

Lpile Run 3 ft shaft. lp9o

0.00003688	8523.	231139382.	13.4387904	0.0004956	-0.0008319	1.8048504	-23.9339059	-23.9339059 C
0.00003813	8787.	230468468.	13.4056088	0.0005111	-0.0008614	1.8526840	-24.7819112	-24.7819112 C
0.00003938	9050.	229832289.	13.3749702	0.0005266	-0.0008909	1.9000435	-25.6294183	-25.6294183 C
0.00004063	9312.	229227598.	13.3466422	0.0005422	-0.0009203	1.9469274	-26.4764245	-26.4764245 C
0.00004188	9575.	228651538.	13.3204205	0.0005578	-0.0009497	1.9933342	-27.3229268	-27.3229268 C
0.00004313	9837.	228101584.	13.2961241	0.0005734	-0.0009791	2.0392624	-28.1689222	-28.1689222 C
0.00004438	10099.	227575492.	13.2735927	0.0005890	-0.0010085	2.0847105	-29.0144078	-29.0144078 C
0.00004563	10360.	227071266.	13.2526834	0.0006047	-0.0010378	2.1296770	-29.8593806	-29.8593806 C
0.00004688	10621.	226587122.	13.2332689	0.0006203	-0.0010672	2.1741603	-30.7038375	-30.7038375 C
0.00004813	10882.	226121460.	13.2152347	0.0006360	-0.0010965	2.2181589	-31.5477755	-31.5477755 C
0.00004938	11143.	225672843.	13.1984782	0.0006517	-0.0011258	2.2616712	-32.3911914	-32.3911914 C
0.00005063	11403.	225239975.	13.1829069	0.0006674	-0.0011551	2.3046956	-33.2340821	-33.2340821 C
0.00005188	11663.	224821685.	13.1684373	0.0006831	-0.0011844	2.3472305	-34.0764445	-34.0764445 C
0.00005313	11922.	224416911.	13.1549937	0.0006989	-0.0012136	2.3892744	-34.9182752	-34.9182752 C
0.00005438	12181.	224024689.	13.1425073	0.0007146	-0.0012429	2.4308257	-35.7595712	-35.7595712 C
0.00005563	12419.	223265540.	13.1228428	0.0007300	-0.0012725	2.4707052	-36.6133515	-36.0000000 CY
0.00005688	12627.	222020441.	13.0934671	0.0007447	-0.0013028	2.5085141	-37.4845750	-36.0000000 CY
0.00005813	12821.	220575479.	13.0602361	0.0007591	-0.0013334	2.5450888	-38.3644268	-36.0000000 CY
0.00005938	13001.	218970027.	13.0238358	0.0007733	-0.0013642	2.5805242	-39.2521450	-36.0000000 CY
0.00006063	13172.	217266124.	12.9855098	0.0007872	-0.0013953	2.6150044	-40.1458879	-36.0000000 CY
0.00006188	13334.	215499072.	12.9459599	0.0008010	-0.0014265	2.6486377	-41.0446054	-36.0000000 CY
0.00006313	13489.	213685340.	12.9054861	0.0008147	-0.0014578	2.6814750	-41.9478817	-36.0000000 CY
0.00006438	13637.	211831186.	12.8641568	0.0008281	-0.0014894	2.7135325	-42.8556895	-36.0000000 CY
0.00006563	13779.	209961463.	12.8225117	0.0008415	-0.0015210	2.7449008	-43.7670947	-36.0000000 CY
0.00006688	13916.	208084678.	12.7807129	0.0008547	-0.0015528	2.7756136	-44.6818172	-36.0000000 CY
0.00006813	14048.	206202733.	12.7377126	0.0008678	-0.0015847	2.8055140	-45.6019438	-36.0000000 CY
0.00006938	14175.	204326080.	12.6947742	0.0008807	-0.0016168	2.8348086	-46.5250635	-36.0000000 CY
0.00007063	14299.	202459627.	12.6520172	0.0008935	-0.0016490	2.8635258	-47.4509246	-36.0000000 CY
0.00007188	14419.	200607394.	12.6095264	0.0009063	-0.0016812	2.8916888	-48.3793307	-36.0000000 CY
0.00007313	14535.	198772729.	12.5673749	0.0009190	-0.0017135	2.9193190	-49.3100979	-36.0000000 CY
0.00007438	14649.	196958420.	12.5256258	0.0009316	-0.0017459	2.9464361	-50.2430531	-36.0000000 CY
0.00007938	15075.	189926123.	12.3615398	0.0009812	-0.0018763	3.0497800	-53.9984429	-36.0000000 CY
0.00008438	15466.	183296794.	12.2029421	0.0010296	-0.0020079	3.1454832	-57.7879883	-36.0000000 CY
0.00008938	15828.	177100702.	12.0534389	0.0010773	-0.0021402	3.2346741	-60.0000000	-36.0000000 CY
0.00009438	16168.	171314289.	11.9090042	0.0011239	-0.0022736	3.3171700	-60.0000000	-36.0000000 CY
0.00009938	16489.	165928786.	11.7737065	0.0011700	-0.0024075	3.3940775	-60.0000000	-36.0000000 CY
0.0001044	16795.	160911023.	11.6453236	0.0012155	-0.0025420	3.4654131	-60.0000000	-36.0000000 CY
0.0001094	17081.	156166632.	11.5208467	0.0012601	-0.0026774	3.5310394	-60.0000000	-36.0000000 CY
0.0001144	17257.	150877874.	11.3906883	0.0013028	-0.0028147	3.5898003	-60.0000000	-36.0000000 CY
0.0001194	17398.	145738433.	11.2677905	0.0013451	-0.0029524	3.6440795	-60.0000000	-36.0000000 CY
0.0001244	17525.	140903772.	11.1545447	0.0013873	-0.0030902	3.6944747	-60.0000000	-36.0000000 CY
0.0001294	17642.	136364554.	11.0509065	0.0014297	-0.0032278	3.7411441	-60.0000000	-36.0000000 CY
0.0001344	17750.	132096551.	10.9542574	0.0014720	-0.0033655	3.7838519	-60.0000000	-36.0000000 CY
0.0001394	17851.	128076230.	10.8621110	0.0015139	-0.0035036	3.8224092	-60.0000000	-36.0000000 CY
0.0001444	17944.	124287305.	10.7773629	0.0015560	-0.0036415	3.8572992	-60.0000000	-36.0000000 CY
0.0001494	18032.	120719235.	10.6981172	0.0015980	-0.0037795	3.8883591	-60.0000000	-36.0000000 CY
0.0001544	18116.	117348059.	10.6248305	0.0016402	-0.0039173	3.9156902	-60.0000000	-36.0000000 CY
0.0001594	18194.	114156339.	10.5530866	0.0016819	-0.0040556	3.9389356	-60.0000000	-36.0000000 CY
0.0001644	18268.	111133617.	10.4861666	0.0017237	-0.0041938	3.9584726	-60.0000000	-36.0000000 CY
0.0001694	18339.	108271753.	10.4232807	0.0017654	-0.0043321	3.9742595	-60.0000000	-36.0000000 CY
0.0001744	18406.	105553222.	10.3649850	0.0018074	-0.0044701	3.9863315	-60.0000000	-36.0000000 CY
0.0001794	18470.	102970825.	10.3095860	0.0018493	-0.0046082	3.9946046	-60.0000000	-36.0000000 CY
0.0001844	18532.	100513137.	10.2582823	0.0018914	-0.0047461	3.9991131	-60.0000000	-36.0000000 CY
0.0001894	18591.	98169531.	10.2075596	0.0019331	-0.0048844	3.9965400	-60.0000000	-36.0000000 CY

Lpile Run 3 ft shaft. Ip90								
0.0001944	18647.	95933794.	10.1591721	0.0019747	-0.0050228	3.9996923	-60.0000000	36.0000000 CY
0.0001994	18701.	93798783.	10.1149056	0.0020167	-0.0051608	3.9972953	-60.0000000	36.0000000 CY
0.0002044	18753.	91757206.	10.0728070	0.0020586	-0.0052989	3.9998493	-60.0000000	36.0000000 CY
0.0002094	18803.	89806304.	10.0333357	0.0021007	-0.0054368	3.9972616	-60.0000000	36.0000000 CY
0.0002144	18851.	87935609.	9.9964437	0.0021430	-0.0055745	3.9997983	60.0000000	36.0000000 CY
0.0002194	18898.	86143359.	9.9622692	0.0021855	-0.0057120	3.9964510	60.0000000	36.0000000 CY
0.0002244	18942.	84423027.	9.9296291	0.0022280	-0.0058495	3.9994658	60.0000000	36.0000000 CY
0.0002294	18986.	82774331.	9.8991743	0.0022706	-0.0059869	3.9959979	60.0000000	36.0000000 CY
0.0002344	19027.	81183550.	9.8688363	0.0023130	-0.0061245	3.9984338	60.0000000	36.0000000 CY
0.0002394	19067.	79653948.	9.8401619	0.0023555	-0.0062620	3.9999747	60.0000000	36.0000000 CY
0.0002444	19104.	78175943.	9.8123498	0.0023979	-0.0063996	3.9959237	60.0000000	36.0000000 CY
0.0002494	19136.	76733883.	9.7828614	0.0024396	-0.0065379	3.9989742	60.0000000	36.0000000 CY
0.0002544	19162.	75328741.	9.7525110	0.0024808	-0.0066767	3.9999994	60.0000000	36.0000000 CY
0.0002594	19181.	73949252.	9.7205990	0.0025213	-0.0068162	3.9952058	60.0000000	36.0000000 CY
0.0002644	19196.	72607313.	9.6879727	0.0025613	-0.0069562	3.9983053	60.0000000	36.0000000 CY
0.0002694	19209.	71309725.	9.6561927	0.0026011	-0.0070964	3.9998258	60.0000000	36.0000000 CY
0.0002744	19221.	70053747.	9.6251873	0.0026409	-0.0072366	3.9956648	60.0000000	36.0000000 CY
0.0003044	19279.	63339182.	9.4589816	0.0028791	-0.0080784	3.9973929	60.0000000	36.0000000 CY
0.0003344	19319.	57775881.	9.3211430	0.0031168	-0.0089207	3.9987420	60.0000000	36.0000000 CY
0.0003644	19347.	53096810.	9.2116697	0.0033565	-0.0097610	3.9983525	60.0000000	36.0000000 CY
0.0003944	19366.	49106251.	9.1155239	0.0035949	-0.0106026	3.9950994	60.0000000	36.0000000 CY
0.0004244	19379.	45663654.	9.0339499	0.0038338	-0.0114437	3.9881412	60.0000000	36.0000000 CY

Axial Thrust Force = 116.000 kips

Bending Curvature rad/in.	Bending Moment in-kip	Bending Stiffness kip-in <sup>2</sup>	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
6.25000E-07	292.9628843	468740615.	54.3718587	0.00003398	0.00001148	0.1423585	0.9822274	0.9822274	
0.00000125	585.9254582	468740367.	36.2020268	0.00004525	2.52533E-07	0.1886902	1.3057985	1.3057985	
0.00000188	878.7872917	468686556.	30.1519533	0.00005653	-0.00001097	0.2347925	1.6297250	1.6297250	
0.00000250	1171.	468455937.	27.1295851	0.00006782	-0.00002218	0.2806415	1.9538449	1.9538449	
0.00000313	1463.	468088576.	25.3171625	0.00007912	-0.00003338	0.3262223	2.2780554	2.2780554	
0.00000375	1754.	467636398.	24.1093377	0.00009041	-0.00004459	0.3715290	2.6023155	2.6023155	
0.00000438	2044.	467130644.	23.2468523	0.0001017	-0.00005580	0.4165590	2.9266069	2.9266069	
0.00000500	2333.	466589488.	22.6001389	0.0001130	-0.00006700	0.4613108	3.2509202	3.2509202	
0.00000563	2621.	466023906.	22.0972413	0.0001243	-0.00007820	0.5057836	3.5752500	3.5752500	
0.00000625	2909.	465440826.	21.6949968	0.0001356	-0.00008941	0.5499771	3.8995932	3.8995932	
0.00000688	3196.	464844817.	21.3659445	0.0001469	-0.0001006	0.5938908	4.2239477	4.2239477	
0.00000750	3482.	464238994.	21.0917801	0.0001582	-0.0001118	0.6375246	4.5483122	4.5483122	
0.00000813	3482.	428528302.	17.6271534	0.0001432	-0.0001493	0.5786290	-4.2866895	-4.2866895	C
0.00000875	3482.	397919138.	17.2835143	0.0001512	-0.0001638	0.6095368	-4.7036332	-4.7036332	C
0.00000938	3482.	371391195.	16.9811659	0.0001592	-0.0001783	0.6401394	-5.1218080	-5.1218080	C
0.00001000	3482.	348179246.	16.7134010	0.0001671	-0.0001929	0.6704791	-5.5409137	-5.5409137	C
0.00001063	3482.	327698113.	16.4733316	0.0001750	-0.0002075	0.7005253	-5.9611922	-5.9611922	C
0.00001125	3482.	309492663.	16.2578834	0.0001829	-0.0002221	0.7303469	-6.3821405	-6.3821405	C
0.00001188	3482.	293203575.	16.0637659	0.0001908	-0.0002367	0.7599719	-6.8035531	-6.8035531	C
0.00001250	3482.	278543396.	15.8867006	0.0001986	-0.0002514	0.7893500	-7.2258210	-7.2258210	C
0.00001313	3522.	268334855.	15.7259800	0.0002064	-0.0002661	0.8185686	-7.6482863	-7.6482863	C
0.00001375	3657.	265996100.	15.5784854	0.0002142	-0.0002808	0.8475819	-8.0713039	-8.0713039	C
0.00001438	3793.	263844942.	15.4428278	0.0002220	-0.0002955	0.8764091	-8.4947336	-8.4947336	C
0.00001500	3928.	261867876.	15.3187268	0.0002298	-0.0003102	0.9051180	-8.9180538	-8.9180538	C



Lpile Run 3 ft shaft. Ip9o

0.00001563	4063.	260029271.	15.2027761	0.0002375	-0.0003250	0.9335911	-9.3421795	-9.3421795 C
0.00001625	4198.	258324715.	15.0956111	0.0002453	-0.0003397	0.9619247	-9.7663682	-9.7663682 C
0.00001688	4333.	256741883.	14.9966089	0.0002531	-0.0003544	0.9901406	-10.1904470	-10.1904470 C
0.00001750	4467.	255262917.	14.9041354	0.0002608	-0.0003692	1.0181902	-10.6148012	-10.6148012 C
0.00001813	4601.	253874553.	14.8171099	0.0002686	-0.0003839	1.0460471	-11.0396441	-11.0396441 C
0.00001875	4736.	252574704.	14.7360896	0.0002763	-0.0003987	1.0737870	-11.4643762	-11.4643762 C
0.00001938	4870.	251354797.	14.6604940	0.0002840	-0.0004135	1.1014099	-11.8889974	-11.8889974 C
0.00002000	5004.	250207329.	14.5898150	0.0002918	-0.0004282	1.1289156	-12.3135073	-12.3135073 C
0.00002063	5138.	249119044.	14.5223575	0.0002995	-0.0004430	1.1562119	-12.7386523	-12.7386523 C
0.00002125	5272.	248090142.	14.4588460	0.0003073	-0.0004577	1.1833760	-13.1638111	-13.1638111 C
0.00002188	5406.	247116587.	14.3991410	0.0003150	-0.0004725	1.2104236	-13.5888574	-13.5888574 C
0.00002250	5539.	246193760.	14.3429257	0.0003227	-0.0004873	1.2373544	-14.0137909	-14.0137909 C
0.00002313	5673.	245317540.	14.2899176	0.0003305	-0.0005020	1.2641682	-14.4386115	-14.4386115 C
0.00002375	5807.	244484240.	14.2398639	0.0003382	-0.0005168	1.2908649	-14.8633187	-14.8633187 C
0.00002438	5940.	243687840.	14.1919157	0.0003459	-0.0005316	1.3173916	-15.2883520	-15.2883520 C
0.00002563	6206.	242199130.	14.1026666	0.0003614	-0.0005611	1.3700210	-16.1386933	-16.1386933 C
0.00002688	6473.	240837660.	14.0223115	0.0003768	-0.0005907	1.4221831	-16.9885734	-16.9885734 C
0.00002813	6738.	239586416.	13.9496675	0.0003923	-0.0006202	1.4738767	-17.8379899	-17.8379899 C
0.00002938	7004.	238431276.	13.8837530	0.0004078	-0.0006497	1.5251003	-18.6869403	-18.6869403 C
0.00003063	7269.	237357610.	13.8250232	0.0004233	-0.0006792	1.5757672	-19.5361715	-19.5361715 C
0.00003188	7534.	236356891.	13.7668330	0.0004388	-0.0007087	1.6259109	-20.3853962	-20.3853962 C
0.00003313	7798.	235422467.	13.7154931	0.0004543	-0.0007382	1.6755839	-21.2341419	-21.2341419 C
0.00003438	8063.	234547063.	13.6683702	0.0004699	-0.0007676	1.7247849	-22.0824059	-22.0824059 C
0.00003563	8326.	233724423.	13.6250229	0.0004854	-0.0007971	1.7735125	-22.9301857	-22.9301857 C
0.00003688	8590.	232949141.	13.5850698	0.0005009	-0.0008266	1.8217651	-23.7774784	-23.7774784 C
0.00003813	8853.	232216518.	13.5481795	0.0005165	-0.0008560	1.8695414	-24.6242814	-24.6242814 C
0.00003938	9116.	231522453.	13.5140628	0.0005321	-0.0008854	1.9168399	-25.4705920	-25.4705920 C
0.00004063	9379.	230862400.	13.4820440	0.0005477	-0.0009148	1.9636072	-26.3169043	-26.3169043 C
0.00004188	9641.	230233537.	13.4520361	0.0005633	-0.0009442	2.0098561	-27.1630961	-27.1630961 C
0.00004313	9903.	229633817.	13.4241748	0.0005789	-0.0009736	2.0556256	-28.0087788	-28.0087788 C
0.00004438	10165.	229060741.	13.3982810	0.0005945	-0.0010030	2.1009143	-28.8539495	-28.8539495 C
0.00004563	10426.	228512084.	13.3741953	0.0006102	-0.0010323	2.1457206	-29.6986053	-29.6986053 C
0.00004688	10687.	227985856.	13.3517753	0.0006259	-0.0010616	2.1900429	-30.5427428	-30.5427428 C
0.00004813	10947.	227480275.	13.3308934	0.0006415	-0.0010910	2.2338798	-31.3863592	-31.3863592 C
0.00004938	11208.	226993739.	13.3114351	0.0006573	-0.0011202	2.2772296	-32.2294513	-32.2294513 C
0.00005063	11468.	226524804.	13.2932969	0.0006730	-0.0011495	2.3200908	-33.0720158	-33.0720158 C
0.00005188	11727.	226072165.	13.2763857	0.0006887	-0.0011788	2.3624617	-33.9140496	-33.9140496 C
0.00005313	11987.	225634638.	13.2606168	0.0007045	-0.0012080	2.4043407	-34.7555495	-34.7555495 C
0.00005438	12246.	225211149.	13.2459137	0.0007202	-0.0012373	2.4457262	-35.5965122	-35.5965122 C
0.00005563	12490.	224534593.	13.2268102	0.0007357	-0.0012668	2.4858335	-36.4456392	-36.0000000 CY
0.00005688	12703.	223353788.	13.1980127	0.0007506	-0.0012969	2.5238733	-37.3121401	-36.0000000 CY
0.00005813	12899.	221916105.	13.1643464	0.0007652	-0.0013273	2.5605262	-38.1889359	-36.0000000 CY
0.00005938	13082.	220336773.	13.1277780	0.0007795	-0.0013580	2.5960739	-39.0731695	-36.0000000 CY
0.00006063	13255.	218631502.	13.0881364	0.0007935	-0.0013890	2.6304880	-39.9654575	-36.0000000 CY
0.00006188	13418.	216857522.	13.0472006	0.0008073	-0.0014202	2.6640359	-40.8629417	-36.0000000 CY
0.00006313	13574.	215037570.	13.0054113	0.0008210	-0.0014515	2.6967897	-41.7649562	-36.0000000 CY
0.00006438	13724.	213186180.	12.9630398	0.0008345	-0.0014830	2.7287976	-42.6710875	-36.0000000 CY
0.00006563	13867.	211310804.	12.9201986	0.0008479	-0.0015146	2.7600846	-43.5811844	-36.0000000 CY
0.00006688	14005.	209423131.	12.8771178	0.0008612	-0.0015463	2.7906947	-44.4948520	-36.0000000 CY
0.00006813	14138.	207535168.	12.8340540	0.0008743	-0.0015782	2.8206769	-45.4116094	-36.0000000 CY
0.00006938	14267.	205652763.	12.7911200	0.0008874	-0.0016101	2.8500583	-46.3312278	-36.0000000 CY
0.00007063	14392.	203776625.	12.7474900	0.0009003	-0.0016422	2.8787178	-47.2553843	-36.0000000 CY
0.00007188	14513.	201913231.	12.7038381	0.0009131	-0.0016744	2.9067703	-48.1827498	-36.0000000 CY
0.00007313	14630.	200067381.	12.6605584	0.0009258	-0.0017067	2.9342881	-49.1124906	-36.0000000 CY

Lpile Run 3 ft shaft. l p9o

0. 00007438	14744.	198241892.	12. 6177134	0. 0009384	-0. 0017391	2. 9612912	-50. 0444316	-36. 0000000	CY
0. 00007938	15174.	191163074.	12. 4509704	0. 0009883	-0. 0018692	3. 0643970	-53. 7925848	-36. 0000000	CY
0. 00008438	15566.	184488214.	12. 2893377	0. 0010369	-0. 0020006	3. 1597131	-57. 5765896	-36. 0000000	CY
0. 00008938	15931.	178246967.	12. 1364776	0. 0010847	-0. 0021328	3. 2483804	-60. 0000000	-36. 0000000	CY
0. 00009438	16272.	172421173.	11. 9909734	0. 0011316	-0. 0022659	3. 3306583	-60. 0000000	-36. 0000000	CY
0. 00009938	16595.	166993180.	11. 8525960	0. 0011779	-0. 0023996	3. 4069492	-60. 0000000	-36. 0000000	CY
0. 0001044	16903.	161941341.	11. 7231646	0. 0012236	-0. 0025339	3. 4779360	-60. 0000000	-36. 0000000	CY
0. 0001094	17188.	157147928.	11. 5990969	0. 0012687	-0. 0026688	3. 5433857	-60. 0000000	36. 0000000	CY
0. 0001144	17370.	151867758.	11. 4701923	0. 0013119	-0. 0028056	3. 6020575	-60. 0000000	36. 0000000	CY
0. 0001194	17512.	146698216.	11. 3484115	0. 0013547	-0. 0029428	3. 6561511	-60. 0000000	36. 0000000	CY
0. 0001244	17639.	141824795.	11. 2333649	0. 0013971	-0. 0030804	3. 7058574	-60. 0000000	36. 0000000	CY
0. 0001294	17756.	137247705.	11. 1285332	0. 0014398	-0. 0032177	3. 7518662	-60. 0000000	36. 0000000	CY
0. 0001344	17865.	132946871.	11. 0317047	0. 0014824	-0. 0033551	3. 7939903	-60. 0000000	36. 0000000	CY
0. 0001394	17966.	128900619.	10. 9403029	0. 0015248	-0. 0034927	3. 8320146	-60. 0000000	36. 0000000	CY
0. 0001444	18059.	125083344.	10. 8538468	0. 0015670	-0. 0036305	3. 8660078	-60. 0000000	36. 0000000	CY
0. 0001494	18147.	121485510.	10. 7795345	0. 0016093	-0. 0037682	3. 8961985	-60. 0000000	36. 0000000	CY
0. 0001544	18230.	118091148.	10. 6985467	0. 0016516	-0. 0039059	3. 9225517	-60. 0000000	36. 0000000	CY
0. 0001594	18309.	114880487.	10. 6291208	0. 0016940	-0. 0040435	3. 9451206	-60. 0000000	36. 0000000	CY
0. 0001644	18383.	111838238.	10. 5611535	0. 0017360	-0. 0041815	3. 9636283	-60. 0000000	36. 0000000	CY
0. 0001694	18454.	108952890.	10. 4975695	0. 0017780	-0. 0043195	3. 9783624	-60. 0000000	36. 0000000	CY
0. 0001744	18521.	106212895.	10. 4376096	0. 0018201	-0. 0044574	3. 9892909	-60. 0000000	36. 0000000	CY
0. 0001794	18585.	103611417.	10. 3813988	0. 0018622	-0. 0045953	3. 9964245	-60. 0000000	36. 0000000	CY
0. 0001844	18647.	101136104.	10. 3293730	0. 0019045	-0. 0047330	3. 9997477	-60. 0000000	36. 0000000	CY
0. 0001894	18706.	98778277.	10. 2799336	0. 0019468	-0. 0048707	3. 9980384	-60. 0000000	36. 0000000	CY
0. 0001944	18762.	96527071.	10. 2323782	0. 0019889	-0. 0050086	3. 9999940	-60. 0000000	36. 0000000	CY
0. 0001994	18816.	94375995.	10. 1871430	0. 0020311	-0. 0051464	3. 9986505	-60. 0000000	36. 0000000	CY
0. 0002044	18868.	92319492.	10. 1439889	0. 0020732	-0. 0052843	3. 9990690	-60. 0000000	36. 0000000	CY
0. 0002094	18918.	90353826.	10. 1040839	0. 0021155	-0. 0054220	3. 9986587	60. 0000000	36. 0000000	CY
0. 0002144	18965.	88467625.	10. 0664778	0. 0021580	-0. 0055595	3. 9994928	60. 0000000	36. 0000000	CY
0. 0002194	19012.	86662335.	10. 0315320	0. 0022007	-0. 0056968	3. 9981110	60. 0000000	36. 0000000	CY
0. 0002244	19056.	84929816.	9. 9980065	0. 0022433	-0. 0058342	3. 9999531	60. 0000000	36. 0000000	CY
0. 0002294	19099.	83265979.	9. 9672608	0. 0022862	-0. 0059713	3. 9966983	60. 0000000	36. 0000000	CY
0. 0002344	19141.	81667008.	9. 9384445	0. 0023293	-0. 0061082	3. 9995037	60. 0000000	36. 0000000	CY
0. 0002394	19181.	80129188.	9. 9110770	0. 0023725	-0. 0062450	3. 9961654	60. 0000000	36. 0000000	CY
0. 0002444	19218.	78642741.	9. 8835360	0. 0024153	-0. 0063822	3. 9979388	60. 0000000	36. 0000000	CY
0. 0002494	19253.	77203591.	9. 8554698	0. 0024577	-0. 0065198	3. 9998354	60. 0000000	36. 0000000	CY
0. 0002544	19278.	75785775.	9. 8249738	0. 0024992	-0. 0066583	3. 9944446	60. 0000000	36. 0000000	CY
0. 0002594	19301.	74412126.	9. 7948422	0. 0025405	-0. 0067970	3. 9976164	60. 0000000	36. 0000000	CY
0. 0002644	19315.	73060467.	9. 7611988	0. 0025806	-0. 0069369	3. 9995740	60. 0000000	36. 0000000	CY
0. 0002694	19329.	71755864.	9. 7289784	0. 0026207	-0. 0070768	3. 9977551	60. 0000000	36. 0000000	CY
0. 0002744	19341.	70492752.	9. 6977532	0. 0026608	-0. 0072167	3. 9952447	60. 0000000	36. 0000000	CY
0. 0003044	19400.	63735996.	9. 5342437	0. 0029020	-0. 0080555	3. 9992834	60. 0000000	36. 0000000	CY
0. 0003344	19439.	58135908.	9. 3944162	0. 0031413	-0. 0088962	3. 9999099	60. 0000000	36. 0000000	CY
0. 0003644	19467.	53425678.	9. 2817339	0. 0033820	-0. 0097355	3. 9998172	60. 0000000	36. 0000000	CY
0. 0003944	19487.	49411341.	9. 1907618	0. 0036246	-0. 0105729	3. 9985144	60. 0000000	36. 0000000	CY
0. 0004244	19499.	45947023.	9. 1082869	0. 0038653	-0. 0114122	3. 9921796	60. 0000000	36. 0000000	CY

Axial Thrust Force = 135.000 kips

Bendi ng Curvature rad/in.	Bendi ng Moment in-kip	Bendi ng Sti ffness kip-in2	Depth to N Axis in	Max Comp Strain in/in	Max Tens Strain in/in	Max Conc Stress ksi	Max Steel Stress ksi	Max Casing Stress ksi	Run Msg
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Lpile Run 3 ft shaft. Ip9o									
6. 25000E-07	292. 5545274	468087244.	60. 3619738	0. 00003773	0. 00001523	0. 1579358	1. 0907983	1. 0907983	
0. 00000125	585. 1094097	468087528.	39. 1971106	0. 00004900	0. 00000400	0. 2041737	1. 4143702	1. 4143702	
0. 00000188	877. 6348220	468071905.	32. 1491828	0. 00006028	-0. 00000722	0. 2501859	1. 7383243	1. 7383243	
0. 00000250	1170.	467930016.	28. 6289162	0. 00007157	-0. 00001843	0. 2959552	2. 0625464	2. 0625464	
0. 00000313	1461.	467641007.	26. 5182472	0. 00008287	-0. 00002963	0. 3414623	2. 3869037	2. 3869037	
0. 00000375	1752.	467250170.	25. 1118210	0. 00009417	-0. 00004083	0. 3866985	2. 7113355	2. 7113355	
0. 00000438	2042.	466792067.	24. 1075973	0. 0001055	-0. 00005203	0. 4316598	3. 0358139	3. 0358139	
0. 00000500	2331.	466288470.	23. 3546494	0. 0001168	-0. 00006323	0. 4763439	3. 3603242	3. 3603242	
0. 00000563	2620.	465753053.	22. 7691684	0. 0001281	-0. 00007442	0. 5207498	3. 6848581	3. 6848581	
0. 00000625	2907.	465194637.	22. 3008863	0. 0001394	-0. 00008562	0. 5648765	4. 0094107	4. 0094107	
0. 00000688	3194.	464619125.	21. 9178240	0. 0001507	-0. 00009681	0. 6087238	4. 3339787	4. 3339787	
0. 00000750	3480.	464030584.	21. 5986668	0. 0001620	-0. 0001080	0. 6522912	4. 6585600	4. 6585600	
0. 00000813	3480.	428335924.	18. 4131074	0. 0001496	-0. 0001429	0. 6036313	4. 2961760	4. 2961760	C
0. 00000875	3480.	397740501.	18. 0268712	0. 0001577	-0. 0001573	0. 6348868	4. 5286436	4. 5286436	C
0. 00000938	3480.	371224467.	17. 6867626	0. 0001658	-0. 0001717	0. 6658027	-4. 9299739	-4. 9299739	C
0. 00001000	3480.	348022938.	17. 3849989	0. 0001738	-0. 0001862	0. 6964154	-5. 3461503	-5. 3461503	C
0. 00001063	3480.	327551001.	17. 1153626	0. 0001819	-0. 0002006	0. 7267493	-5. 7633664	-5. 7633664	C
0. 00001125	3480.	309353723.	16. 8717081	0. 0001898	-0. 0002152	0. 7567724	-6. 1818802	-6. 1818802	C
0. 00001188	3480.	293071948.	16. 6520668	0. 0001977	-0. 0002298	0. 7865834	-6. 6009569	-6. 6009569	C
0. 00001250	3489.	279130274.	16. 4523672	0. 0002057	-0. 0002443	0. 8161610	-7. 0207669	-7. 0207669	C
0. 00001313	3625.	276222657.	16. 2698116	0. 0002135	-0. 0002590	0. 8455093	-7. 4412904	-7. 4412904	C
0. 00001375	3761.	273560033.	16. 1028111	0. 0002214	-0. 0002736	0. 8746680	-7. 8622290	-7. 8622290	C
0. 00001438	3897.	271110282.	15. 9491782	0. 0002293	-0. 0002882	0. 9036294	-8. 2836488	-8. 2836488	C
0. 00001500	4033.	268845114.	15. 8070497	0. 0002371	-0. 0003029	0. 9323836	-8. 7056334	-8. 7056334	C
0. 00001563	4168.	266756065.	15. 6765364	0. 0002449	-0. 0003176	0. 9610179	-9. 1275069	-9. 1275069	C
0. 00001625	4303.	264805124.	15. 5541301	0. 0002528	-0. 0003322	0. 9894024	-9. 5502911	-9. 5502911	C
0. 00001688	4438.	262991440.	15. 4406977	0. 0002606	-0. 0003469	1. 0176479	-9. 9731210	-9. 9731210	C
0. 00001750	4573.	261302816.	15. 3355865	0. 0002684	-0. 0003616	1. 0457742	-10. 3958398	-10. 3958398	C
0. 00001813	4707.	259716817.	15. 2366118	0. 0002762	-0. 0003763	1. 0736942	-10. 8191434	-10. 8191434	C
0. 00001875	4842.	258227337.	15. 1437321	0. 0002839	-0. 0003911	1. 1014475	-11. 2427206	-11. 2427206	C
0. 00001938	4976.	256829947.	15. 0570432	0. 0002917	-0. 0004058	1. 1290824	-11. 6661863	-11. 6661863	C
0. 00002000	5110.	255516006.	14. 9759651	0. 0002995	-0. 0004205	1. 1565987	-12. 0895402	-12. 0895402	C
0. 00002063	5244.	254272530.	14. 8991160	0. 0003073	-0. 0004352	1. 1839322	-12. 5133037	-12. 5133037	C
0. 00002125	5378.	253094019.	14. 8262328	0. 0003151	-0. 0004499	1. 2110920	-12. 9374090	-12. 9374090	C
0. 00002188	5512.	251979336.	14. 7576920	0. 0003228	-0. 0004647	1. 2381339	-13. 3614015	-13. 3614015	C
0. 00002250	5646.	250923152.	14. 6931321	0. 0003306	-0. 0004794	1. 2650577	-13. 7852812	-13. 7852812	C
0. 00002313	5779.	249920717.	14. 6322308	0. 0003384	-0. 0004941	1. 2918633	-14. 2090477	-14. 2090477	C
0. 00002375	5913.	248967166.	14. 5745814	0. 0003461	-0. 0005089	1. 3185407	-14. 6327820	-14. 6327820	C
0. 00002438	6046.	248053626.	14. 5189471	0. 0003539	-0. 0005236	1. 3450067	-15. 0571817	-15. 0571817	C
0. 00002563	6313.	246351261.	14. 4162828	0. 0003694	-0. 0005531	1. 3975856	-15. 9056372	-15. 9056372	C
0. 00002688	6579.	244795804.	14. 3237595	0. 0003850	-0. 0005825	1. 4496924	-16. 7536324	-16. 7536324	C
0. 00002813	6845.	243367617.	14. 2400278	0. 0004005	-0. 0006120	1. 5013258	-17. 6011648	-17. 6011648	C
0. 00002938	7110.	242045054.	14. 1626862	0. 0004160	-0. 0006415	1. 5523594	-18. 4493241	-18. 4493241	C
0. 00003063	7375.	240818639.	14. 0917691	0. 0004316	-0. 0006709	1. 6028776	-19. 2973850	-19. 2973850	C
0. 00003188	7640.	239678711.	14. 0269268	0. 0004471	-0. 0007004	1. 6529221	-20. 1449720	-20. 1449720	C
0. 00003313	7904.	238615434.	13. 9674741	0. 0004627	-0. 0007298	1. 7024915	-20. 9920826	-20. 9920826	C
0. 00003438	8168.	237620403.	13. 9128257	0. 0004783	-0. 0007592	1. 7515843	-21. 8387143	-21. 8387143	C
0. 00003563	8432.	236686392.	13. 8624785	0. 0004939	-0. 0007886	1. 8001992	-22. 6848643	-22. 6848643	C
0. 00003688	8695.	235803918.	13. 8149606	0. 0005094	-0. 0008181	1. 8482158	-23. 5316389	-23. 5316389	C
0. 00003813	8958.	234970922.	13. 7709500	0. 0005250	-0. 0008475	1. 8957484	-24. 3779808	-24. 3779808	C
0. 00003938	9221.	234182820.	13. 7301678	0. 0005406	-0. 0008769	1. 9428022	-25. 2238270	-25. 2238270	C
0. 00004063	9483.	233435429.	13. 6923184	0. 0005563	-0. 0009062	1. 9893756	-26. 0691747	-26. 0691747	C
0. 00004188	9745.	232725064.	13. 6571415	0. 0005719	-0. 0009356	2. 0354671	-26. 9140211	-26. 9140211	C
0. 00004313	10007.	232048470.	13. 6244070	0. 0005876	-0. 0009649	2. 0810752	-27. 7583634	-27. 7583634	C

Lpile Run 3 ft shaft. lp9o

0.00004438	10268.	231402755.	13.5939107	0.0006032	-0.0009943	2.1261985	-28.6021985	-28.6021985 C
0.00004563	10530.	230785346.	13.5654710	0.0006189	-0.0010236	2.1708353	-29.4455236	-29.4455236 C
0.00004688	10790.	230193942.	13.5389254	0.0006346	-0.0010529	2.2149842	-30.2883356	-30.2883356 C
0.00004813	11051.	229626484.	13.5141286	0.0006504	-0.0010821	2.2586435	-31.1306317	-31.1306317 C
0.00004938	11311.	229080684.	13.4907283	0.0006661	-0.0011114	2.3017815	-31.9727257	-31.9727257 C
0.00005063	11571.	228554722.	13.4685176	0.0006818	-0.0011407	2.3443832	-32.8147699	-32.8147699 C
0.00005188	11830.	228047771.	13.4477326	0.0006976	-0.0011699	2.3864933	-33.6562797	-33.6562797 C
0.00005313	12089.	227558457.	13.4282747	0.0007134	-0.0011991	2.4281103	-34.4972517	-34.4972517 C
0.00005438	12348.	227085529.	13.4100545	0.0007292	-0.0012283	2.4692325	-35.3376826	-35.3376826 C
0.00005563	12600.	226519761.	13.3907907	0.0007449	-0.0012576	2.5095415	-36.1811181	-36.0000000 CY
0.00005688	12821.	225418677.	13.3613328	0.0007599	-0.0012876	2.5477083	-37.0427640	-36.0000000 CY
0.00005813	13021.	224024822.	13.3263879	0.0007746	-0.0013179	2.5843898	-37.9157947	-36.0000000 CY
0.00005938	13208.	222446232.	13.2880251	0.0007890	-0.0013485	2.6198789	-38.7972440	-36.0000000 CY
0.00006063	13384.	220763130.	13.2478275	0.0008031	-0.0013794	2.6544081	-39.6847006	-36.0000000 CY
0.00006188	13551.	218997995.	13.2061754	0.0008171	-0.0014104	2.6880371	-40.5776814	-36.0000000 CY
0.00006313	13709.	2171170105.	13.1673986	0.0008309	-0.0014416	2.7208206	-41.4757408	-36.0000000 CY
0.00006438	13860.	215307607.	13.1195676	0.0008446	-0.0014729	2.7527754	-42.3788696	-36.0000000 CY
0.00006563	14006.	213421575.	13.0747776	0.0008580	-0.0015045	2.7839226	-43.2870011	-36.0000000 CY
0.00006688	14146.	211524312.	13.0298498	0.0008714	-0.0015361	2.8143961	-44.1986474	-36.0000000 CY
0.00006813	14281.	209623635.	12.9849294	0.0008846	-0.0015679	2.8442280	-45.1135362	-36.0000000 CY
0.00006938	14411.	207725971.	12.9401370	0.0008977	-0.0015998	2.8734471	-46.0314241	-36.0000000 CY
0.00007063	14537.	205836631.	12.8955740	0.0009107	-0.0016318	2.9020793	-46.9520898	-36.0000000 CY
0.00007188	14660.	203960026.	12.8513258	0.0009237	-0.0016638	2.9301482	-47.8753301	-36.0000000 CY
0.00007313	14779.	202099822.	12.8074653	0.0009365	-0.0016960	2.9576755	-48.8009563	-36.0000000 CY
0.00007438	14894.	200256883.	12.7635824	0.0009493	-0.0017282	2.9846062	-49.7298105	-36.0000000 CY
0.00007938	15328.	193107348.	12.5903056	0.0009994	-0.0018581	3.0869449	-53.4718525	-36.0000000 CY
0.00008438	15725.	186371716.	12.4264457	0.0010485	-0.0019890	3.1820504	-57.2411029	-36.0000000 CY
0.00008938	16092.	180053092.	12.2679317	0.0010964	-0.0021211	3.2698247	-60.0000000	-36.0000000 CY
0.00009438	16437.	174163590.	12.1193253	0.0011438	-0.0022537	3.3515089	-60.0000000	-36.0000000 CY
0.00009938	16762.	168672168.	11.9778283	0.0011903	-0.0023872	3.4270984	-60.0000000	-36.0000000 CY
0.0001044	17071.	163554578.	11.8437971	0.0012362	-0.0025213	3.4970498	-60.0000000	-36.0000000 CY
0.0001094	17357.	158691528.	11.7231660	0.0012822	-0.0026553	3.5626239	-60.0000000	-36.0000000 CY
0.0001144	17549.	153432599.	11.5968455	0.0013264	-0.0027911	3.6211998	-60.0000000	-36.0000000 CY
0.0001194	17690.	148187148.	11.4726096	0.0013695	-0.0029280	3.6743400	-60.0000000	-36.0000000 CY
0.0001244	17819.	143265831.	11.3595686	0.0014128	-0.0030647	3.7236331	-60.0000000	-36.0000000 CY
0.0001294	17936.	138635471.	11.2522462	0.0014558	-0.0032017	3.7684850	-60.0000000	-36.0000000 CY
0.0001344	18044.	134283270.	11.1531628	0.0014987	-0.0033388	3.8093997	-60.0000000	-36.0000000 CY
0.0001394	18145.	130190808.	11.0616788	0.0015417	-0.0034758	3.8463960	-60.0000000	-36.0000000 CY
0.0001444	18240.	126339335.	10.9762147	0.0015847	-0.0036128	3.8793706	-60.0000000	-36.0000000 CY
0.0001494	18328.	122696835.	10.8938545	0.0016273	-0.0037502	3.9081146	-60.0000000	-36.0000000 CY
0.0001544	18411.	119261401.	10.8169044	0.0016699	-0.0038876	3.9329593	-60.0000000	-36.0000000 CY
0.0001594	18490.	116013838.	10.7453912	0.0017125	-0.0040250	3.9539401	-60.0000000	-36.0000000 CY
0.0001644	18564.	112939422.	10.6783110	0.0017552	-0.0041623	3.9709997	-60.0000000	-36.0000000 CY
0.0001694	18635.	110023910.	10.6156639	0.0017980	-0.0042995	3.9841520	-60.0000000	-36.0000000 CY
0.0001744	18703.	107254535.	10.5537982	0.0018403	-0.0044372	3.9932755	-60.0000000	-36.0000000 CY
0.0001794	18766.	104621229.	10.4966739	0.0018828	-0.0045747	3.9985658	-60.0000000	-36.0000000 CY
0.0001844	18828.	102116587.	10.4424608	0.0019253	-0.0047122	3.9981595	-60.0000000	-36.0000000 CY
0.0001894	18886.	99730295.	10.3917248	0.0019679	-0.0048496	3.9995229	-60.0000000	-36.0000000 CY
0.0001944	18943.	97455392.	10.3447964	0.0020108	-0.0049867	3.9971399	-60.0000000	-36.0000000 CY
0.0001994	18997.	95281411.	10.3000321	0.0020536	-0.0051239	3.9998343	-60.0000000	-36.0000000 CY
0.0002044	19049.	93205075.	10.2585423	0.0020966	-0.0052609	3.9974961	-60.0000000	-36.0000000 CY
0.0002094	19098.	91212631.	10.2173934	0.0021393	-0.0053982	3.9998685	-60.0000000	-36.0000000 CY
0.0002144	19145.	89306660.	10.1788476	0.0021821	-0.0055354	3.9970220	-60.0000000	-36.0000000 CY
0.0002194	19191.	87479391.	10.1420965	0.0022249	-0.0056726	3.9996851	-60.0000000	-36.0000000 CY

Lpile Run 3 ft shaft. l p9o								
0.0002244	19235.	85726621.	10.1085443	0.0022681	-0.0058094	3.9956185	60.0000000	36.0000000 CY
0.0002294	19277.	84041386.	10.0765389	0.0023113	-0.0059462	3.9990462	60.0000000	36.0000000 CY
0.0002344	19318.	82425330.	10.0466323	0.0023547	-0.0060828	3.9986374	60.0000000	36.0000000 CY
0.0002394	19358.	80869767.	10.0182188	0.0023981	-0.0062194	3.9973776	60.0000000	36.0000000 CY
0.0002444	19396.	79369565.	9.9913752	0.0024416	-0.0063559	3.9996952	60.0000000	36.0000000 CY
0.0002494	19432.	77921378.	9.9660172	0.0024853	-0.0064922	3.9951507	60.0000000	36.0000000 CY
0.0002544	19461.	76504339.	9.9385755	0.0025281	-0.0066294	3.9977277	60.0000000	36.0000000 CY
0.0002594	19486.	75125717.	9.9104555	0.0025705	-0.0067670	3.9997101	60.0000000	36.0000000 CY
0.0002644	19504.	73775558.	9.8792698	0.0026118	-0.0069057	3.9963165	60.0000000	36.0000000 CY
0.0002694	19518.	72456905.	9.8462290	0.0026523	-0.0070452	3.9961880	60.0000000	36.0000000 CY
0.0002744	19530.	71180947.	9.8145199	0.0026929	-0.0071846	3.9987758	60.0000000	36.0000000 CY
0.0003044	19588.	64354335.	9.6461367	0.0029360	-0.0080215	3.9972380	60.0000000	36.0000000 CY
0.0003344	19628.	58701078.	9.5125231	0.0031807	-0.0088568	3.9909275	60.0000000	36.0000000 CY
0.0003644	19655.	53942887.	9.3961764	0.0034237	-0.0096938	3.9909240	60.0000000	36.0000000 CY
0.0003944	19674.	49886859.	9.3015681	0.0036683	-0.0105292	3.9976964	60.0000000	36.0000000 CY
0.0004244	19679.	46371476.	9.2282406	0.0039162	-0.0113613	3.9988126	60.0000000	36.0000000 CY

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Summary of Results for Nominal (Unfactored) Moment Capacity for Section 1  
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Moment values interpolated at maximum compressive strain = 0.003  
or maximum developed moment if pile fails at smaller strains.

Load No.	Axial Thrust kips	Nominal Mom. Cap. in-kip	Max. Comp. Strain
1	-8.000	18171.479	0.00300000
2	56.000	18826.381	0.00300000
3	71.000	18975.525	0.00300000
4	104.000	19299.187	0.00300000
5	116.000	19415.845	0.00300000
6	135.000	19598.389	0.00300000

Note that the values of moment capacity in the table above are not factored by a strength reduction factor (phi-factor).

In ACI 318, the value of the strength reduction factor depends on whether the transverse reinforcing steel bars are tied hoops (0.65) or spirals (0.70).

The above values should be multiplied by the appropriate strength reduction factor to compute ultimate moment capacity according to ACI 318, Section 9.3.2.2 or the value required by the design standard being followed.

The following table presents factored moment capacities and corresponding bending stiffnesses computed for common resistance factor values used for reinforced concrete sections.

Axial Load No.	Resist. Factor for Moment	Nominal Moment Cap in-kips	Ult. (Fac) Ax. Thrust kips	Ult. (Fac) Moment Cap in-kips	Bend. Stiff. at Ult Mom kip-in^2
1	0.65	18171.	-5.200000	11811.	209491180.

Lpile Run 3 ft shaft. l p90					
2	0.65	18826.	36.400000	12237.	217106212.
3	0.65	18976.	46.150000	12334.	218831290.
4	0.65	19299.	67.600000	12544.	222516294.
5	0.65	19416.	75.400000	12620.	223812524.
6	0.65	19598.	87.750000	12739.	225826776.
1	0.70	18171.	-5.600000	12720.	199722415.
2	0.70	18826.	39.200000	13178.	207651644.
3	0.70	18976.	49.700000	13283.	209472637.
4	0.70	19299.	72.800000	13509.	213427523.
5	0.70	19416.	81.200000	13591.	214829123.
6	0.70	19598.	94.500000	13719.	217047100.
1	0.75	18171.	-6.000000	13629.	186361752.
2	0.75	18826.	42.000000	14120.	194042591.
3	0.75	18976.	53.250000	14232.	195839379.
4	0.75	19299.	78.000000	14474.	199730436.
5	0.75	19416.	87.000000	14562.	201137086.
6	0.75	19598.	101.250000	14699.	203347399.

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Layering Correction Equivalent Depths of Soil & Rock Layers  
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Layer No.	Top of Layer Below Pile Head ft	Equivalent Top Depth Below Grnd Surf ft	Same Layer Type As Layer Above	Layer is Rock or is Below Rock Layer	F0 Integral for Layer lbs	F1 Integral for Layer lbs
1	0.00	0.00	N. A.	No	0.00	26764.
2	4.0000	4.0000	Yes	No	26764.	70114.
3	8.0000	8.0000	Yes	No	96879.	645913.
4	21.0000	21.0000	Yes	No	742792.	650456.
5	27.0000	27.0000	Yes	No	1393249.	2299745.
6	37.0000	37.0000	Yes	No	3692994.	N. A.

Notes: The F0 integral of Layer n+1 equals the sum of the F0 and F1 integrals for Layer n. Layering correction equivalent depths are computed only for soil types with both shallow-depth and deep-depth expressions for peak lateral load transfer. These soil types are soft and stiff clays, non-liquefied sands, and cemented c-phi soil.

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Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 1  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Lpile Run 3 ft shaft.lp9o

Shear force at pile head = 0.0 lbs  
 Applied moment at pile head = 5014935.0 in-lbs  
 Axial thrust load on pile head = 104000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.9667	5014935.	-9.88E-08	-0.00673	0.00	2.46E+11	0.00	0.00	791.7000
0.4000	0.9347	5027388.	3602.	-0.00663	0.00	2.46E+11	-82.7553	424.9919	791.7000
0.8000	0.9031	5056126.	6792.	-0.00653	0.00	2.46E+11	-171.1397	909.6211	791.7000
1.2000	0.8720	5099113.	9550.	-0.00643	0.00	2.46E+11	-263.1942	1449.	791.7000
1.6000	0.8414	5154227.	11862.	-0.00633	0.00	2.45E+11	-357.0896	2037.	791.7000
2.0000	0.8112	5219304.	13721.	-0.00623	0.00	2.45E+11	-451.3930	2671.	791.7000
2.4000	0.7816	5292170.	15132.	-0.00612	0.00	2.44E+11	-544.3361	3343.	791.7000
2.8000	0.7524	5370684.	16103.	-0.00602	0.00	2.44E+11	-634.3545	4047.	791.7000
3.2000	0.7238	5452770.	16650.	-0.00591	0.00	2.43E+11	-721.1545	4783.	791.7000
3.6000	0.6957	5536428.	16790.	-0.00580	0.00	2.43E+11	-803.9735	5547.	791.7000
4.0000	0.6681	5619749.	16688.	-0.00569	0.00	2.42E+11	-821.7126	5904.	791.7000
4.4000	0.6410	5702322.	16536.	-0.00558	0.00	2.42E+11	-825.3702	6181.	791.7000
4.8000	0.6145	5784063.	16234.	-0.00547	0.00	2.41E+11	-883.6657	6903.	791.7000
5.2000	0.5885	5863628.	15663.	-0.00535	0.00	2.41E+11	-937.7632	7649.	791.7000
5.6000	0.5631	5939769.	14850.	-0.00523	0.00	2.41E+11	-984.4402	8392.	791.7000
6.0000	0.5383	6011411.	13832.	-0.00511	0.00	2.40E+11	-1023.	9121.	791.7000
6.4000	0.5140	6077667.	12631.	-0.00499	0.00	2.40E+11	-1061.	9909.	791.7000
6.8000	0.4903	6137656.	11266.	-0.00487	0.00	2.40E+11	-1091.	10683.	791.7000
7.2000	0.4672	6190682.	9776.	-0.00475	0.00	2.39E+11	-1113.	11434.	791.7000
7.6000	0.4447	6236243.	8196.	-0.00462	0.00	2.39E+11	-1129.	12180.	791.7000
8.0000	0.4228	6273982.	6542.	-0.00450	0.00	2.39E+11	-1144.	12990.	791.7000
8.4000	0.4016	6303533.	4833.	-0.00437	0.00	2.39E+11	-1151.	13758.	791.7000
8.8000	0.3809	6324743.	3116.	-0.00424	0.00	2.39E+11	-1148.	14468.	791.7000
9.2000	0.3608	6337680.	1405.	-0.00412	0.00	2.39E+11	-1148.	15273.	791.7000
9.6000	0.3413	6342342.	-316.8476	-0.00399	0.00	2.39E+11	-1153.	16211.	791.7000
10.0000	0.3225	6338621.	-2042.	-0.00386	0.00	2.39E+11	-1149.	17106.	791.7000
10.4000	0.3043	6326597.	-3730.	-0.00373	0.00	2.39E+11	-1137.	17941.	791.7000
10.8000	0.2867	6306546.	-5339.	-0.00361	0.00	2.39E+11	-1117.	18697.	791.7000
11.2000	0.2696	6278948.	-6827.	-0.00348	0.00	2.39E+11	-1087.	19349.	791.7000
11.6000	0.2532	6244485.	-8151.	-0.00336	0.00	2.39E+11	-1048.	19873.	791.7000
12.0000	0.2374	6204045.	-9270.	-0.00323	0.00	2.39E+11	-1001.	20242.	791.7000
12.4000	0.2222	6158715.	-10290.	-0.00311	0.00	2.39E+11	-1007.	21756.	791.7000
12.8000	0.2076	6108359.	-11330.	-0.00298	0.00	2.40E+11	-1009.	23341.	791.7000
13.2000	0.1936	6052924.	-12372.	-0.00286	0.00	2.40E+11	-1008.	24998.	791.7000
13.6000	0.1801	5992442.	-13399.	-0.00274	0.00	2.40E+11	-1003.	26729.	791.7000
14.0000	0.1673	5927031.	-14392.	-0.00262	0.00	2.41E+11	-994.2111	28533.	791.7000
14.4000	0.1549	5856895.	-15334.	-0.00251	0.00	2.41E+11	-981.7013	30411.	791.7000
14.8000	0.1432	5782324.	-16207.	-0.00239	0.00	2.41E+11	-965.5485	32364.	791.7000
15.2000	0.1320	5703689.	-17016.	-0.00228	0.00	2.42E+11	-954.6936	34714.	791.7000
15.6000	0.1214	5621243.	-17787.	-0.00216	0.00	2.42E+11	-949.8521	37569.	791.7000
16.0000	0.1112	5535098.	-18528.	-0.00205	0.00	2.43E+11	-942.3692	40662.	791.7000
16.4000	0.1017	5445426.	-19227.	-0.00194	0.00	2.43E+11	-932.2345	44019.	791.7000
16.8000	0.09258	5352463.	-19871.	-0.00184	0.00	2.44E+11	-919.4453	47671.	791.7000
17.2000	0.08401	5256504.	-20447.	-0.00173	0.00	2.45E+11	-904.0075	51652.	791.7000
17.6000	0.07594	5157905.	-20942.	-0.00163	0.00	2.45E+11	-885.9352	56001.	791.7000

Lpile Run 3 ft shaft. lp90									
18. 0000	0. 06835	5057086.	-21345.	-0. 00153	0. 00	2. 46E+11	-865. 2515	60767.	791. 7000
18. 4000	0. 06123	4954522.	-21568.	-0. 00143	0. 00	2. 47E+11	-811. 1946	63590.	791. 7000
18. 8000	0. 05458	4851461.	-21488.	-0. 00134	0. 00	2. 47E+11	-738. 7790	64973.	791. 7000
19. 2000	0. 04838	4749573.	-21066.	-0. 00125	0. 00	2. 48E+11	-668. 7755	66355.	791. 7000
19. 6000	0. 04262	4650470.	-20314.	-0. 00116	0. 00	2. 49E+11	-601. 4200	67738.	791. 7000
20. 0000	0. 03729	4555708.	-20196.	-0. 00107	0. 00	2. 50E+11	-536. 9400	69120.	395. 8500
20. 4000	0. 03238	4457650.	-21676.	-9. 80E-04	0. 00	2. 51E+11	-475. 5577	70502.	0. 00
20. 8000	0. 02788	4348594.	-23820.	-8. 96E-04	0. 00	2. 52E+11	-417. 4787	71885.	0. 00
21. 2000	0. 02377	4229877.	-25402.	-8. 15E-04	0. 00	2. 53E+11	-241. 9189	48845.	0. 00
21. 6000	0. 02006	4105546.	-26482.	-7. 36E-04	0. 00	2. 54E+11	-207. 9352	49766.	0. 00
22. 0000	0. 01671	3976386.	-27404.	-6. 60E-04	0. 00	2. 56E+11	-176. 4492	50688.	0. 00
22. 4000	0. 01372	3843123.	-28182.	-5. 87E-04	0. 00	2. 58E+11	-147. 5267	51610.	0. 00
22. 8000	0. 01108	3706426.	-28827.	-5. 17E-04	0. 00	2. 59E+11	-121. 2182	52531.	0. 00
23. 2000	0. 00876	3566901.	-29352.	-4. 50E-04	0. 00	2. 62E+11	-97. 5593	53453.	0. 00
23. 6000	0. 00676	3425096.	-29770.	-3. 99E-04	0. 00	4. 64E+11	-76. 5636	54374.	0. 00
24. 0000	0. 00493	3281510.	-30090.	-3. 65E-04	0. 00	4. 65E+11	-56. 7565	55296.	0. 00
24. 4000	0. 00326	3136598.	-30318.	-3. 32E-04	0. 00	4. 65E+11	-38. 1511	56218.	0. 00
24. 8000	0. 00174	2990792.	-30459.	-3. 00E-04	0. 00	4. 65E+11	-20. 7543	57139.	0. 00
25. 2000	3. 78E-04	2844492.	-30520.	-2. 70E-04	0. 00	4. 66E+11	-4. 5671	58061.	0. 00
25. 6000	-8. 48E-04	2698072.	-30506.	-2. 41E-04	0. 00	4. 66E+11	10. 4153	58982.	0. 00
26. 0000	-0. 00194	2551878.	-30423.	-2. 14E-04	0. 00	4. 66E+11	24. 2033	59904.	0. 00
26. 4000	-0. 00291	2406229.	-30276.	-1. 89E-04	0. 00	4. 67E+11	36. 8129	60826.	0. 00
26. 8000	-0. 00375	2261416.	-30072.	-1. 65E-04	0. 00	4. 67E+11	48. 2648	61747.	0. 00
27. 2000	-0. 00449	2117703.	-29640.	-1. 42E-04	0. 00	4. 67E+11	131. 8159	141005.	0. 00
27. 6000	-0. 00512	1977016.	-28957.	-1. 21E-04	0. 00	4. 67E+11	152. 5582	143078.	0. 00
28. 0000	-0. 00565	1839834.	-28181.	-1. 02E-04	0. 00	4. 68E+11	170. 8986	145152.	0. 00
28. 4000	-0. 00609	1706580.	-27322.	-8. 35E-05	0. 00	4. 68E+11	186. 9198	147226.	0. 00
28. 8000	-0. 00645	1577624.	-26392.	-6. 66E-05	0. 00	4. 68E+11	200. 7099	149299.	0. 00
29. 2000	-0. 00673	1453284.	-25401.	-5. 11E-05	0. 00	4. 68E+11	212. 3612	151373.	0. 00
29. 6000	-0. 00694	1333829.	-24358.	-3. 68E-05	0. 00	4. 69E+11	221. 9699	153446.	0. 00
30. 0000	-0. 00709	1219482.	-23274.	-2. 38E-05	0. 00	4. 69E+11	229. 6344	155520.	0. 00
30. 4000	-0. 00717	1110420.	-22158.	-1. 18E-05	0. 00	4. 69E+11	235. 4551	157594.	0. 00
30. 8000	-0. 00720	1006777.	-21018.	-9. 84E-07	0. 00	4. 69E+11	239. 5330	159667.	0. 00
31. 2000	-0. 00718	908647.	-19863.	8. 82E-06	0. 00	4. 69E+11	241. 9695	161741.	0. 00
31. 6000	-0. 00712	816088.	-18699.	1. 76E-05	0. 00	4. 69E+11	242. 8654	163814.	0. 00
32. 0000	-0. 00701	729120.	-17534.	2. 55E-05	0. 00	4. 69E+11	242. 3200	165888.	0. 00
32. 4000	-0. 00687	647731.	-16376.	3. 26E-05	0. 00	4. 69E+11	240. 4311	167962.	0. 00
32. 8000	-0. 00670	571879.	-15229.	3. 88E-05	0. 00	4. 69E+11	237. 2938	170035.	0. 00
33. 2000	-0. 00650	501491.	-14101.	4. 43E-05	0. 00	4. 69E+11	233. 0005	172109.	0. 00
33. 6000	-0. 00627	436469.	-12995.	4. 91E-05	0. 00	4. 69E+11	227. 6404	174182.	0. 00
34. 0000	-0. 00603	376690.	-11918.	5. 33E-05	0. 00	4. 69E+11	221. 2987	176256.	0. 00
34. 4000	-0. 00576	322007.	-10873.	5. 69E-05	0. 00	4. 69E+11	214. 0568	178330.	0. 00
34. 8000	-0. 00548	272254.	-9865.	5. 99E-05	0. 00	4. 69E+11	205. 9915	180403.	0. 00
35. 2000	-0. 00519	227246.	-8897.	6. 25E-05	0. 00	4. 69E+11	197. 1754	182477.	0. 00
35. 6000	-0. 00488	186780.	-7973.	6. 46E-05	0. 00	4. 69E+11	187. 6759	184550.	0. 00
36. 0000	-0. 00457	150637.	-7097.	6. 63E-05	0. 00	4. 69E+11	177. 5561	186624.	0. 00
36. 4000	-0. 00424	118584.	-6270.	6. 77E-05	0. 00	4. 69E+11	166. 8736	188698.	0. 00
36. 8000	-0. 00392	90376.	-5496.	6. 87E-05	0. 00	4. 69E+11	155. 6816	190771.	0. 00
37. 2000	-0. 00358	65753.	-4642.	6. 95E-05	0. 00	4. 69E+11	200. 0390	267840.	0. 00
37. 6000	-0. 00325	45740.	-3722.	7. 01E-05	0. 00	4. 69E+11	183. 2728	270720.	0. 00
38. 0000	-0. 00291	29948.	-2884.	7. 05E-05	0. 00	4. 69E+11	165. 9761	273600.	0. 00
38. 4000	-0. 00257	17981.	-2130.	7. 07E-05	0. 00	4. 69E+11	148. 1894	276480.	0. 00
38. 8000	-0. 00223	9428.	-1463.	7. 09E-05	0. 00	4. 69E+11	129. 9445	279360.	0. 00
39. 2000	-0. 00189	3868.	-883. 7890	7. 10E-05	0. 00	4. 69E+11	111. 2643	282240.	0. 00



						Lpile Run 3 ft shaft.lp9o				
39.6000	-0.00155	872.3933	-395.5607	7.10E-05	0.00	4.69E+11	92.1642	285120.	0.00	
40.0000	-0.00121	0.00	0.00	7.10E-05	0.00	4.69E+11	72.6528	144000.	0.00	

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

Output Summary for Load Case No. 1:

Pile-head deflection	=	0.96671165 inches
Computed slope at pile head	=	-0.00672505 radians
Maximum bending moment	=	6342342. inch-lbs
Maximum shear force	=	-30520. lbs
Depth of maximum bending moment	=	9.60000000 feet below pile head
Depth of maximum shear force	=	25.20000000 feet below pile head
Number of iterations	=	27
Number of zero deflection points	=	1

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Pile-head Deflection vs. Pile Length for Load Case 1  
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Boundary Condition Type 1, Shear and Moment

Shear	=	0. lbs
Moment	=	5014935. in-lbs
Axial Load	=	104000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.96671165	6342342.	-30520.
38.00000	0.96650080	6341950.	-31051.
36.00000	0.96387742	6330440.	-32556.
34.00000	0.96840157	6343052.	-35117.
32.00000	0.97022307	6328956.	-38655.
30.00000	0.98200472	6302358.	-42164.
28.00000	1.01816271	6246034.	-44341.
26.00000	1.10866460	6138467.	-45248.
24.00000	1.22300243	6033526.	-52220.
22.00000	1.37154884	5912737.	-58047.
20.00000	1.59772059	5802661.	-61823.
18.00000	2.25279591	5750728.	-69037.

Lpile Run 3 ft shaft.lp9o

Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 2

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = -1300.0 lbs  
Applied moment at pile head = 5497571.0 in-lbs  
Axial thrust load on pile head = 116000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.9888	5497571.	-1300.	-0.00699	0.00	2.46E+11	0.00	0.00	791.7000
0.4000	0.9555	5504314.	2300.	-0.00688	0.00	2.46E+11	-83.4165	419.0540	791.7000
0.8000	0.9227	5527316.	5486.	-0.00678	0.00	2.46E+11	-172.4729	897.2234	791.7000
1.2000	0.8904	5564525.	8236.	-0.00667	0.00	2.46E+11	-265.1940	1430.	791.7000
1.6000	0.8587	5613804.	10536.	-0.00656	0.00	2.46E+11	-359.7255	2011.	791.7000
2.0000	0.8275	5672975.	12382.	-0.00645	0.00	2.45E+11	-454.5874	2637.	791.7000
2.4000	0.7968	5739851.	13776.	-0.00634	0.00	2.45E+11	-548.0262	3301.	791.7000
2.8000	0.7666	5812278.	14728.	-0.00622	0.00	2.44E+11	-638.4710	3997.	791.7000
3.2000	0.7371	5888173.	15255.	-0.00611	0.00	2.44E+11	-725.6239	4726.	791.7000
3.6000	0.7080	5965525.	15372.	-0.00599	0.00	2.44E+11	-808.7198	5483.	791.7000
4.0000	0.6795	6042420.	15248.	-0.00587	0.00	2.43E+11	-826.3290	5837.	791.7000
4.4000	0.6516	6118451.	15074.	-0.00575	0.00	2.43E+11	-829.7785	6112.	791.7000
4.8000	0.6243	6193537.	14751.	-0.00563	0.00	2.42E+11	-888.1495	6829.	791.7000
5.2000	0.5976	6266332.	14158.	-0.00551	0.00	2.42E+11	-942.3154	7569.	791.7000
5.6000	0.5714	6335588.	13323.	-0.00538	0.00	2.42E+11	-989.1106	8308.	791.7000
6.0000	0.5459	6400225.	12283.	-0.00526	0.00	2.41E+11	-1028.	9035.	791.7000
6.4000	0.5210	6459357.	11059.	-0.00513	0.00	2.41E+11	-1066.	9820.	791.7000
6.8000	0.4967	6512102.	9671.	-0.00500	0.00	2.41E+11	-1096.	10592.	791.7000
7.2000	0.4730	6557763.	8158.	-0.00487	0.00	2.40E+11	-1118.	11341.	791.7000
7.6000	0.4500	6595841.	6557.	-0.00474	0.00	2.40E+11	-1133.	12088.	791.7000
8.0000	0.4275	6625980.	4880.	-0.00460	0.00	2.40E+11	-1149.	12899.	791.7000
8.4000	0.4058	6647816.	3150.	-0.00447	0.00	2.40E+11	-1155.	13669.	791.7000
8.8000	0.3846	6661197.	1411.	-0.00434	0.00	2.40E+11	-1152.	14382.	791.7000
9.2000	0.3641	6666195.	-319.7184	-0.00421	0.00	2.40E+11	-1152.	15191.	791.7000
9.6000	0.3442	6662811.	-2062.	-0.00407	0.00	2.40E+11	-1157.	16132.	791.7000
10.0000	0.3250	6650938.	-3806.	-0.00394	0.00	2.40E+11	-1153.	17032.	791.7000
10.4000	0.3064	6630662.	-5512.	-0.00381	0.00	2.40E+11	-1141.	17873.	791.7000
10.8000	0.2885	6602263.	-7138.	-0.00367	0.00	2.40E+11	-1120.	18635.	791.7000
11.2000	0.2712	6566229.	-8642.	-0.00354	0.00	2.40E+11	-1090.	19295.	791.7000
11.6000	0.2545	6523248.	-9980.	-0.00341	0.00	2.41E+11	-1051.	19827.	791.7000
12.0000	0.2384	6474218.	-11111.	-0.00328	0.00	2.41E+11	-1004.	20205.	791.7000
12.4000	0.2230	6420235.	-12141.	-0.00315	0.00	2.41E+11	-1009.	21724.	791.7000
12.8000	0.2081	6361173.	-13189.	-0.00303	0.00	2.41E+11	-1011.	23315.	791.7000
13.2000	0.1939	6296988.	-14237.	-0.00290	0.00	2.42E+11	-1009.	24980.	791.7000
13.6000	0.1803	6227723.	-15268.	-0.00278	0.00	2.42E+11	-1004.	26719.	791.7000
14.0000	0.1673	6153508.	-16262.	-0.00265	0.00	2.42E+11	-994.2325	28533.	791.7000
14.4000	0.1548	6074560.	-17203.	-0.00253	0.00	2.43E+11	-981.1944	30422.	791.7000
14.8000	0.1429	5991178.	-18073.	-0.00241	0.00	2.43E+11	-964.4981	32387.	791.7000
15.2000	0.1316	5903750.	-18875.	-0.00230	0.00	2.44E+11	-953.0828	34752.	791.7000
15.6000	0.1209	5812538.	-19636.	-0.00218	0.00	2.44E+11	-947.6596	37625.	791.7000

Lpile Run 3 ft shaft. lp90									
16. 0000	0. 1107	5717670.	-20366.	-0. 00207	0. 00	2. 45E+11	-939. 5786	40740.	791. 7000
16. 4000	0. 1010	5619332.	-21050.	-0. 00196	0. 00	2. 46E+11	-928. 8301	44123.	791. 7000
16. 8000	0. 09191	5517773.	-21676.	-0. 00185	0. 00	2. 46E+11	-915. 4125	47806.	791. 7000
17. 2000	0. 08330	5413305.	-22231.	-0. 00174	0. 00	2. 47E+11	-899. 3316	51825.	791. 7000
17. 6000	0. 07519	5306298.	-22703.	-0. 00164	0. 00	2. 48E+11	-880. 6014	56219.	791. 7000
18. 0000	0. 06757	5197185.	-23078.	-0. 00154	0. 00	2. 49E+11	-859. 2438	61040.	791. 7000
18. 4000	0. 06043	5086460.	-23261.	-0. 00144	0. 00	2. 50E+11	-800. 6047	63590.	791. 7000
18. 8000	0. 05377	4975476.	-23129.	-0. 00134	0. 00	2. 50E+11	-727. 7748	64973.	791. 7000
19. 2000	0. 04756	4865912.	-22654.	-0. 00125	0. 00	2. 51E+11	-657. 4327	66355.	791. 7000
19. 6000	0. 04179	4759389.	-21847.	-0. 00116	0. 00	2. 52E+11	-589. 8079	67738.	791. 7000
20. 0000	0. 03647	4657467.	-21673.	-0. 00107	0. 00	2. 53E+11	-525. 1211	69120.	395. 8500
20. 4000	0. 03156	4552518.	-23096.	-9. 79E-04	0. 00	2. 54E+11	-463. 5872	70502.	0. 00
20. 8000	0. 02707	4436840.	-25181.	-8. 94E-04	0. 00	2. 56E+11	-405. 4038	71885.	0. 00
21. 2000	0. 02298	4311775.	-26715.	-8. 12E-04	0. 00	2. 57E+11	-233. 8253	48845.	0. 00
21. 6000	0. 01927	4181278.	-27756.	-7. 33E-04	0. 00	2. 59E+11	-199. 8180	49766.	0. 00
22. 0000	0. 01594	4046134.	-28640.	-6. 57E-04	0. 00	2. 60E+11	-168. 3229	50688.	0. 00
22. 4000	0. 01296	3907070.	-29378.	-5. 84E-04	0. 00	2. 62E+11	-139. 3993	51610.	0. 00
22. 8000	0. 01033	3764755.	-29984.	-5. 14E-04	0. 00	2. 64E+11	-113. 0913	52531.	0. 00
23. 2000	0. 00803	3619796.	-30470.	-4. 47E-04	0. 00	2. 67E+11	-89. 4279	53453.	0. 00
23. 6000	0. 00604	3472740.	-30849.	-3. 97E-04	0. 00	4. 64E+11	-68. 4234	54374.	0. 00
24. 0000	0. 00422	3324088.	-31130.	-3. 62E-04	0. 00	4. 65E+11	-48. 6400	55296.	0. 00
24. 4000	0. 00257	3174296.	-31319.	-3. 28E-04	0. 00	4. 65E+11	-30. 0893	56218.	0. 00
24. 8000	0. 00107	3023792.	-31422.	-2. 96E-04	0. 00	4. 65E+11	-12. 7766	57139.	0. 00
25. 2000	-2. 73E-04	2872977.	-31444.	-2. 66E-04	0. 00	4. 66E+11	3. 2989	58061.	0. 00
25. 6000	-0. 00148	2722221.	-31393.	-2. 37E-04	0. 00	4. 66E+11	18. 1441	58982.	0. 00
26. 0000	-0. 00255	2571868.	-31273.	-2. 10E-04	0. 00	4. 66E+11	31. 7711	59904.	0. 00
26. 4000	-0. 00349	2422231.	-31091.	-1. 84E-04	0. 00	4. 66E+11	44. 1977	60826.	0. 00
26. 8000	-0. 00431	2273600.	-30852.	-1. 60E-04	0. 00	4. 67E+11	55. 4468	61747.	0. 00
27. 2000	-0. 00502	2126232.	-30365.	-1. 37E-04	0. 00	4. 67E+11	147. 4789	141005.	0. 00
27. 6000	-0. 00563	1982251.	-29608.	-1. 16E-04	0. 00	4. 67E+11	167. 6890	143078.	0. 00
28. 0000	-0. 00613	1842122.	-28761.	-9. 63E-05	0. 00	4. 67E+11	185. 4661	145152.	0. 00
28. 4000	-0. 00655	1706255.	-27833.	-7. 81E-05	0. 00	4. 68E+11	200. 8969	147226.	0. 00
28. 8000	-0. 00688	1575007.	-26838.	-6. 12E-05	0. 00	4. 68E+11	214. 0733	149299.	0. 00
29. 2000	-0. 00714	1448683.	-25784.	-4. 57E-05	0. 00	4. 68E+11	225. 0913	151373.	0. 00
29. 6000	-0. 00732	1327536.	-24682.	-3. 15E-05	0. 00	4. 68E+11	234. 0503	153446.	0. 00
30. 0000	-0. 00744	1211775.	-23541.	-1. 85E-05	0. 00	4. 68E+11	241. 0516	155520.	0. 00
30. 4000	-0. 00750	1101560.	-22372.	-6. 62E-06	0. 00	4. 68E+11	246. 1983	157594.	0. 00
30. 8000	-0. 00750	997011.	-21182.	4. 13E-06	0. 00	4. 69E+11	249. 5938	159667.	0. 00
31. 2000	-0. 00746	898207.	-19980.	1. 38E-05	0. 00	4. 69E+11	251. 3415	161741.	0. 00
31. 6000	-0. 00737	805189.	-18773.	2. 26E-05	0. 00	4. 69E+11	251. 5439	163814.	0. 00
32. 0000	-0. 00724	717962.	-17568.	3. 04E-05	0. 00	4. 69E+11	250. 3020	165888.	0. 00
32. 4000	-0. 00708	636498.	-16373.	3. 73E-05	0. 00	4. 69E+11	247. 7144	167962.	0. 00
32. 8000	-0. 00688	560738.	-15193.	4. 34E-05	0. 00	4. 69E+11	243. 8775	170035.	0. 00
33. 2000	-0. 00666	490593.	-14035.	4. 88E-05	0. 00	4. 69E+11	238. 8840	172109.	0. 00
33. 6000	-0. 00642	425950.	-12903.	5. 35E-05	0. 00	4. 69E+11	232. 8236	174182.	0. 00
34. 0000	-0. 00615	366668.	-11802.	5. 76E-05	0. 00	4. 69E+11	225. 7815	176256.	0. 00
34. 4000	-0. 00586	312586.	-10737.	6. 10E-05	0. 00	4. 69E+11	217. 8389	178330.	0. 00
34. 8000	-0. 00556	263522.	-9713.	6. 40E-05	0. 00	4. 69E+11	209. 0723	180403.	0. 00
35. 2000	-0. 00525	219273.	-8732.	6. 65E-05	0. 00	4. 69E+11	199. 5536	182477.	0. 00
35. 6000	-0. 00492	179620.	-7799.	6. 85E-05	0. 00	4. 69E+11	189. 3496	184550.	0. 00
36. 0000	-0. 00459	144329.	-6916.	7. 02E-05	0. 00	4. 69E+11	178. 5220	186624.	0. 00
36. 4000	-0. 00425	113150.	-6086.	7. 15E-05	0. 00	4. 69E+11	167. 1276	188698.	0. 00
36. 8000	-0. 00391	85822.	-5313.	7. 25E-05	0. 00	4. 69E+11	155. 2182	190771.	0. 00
37. 2000	-0. 00356	62069.	-4464.	7. 33E-05	0. 00	4. 69E+11	198. 3896	267840.	0. 00

Lpile Run 3 ft shaft.lp9o									
37.6000	-0.00320	42886.	-3554.	7.38E-05	0.00	4.69E+11	180.6061	270720.	0.00
38.0000	-0.00285	27865.	-2731.	7.42E-05	0.00	4.69E+11	162.2788	273600.	0.00
38.4000	-0.00249	16582.	-1998.	7.44E-05	0.00	4.69E+11	143.4462	276480.	0.00
38.8000	-0.00213	8604.	-1355.	7.45E-05	0.00	4.69E+11	124.1383	279360.	0.00
39.2000	-0.00178	3486.	-807.0463	7.46E-05	0.00	4.69E+11	104.3766	282240.	0.00
39.6000	-0.00142	773.5397	-354.5218	7.46E-05	0.00	4.69E+11	84.1753	285120.	0.00
40.0000	-0.00106	0.00	0.00	7.46E-05	0.00	4.69E+11	63.5421	144000.	0.00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 2:

Pile-head deflection = 0.98878019 inches  
 Computed slope at pile head = -0.00699027 radians  
 Maximum bending moment = 6666195. inch-lbs  
 Maximum shear force = -31444. lbs  
 Depth of maximum bending moment = 9.20000000 feet below pile head  
 Depth of maximum shear force = 25.20000000 feet below pile head  
 Number of iterations = 20  
 Number of zero deflection points = 1

#### Pile-head Deflection vs. Pile Length for Load Case 2

#### Boundary Condition Type 1, Shear and Moment

Shear = -1300. lbs  
 Moment = 5497571. in-lbs  
 Axial Load = 116000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.98878019	6666195.	-31444.
38.00000	0.98858788	6665776.	-31930.
36.00000	0.98594961	6654645.	-33388.
34.00000	0.99053399	6667249.	-35928.
32.00000	0.99257267	6653675.	-39469.
30.00000	1.00442568	6630337.	-43123.
28.00000	1.04252266	6578308.	-45422.
26.00000	1.13544145	6479480.	-46913.
24.00000	1.25292984	6383718.	-54453.
22.00000	1.40729665	6272594.	-60588.

Lpile Run 3 ft shaft.lp9o

20.00000 1.65013082 6176758. -64837.  
18.00000 2.38893818 6158330. -73476.

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Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 3  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 1300.0 lbs  
Applied moment at pile head = 449695.0 in-lbs  
Axial thrust load on pile head = -8000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.5920	449695.	1300.	-0.00287	0.00	4.72E+11	0.00	0.00	791.7000
0.4000	0.5782	464945.	4929.	-0.00287	0.00	4.72E+11	-71.4255	592.9276	791.7000
0.8000	0.5645	496791.	8202.	-0.00286	0.00	4.71E+11	-148.0672	1259.	791.7000
1.2000	0.5507	543465.	11099.	-0.00286	0.00	4.71E+11	-228.2070	1989.	791.7000
1.6000	0.5370	603124.	13609.	-0.00285	0.00	4.71E+11	-309.3221	2765.	791.7000
2.0000	0.5233	673896.	15763.	-0.00285	0.00	4.71E+11	-376.8038	3456.	791.7000
2.4000	0.5097	754227.	17602.	-0.00284	0.00	4.71E+11	-440.3745	4147.	791.7000
2.8000	0.4961	842654.	19145.	-0.00283	0.00	4.71E+11	-500.0523	4838.	791.7000
3.2000	0.4825	937800.	20411.	-0.00282	0.00	4.71E+11	-555.8583	5530.	791.7000
3.6000	0.4690	1038381.	21418.	-0.00281	0.00	4.70E+11	-607.8162	6221.	791.7000
4.0000	0.4555	1143199.	22185.	-0.00280	0.00	4.70E+11	-655.9531	6912.	791.7000
4.4000	0.4421	1251144.	22730.	-0.00279	0.00	4.70E+11	-700.2990	7603.	791.7000
4.8000	0.4288	1361197.	23072.	-0.00278	0.00	4.70E+11	-740.8875	8294.	791.7000
5.2000	0.4155	1472420.	23227.	-0.00276	0.00	4.69E+11	-777.7551	8986.	791.7000
5.6000	0.4023	1583965.	23214.	-0.00274	0.00	4.69E+11	-810.9418	9677.	791.7000
6.0000	0.3891	1695068.	23051.	-0.00273	0.00	4.69E+11	-840.4907	10368.	791.7000
6.4000	0.3761	1805047.	22755.	-0.00271	0.00	4.69E+11	-866.4482	11059.	791.7000
6.8000	0.3631	1913304.	22342.	-0.00269	0.00	4.68E+11	-888.8635	11750.	791.7000
7.2000	0.3502	2019324.	21830.	-0.00267	0.00	4.68E+11	-907.7888	12442.	791.7000
7.6000	0.3375	2122670.	21236.	-0.00265	0.00	4.68E+11	-923.2793	13133.	791.7000
8.0000	0.3248	2222985.	20322.	-0.00263	0.00	4.68E+11	-1041.	15384.	791.7000
8.4000	0.3122	2317558.	19108.	-0.00260	0.00	4.67E+11	-1048.	16113.	791.7000
8.8000	0.2998	2406223.	17881.	-0.00258	0.00	4.67E+11	-1047.	16756.	791.7000
9.2000	0.2875	2489018.	16655.	-0.00255	0.00	4.67E+11	-1048.	17494.	791.7000
9.6000	0.2753	2565917.	15413.	-0.00253	0.00	4.67E+11	-1053.	18365.	791.7000
10.0000	0.2632	2636792.	14163.	-0.00250	0.00	4.67E+11	-1051.	19172.	791.7000
10.4000	0.2512	2701690.	12941.	-0.00247	0.00	4.67E+11	-1042.	19899.	791.7000
10.8000	0.2394	2760832.	11784.	-0.00245	0.00	4.66E+11	-1024.	20527.	791.7000
11.2000	0.2278	2814625.	10731.	-0.00242	0.00	4.66E+11	-998.1297	21036.	791.7000
11.6000	0.2162	2863662.	9822.	-0.00239	0.00	4.66E+11	-964.1186	21403.	791.7000
12.0000	0.2048	2908728.	9095.	-0.00235	0.00	3.18E+11	-921.9431	21605.	791.7000
12.4000	0.1936	2950796.	8446.	-0.00230	0.00	2.14E+11	-931.8484	23099.	791.7000
12.8000	0.1828	2989636.	7757.	-0.00223	0.00	2.14E+11	-938.6719	24651.	791.7000
13.2000	0.1722	3025093.	7043.	-0.00216	0.00	2.14E+11	-942.3439	26262.	791.7000
13.6000	0.1620	3057082.	6319.	-0.00209	0.00	2.14E+11	-942.8139	27933.	791.7000

Lpile Run 3 ft shaft. lp90									
14. 0000	0. 1521	3085592.	5600.	-0. 00203	0. 00	2. 14E+11	-940. 0514	29661.	791. 7000
14. 4000	0. 1426	3110686.	4902.	-0. 00196	0. 00	2. 14E+11	-934. 0479	31447.	791. 7000
14. 8000	0. 1333	3132504.	4241.	-0. 00189	0. 00	2. 14E+11	-924. 8171	33289.	791. 7000
15. 2000	0. 1245	3151257.	3611.	-0. 00182	0. 00	2. 14E+11	-921. 1364	35524.	791. 7000
15. 6000	0. 1159	3167031.	2984.	-0. 00174	0. 00	2. 14E+11	-923. 7356	38250.	791. 7000
16. 0000	0. 1077	3179765.	2349.	-0. 00167	0. 00	2. 14E+11	-924. 0868	41178.	791. 7000
16. 4000	0. 09986	3189452.	1718.	-0. 00160	0. 00	2. 14E+11	-922. 1725	44328.	791. 7000
16. 8000	0. 09234	3196135.	1102.	-0. 00153	0. 00	2. 14E+11	-917. 9873	47719.	791. 7000
17. 2000	0. 08516	3199912.	511. 1206	-0. 00146	0. 00	2. 14E+11	-911. 5384	51375.	791. 7000
17. 6000	0. 07834	3200930.	-43. 2476	-0. 00139	0. 00	2. 14E+11	-902. 8483	55322.	791. 7000
18. 0000	0. 07185	3199390.	-550. 6177	-0. 00132	0. 00	2. 14E+11	-891. 9558	59587.	791. 7000
18. 4000	0. 06571	3195543.	-980. 4549	-0. 00124	0. 00	2. 14E+11	-870. 5430	63590.	791. 7000
18. 8000	0. 05992	3189882.	-1216.	-0. 00117	0. 00	2. 14E+11	-811. 0135	64973.	791. 7000
19. 2000	0. 05446	3183779.	-1169.	-0. 00110	0. 00	2. 14E+11	-752. 8934	66355.	791. 7000
19. 6000	0. 04935	3178573.	-847. 5594	-0. 00103	0. 00	2. 14E+11	-696. 4701	67738.	791. 7000
20. 0000	0. 04459	3175563.	-1210.	-9. 58E-04	0. 00	2. 14E+11	-642. 0319	69120.	395. 8500
20. 4000	0. 04016	3166885.	-3216.	-8. 86E-04	0. 00	2. 14E+11	-589. 8697	70502.	0. 00
20. 8000	0. 03608	3144618.	-5929.	-8. 16E-04	0. 00	2. 14E+11	-540. 2652	71885.	0. 00
21. 2000	0. 03233	3109907.	-8015.	-7. 46E-04	0. 00	2. 14E+11	-328. 9844	48845.	0. 00
21. 6000	0. 02892	3067618.	-9524.	-6. 76E-04	0. 00	2. 14E+11	-299. 8259	49766.	0. 00
22. 0000	0. 02584	3018424.	-10898.	-6. 08E-04	0. 00	2. 14E+11	-272. 8468	50688.	0. 00
22. 4000	0. 02308	2962946.	-12149.	-5. 41E-04	0. 00	2. 14E+11	-248. 1808	51610.	0. 00
22. 8000	0. 02065	2901753.	-13287.	-4. 92E-04	0. 00	4. 37E+11	-225. 9505	52531.	0. 00
23. 2000	0. 01836	2835355.	-14320.	-4. 61E-04	0. 00	4. 66E+11	-204. 4890	53453.	0. 00
23. 6000	0. 01622	2764247.	-15252.	-4. 32E-04	0. 00	4. 66E+11	-183. 7377	54374.	0. 00
24. 0000	0. 01421	2688906.	-16086.	-4. 04E-04	0. 00	4. 67E+11	-163. 7364	55296.	0. 00
24. 4000	0. 01234	2609794.	-16825.	-3. 77E-04	0. 00	4. 67E+11	-144. 5194	56218.	0. 00
24. 8000	0. 01059	2527353.	-17475.	-3. 51E-04	0. 00	4. 67E+11	-126. 1162	57139.	0. 00
25. 2000	0. 00897	2442008.	-18038.	-3. 25E-04	0. 00	4. 67E+11	-108. 5511	58061.	0. 00
25. 6000	0. 00747	2354163.	-18519.	-3. 00E-04	0. 00	4. 67E+11	-91. 8437	58982.	0. 00
26. 0000	0. 00609	2264202.	-18922.	-2. 77E-04	0. 00	4. 68E+11	-76. 0085	59904.	0. 00
26. 4000	0. 00482	2172491.	-19251.	-2. 54E-04	0. 00	4. 68E+11	-61. 0557	60826.	0. 00
26. 8000	0. 00365	2079374.	-19510.	-2. 32E-04	0. 00	4. 68E+11	-46. 9907	61747.	0. 00
27. 2000	0. 00259	1985176.	-19806.	-2. 11E-04	0. 00	4. 68E+11	-76. 0831	141005.	0. 00
27. 6000	0. 00162	1889225.	-20104.	-1. 91E-04	0. 00	4. 68E+11	-48. 4305	143078.	0. 00
28. 0000	7. 52E-04	1792159.	-20275.	-1. 73E-04	0. 00	4. 69E+11	-22. 7538	145152.	0. 00
28. 4000	-3. 18E-05	1694569.	-20327.	-1. 55E-04	0. 00	4. 69E+11	0. 9743	147226.	0. 00
28. 8000	-7. 33E-04	1597003.	-20270.	-1. 38E-04	0. 00	4. 69E+11	22. 7900	149299.	0. 00
29. 2000	-0. 00136	1499963.	-20113.	-1. 22E-04	0. 00	4. 69E+11	42. 7376	151373.	0. 00
29. 6000	-0. 00190	1403907.	-19865.	-1. 07E-04	0. 00	4. 70E+11	60. 8692	153446.	0. 00
30. 0000	-0. 00238	1309255.	-19533.	-9. 33E-05	0. 00	4. 70E+11	77. 2430	155520.	0. 00
30. 4000	-0. 00280	1216383.	-19127.	-8. 04E-05	0. 00	4. 70E+11	91. 9232	157594.	0. 00
30. 8000	-0. 00316	1125629.	-18654.	-6. 84E-05	0. 00	4. 70E+11	104. 9788	159667.	0. 00
31. 2000	-0. 00346	1037294.	-18123.	-5. 74E-05	0. 00	4. 70E+11	116. 4835	161741.	0. 00
31. 6000	-0. 00371	951644.	-17540.	-4. 73E-05	0. 00	4. 71E+11	126. 5141	163814.	0. 00
32. 0000	-0. 00391	868908.	-16912.	-3. 80E-05	0. 00	4. 71E+11	135. 1504	165888.	0. 00
32. 4000	-0. 00407	789287.	-16246.	-2. 95E-05	0. 00	4. 71E+11	142. 4745	167962.	0. 00
32. 8000	-0. 00419	712949.	-15547.	-2. 19E-05	0. 00	4. 71E+11	148. 5696	170035.	0. 00
33. 2000	-0. 00428	640035.	-14822.	-1. 50E-05	0. 00	4. 71E+11	153. 5201	172109.	0. 00
33. 6000	-0. 00434	570657.	-14076.	-8. 81E-06	0. 00	4. 71E+11	157. 4107	174182.	0. 00
34. 0000	-0. 00437	504907.	-13313.	-3. 34E-06	0. 00	4. 71E+11	160. 3257	176256.	0. 00
34. 4000	-0. 00437	442850.	-12539.	1. 49E-06	0. 00	4. 72E+11	162. 3485	178330.	0. 00
34. 8000	-0. 00435	384535.	-11757.	5. 70E-06	0. 00	4. 72E+11	163. 5613	180403.	0. 00
35. 2000	-0. 00432	329988.	-10970.	9. 33E-06	0. 00	4. 72E+11	164. 0446	182477.	0. 00

Lpile Run 3 ft shaft.lp9o									
35.6000	-0.00426	279220.	-10183.	1.24E-05	0.00	4.72E+11	163.8767	184550.	0.00
36.0000	-0.00420	232229.	-9398.	1.50E-05	0.00	4.72E+11	163.1332	186624.	0.00
36.4000	-0.00412	188996.	-8618.	1.72E-05	0.00	4.72E+11	161.8867	188698.	0.00
36.8000	-0.00403	149493.	-7845.	1.89E-05	0.00	4.72E+11	160.2063	190771.	0.00
37.2000	-0.00394	113682.	-6934.	2.02E-05	0.00	4.72E+11	219.6633	267840.	0.00
37.6000	-0.00384	82931.	-5887.	2.12E-05	0.00	4.72E+11	216.3916	270720.	0.00
38.0000	-0.00373	57166.	-4857.	2.19E-05	0.00	4.72E+11	212.7693	273600.	0.00
38.4000	-0.00363	36303.	-3845.	2.24E-05	0.00	4.72E+11	208.8616	276480.	0.00
38.8000	-0.00352	20253.	-2853.	2.27E-05	0.00	4.72E+11	204.7226	279360.	0.00
39.2000	-0.00341	8919.	-1880.	2.29E-05	0.00	4.72E+11	200.3954	282240.	0.00
39.6000	-0.00330	2203.	-929.2773	2.29E-05	0.00	4.72E+11	195.9109	285120.	0.00
40.0000	-0.00319	0.00	0.00	2.29E-05	0.00	4.72E+11	191.2880	144000.	0.00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 3:

Pile-head deflection = 0.59200198 inches  
 Computed slope at pile head = -0.00287352 radians  
 Maximum bending moment = 3200930. inch-lbs  
 Maximum shear force = 23227. lbs  
 Depth of maximum bending moment = 17.60000000 feet below pile head  
 Depth of maximum shear force = 5.20000000 feet below pile head  
 Number of iterations = 61  
 Number of zero deflection points = 1

#### Pile-head Deflection vs. Pile Length for Load Case 3

#### Boundary Condition Type 1, Shear and Moment

Shear = 1300. lbs  
 Moment = 449695. in-lbs  
 Axial Load = -8000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.59200198	3200930.	23227.
38.00000	0.59430297	3205380.	23137.
36.00000	0.59318315	3197538.	-23723.
34.00000	0.59137039	3175317.	-26064.
32.00000	0.58917595	3131708.	-28806.

Lpile Run 3 ft shaft.lp9o

30.00000	0.58911093	3062340.	-31205.
28.00000	0.58660502	2929775.	-31206.
26.00000	0.62429008	2487350.	-26113.
24.00000	0.67844375	2196371.	-22578.
22.00000	0.74868601	2010432.	-24251.
20.00000	0.82308184	1900346.	-24468.
18.00000	1.00268665	1686752.	-23530.
16.00000	1.26662764	1465611.	-23155.
14.00000	1.69342184	1256563.	-23575.
12.00000	3.02510214	1165360.	-26733.
10.00000	46.18313650	938909.	-32924.

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Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 4  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 0.0 lbs  
Applied moment at pile head = 6634768.0 in-lbs  
Axial thrust load on pile head = 135000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	1.1215	6634768.	1.50E-07	-0.00812	0.00	2.44E+11	0.00	0.00	791.7000
0.4000	1.0828	6649110.	3590.	-0.00799	0.00	2.44E+11	-87.4593	387.7027	791.7000
0.8000	1.0447	6679594.	6747.	-0.00786	0.00	2.44E+11	-180.7676	830.5210	791.7000
1.2000	1.0073	6724068.	9446.	-0.00773	0.00	2.44E+11	-277.8610	1324.	791.7000
1.6000	0.9705	6780295.	11675.	-0.00760	0.00	2.44E+11	-376.7345	1863.	791.7000
2.0000	0.9344	6845997.	13430.	-0.00746	0.00	2.43E+11	-475.5975	2443.	791.7000
2.4000	0.8989	6918894.	14714.	-0.00733	0.00	2.43E+11	-572.7826	3059.	791.7000
2.8000	0.8640	6996746.	15539.	-0.00719	0.00	2.43E+11	-666.6621	3703.	791.7000
3.2000	0.8299	7077390.	15923.	-0.00705	0.00	2.42E+11	-756.8920	4378.	791.7000
3.6000	0.7964	7158744.	15884.	-0.00691	0.00	2.42E+11	-842.6714	5079.	791.7000
4.0000	0.7635	7238832.	15598.	-0.00677	0.00	2.41E+11	-860.1247	5407.	791.7000
4.4000	0.7314	7317251.	15263.	-0.00662	0.00	2.41E+11	-862.8420	5663.	791.7000
4.8000	0.7000	7393936.	14778.	-0.00647	0.00	2.41E+11	-922.6435	6327.	791.7000
5.2000	0.6692	7467508.	14016.	-0.00633	0.00	2.40E+11	-977.9975	7014.	791.7000
5.6000	0.6392	7536691.	13007.	-0.00618	0.00	2.40E+11	-1026.	7703.	791.7000
6.0000	0.6099	7600381.	11788.	-0.00603	0.00	2.40E+11	-1066.	8386.	791.7000
6.4000	0.5814	7657662.	10378.	-0.00587	0.00	2.40E+11	-1105.	9125.	791.7000
6.8000	0.5536	7707617.	8797.	-0.00572	0.00	2.39E+11	-1137.	9856.	791.7000
7.2000	0.5265	7749525.	7087.	-0.00556	0.00	2.39E+11	-1159.	10568.	791.7000
7.6000	0.5002	7782867.	5285.	-0.00541	0.00	2.39E+11	-1175.	11281.	791.7000
8.0000	0.4746	7807266.	3401.	-0.00525	0.00	2.39E+11	-1193.	12064.	791.7000
8.4000	0.4497	7822323.	1457.	-0.00509	0.00	2.39E+11	-1201.	12813.	791.7000
8.8000	0.4257	7827859.	-499.9448	-0.00494	0.00	2.39E+11	-1198.	13514.	791.7000
9.2000	0.4023	7823922.	-2455.	-0.00478	0.00	2.39E+11	-1200.	14311.	791.7000
9.6000	0.3798	7810486.	-4427.	-0.00462	0.00	2.39E+11	-1206.	15238.	791.7000
10.0000	0.3580	7787411.	-6408.	-0.00447	0.00	2.39E+11	-1203.	16133.	791.7000



Lpile Run 3 ft shaft. lp9o									
10. 4000	0. 3369	7754753.	-8356.	-0. 00431	0. 00	2. 39E+11	-1192.	16980.	791. 7000
10. 8000	0. 3166	7712777.	-10227.	-0. 00416	0. 00	2. 39E+11	-1171.	17757.	791. 7000
11. 2000	0. 2970	7661957.	-11977.	-0. 00400	0. 00	2. 40E+11	-1141.	18444.	791. 7000
11. 6000	0. 2782	7602983.	-13561.	-0. 00385	0. 00	2. 40E+11	-1102.	19015.	791. 7000
12. 0000	0. 2601	7536762.	-14934.	-0. 00370	0. 00	2. 40E+11	-1053.	19443.	791. 7000
12. 4000	0. 2427	7464411.	-16203.	-0. 00355	0. 00	2. 40E+11	-1059.	20937.	791. 7000
12. 8000	0. 2260	7385814.	-17486.	-0. 00340	0. 00	2. 41E+11	-1060.	22505.	791. 7000
13. 2000	0. 2101	7300947.	-18766.	-0. 00325	0. 00	2. 41E+11	-1057.	24150.	791. 7000
13. 6000	0. 1948	7209876.	-20022.	-0. 00311	0. 00	2. 42E+11	-1050.	25872.	791. 7000
14. 0000	0. 1802	7112761.	-21236.	-0. 00297	0. 00	2. 42E+11	-1039.	27674.	791. 7000
14. 4000	0. 1663	7009855.	-22387.	-0. 00283	0. 00	2. 43E+11	-1024.	29556.	791. 7000
14. 8000	0. 1531	6901504.	-23458.	-0. 00269	0. 00	2. 43E+11	-1005.	31521.	791. 7000
15. 2000	0. 1405	6788142.	-24451.	-0. 00255	0. 00	2. 44E+11	-991. 6348	33874.	791. 7000
15. 6000	0. 1286	6670087.	-25392.	-0. 00242	0. 00	2. 44E+11	-983. 8147	36727.	791. 7000
16. 0000	0. 1173	6547520.	-26288.	-0. 00229	0. 00	2. 45E+11	-973. 0881	39830.	791. 7000
16. 4000	0. 1066	6420692.	-27126.	-0. 00216	0. 00	2. 46E+11	-959. 4406	43211.	791. 7000
16. 8000	0. 09649	6289917.	-27891.	-0. 00204	0. 00	2. 46E+11	-942. 8633	46904.	791. 7000
17. 2000	0. 08699	6155580.	-28570.	-0. 00192	0. 00	2. 47E+11	-923. 3529	50951.	791. 7000
17. 6000	0. 07806	6018133.	-29148.	-0. 00180	0. 00	2. 48E+11	-900. 9107	55399.	791. 7000
18. 0000	0. 06969	5878094.	-29611.	-0. 00169	0. 00	2. 49E+11	-875. 5419	60305.	791. 7000
18. 4000	0. 06186	5736049.	-29880.	-0. 00158	0. 00	2. 50E+11	-819. 5553	63590.	791. 7000
18. 8000	0. 05456	5593292.	-29819.	-0. 00147	0. 00	2. 51E+11	-738. 5829	64973.	791. 7000
19. 2000	0. 04778	5451689.	-29377.	-0. 00136	0. 00	2. 52E+11	-660. 4949	66355.	791. 7000
19. 6000	0. 04149	5313042.	-28567.	-0. 00126	0. 00	2. 54E+11	-585. 5193	67738.	791. 7000
20. 0000	0. 03569	5179081.	-28355.	-0. 00116	0. 00	2. 55E+11	-513. 8710	69120.	395. 8500
20. 4000	0. 03035	5042337.	-29708.	-0. 00106	0. 00	2. 56E+11	-445. 7556	70502.	0. 00
20. 8000	0. 02546	4895261.	-31693.	-9. 72E-04	0. 00	2. 58E+11	-381. 3576	71885.	0. 00
21. 2000	0. 02102	4739340.	-33122.	-8. 82E-04	0. 00	2. 59E+11	-213. 8855	48845.	0. 00
21. 6000	0. 01699	4578434.	-34058.	-7. 96E-04	0. 00	2. 61E+11	-176. 1905	49766.	0. 00
22. 0000	0. 01337	4413415.	-34820.	-7. 14E-04	0. 00	2. 63E+11	-141. 2140	50688.	0. 00
22. 4000	0. 01014	4245089.	-35420.	-6. 36E-04	0. 00	2. 66E+11	-108. 9993	51610.	0. 00
22. 8000	0. 00727	4074203.	-35873.	-5. 61E-04	0. 00	2. 68E+11	-79. 5720	52531.	0. 00
23. 2000	0. 00475	3901435.	-36191.	-4. 90E-04	0. 00	2. 71E+11	-52. 9417	53453.	0. 00
23. 6000	0. 00257	3727404.	-36388.	-4. 23E-04	0. 00	2. 74E+11	-29. 1019	54374.	0. 00
24. 0000	6. 97E-04	3552659.	-36477.	-3. 59E-04	0. 00	2. 78E+11	-8. 0311	55296.	0. 00
24. 4000	-8. 80E-04	3377690.	-36472.	-3. 11E-04	0. 00	4. 64E+11	10. 3070	56218.	0. 00
24. 8000	-0. 00229	3202936.	-36381.	-2. 77E-04	0. 00	4. 65E+11	27. 2552	57139.	0. 00
25. 2000	-0. 00354	3028788.	-36213.	-2. 45E-04	0. 00	4. 65E+11	42. 8233	58061.	0. 00
25. 6000	-0. 00464	2855606.	-35974.	-2. 15E-04	0. 00	4. 65E+11	57. 0274	58982.	0. 00
26. 0000	-0. 00560	2683719.	-35669.	-1. 86E-04	0. 00	4. 66E+11	69. 8895	59904.	0. 00
26. 4000	-0. 00643	2513425.	-35306.	-1. 59E-04	0. 00	4. 66E+11	81. 4370	60826.	0. 00
26. 8000	-0. 00713	2344990.	-34890.	-1. 34E-04	0. 00	4. 66E+11	91. 7031	61747.	0. 00
27. 2000	-0. 00771	2178653.	-34126.	-1. 11E-04	0. 00	4. 67E+11	226. 6333	141005.	0. 00
27. 6000	-0. 00819	2017522.	-32996.	-8. 93E-05	0. 00	4. 67E+11	244. 2340	143078.	0. 00
28. 0000	-0. 00857	1862005.	-31788.	-6. 94E-05	0. 00	4. 67E+11	259. 2372	145152.	0. 00
28. 4000	-0. 00886	1712449.	-30513.	-5. 10E-05	0. 00	4. 67E+11	271. 7506	147226.	0. 00
28. 8000	-0. 00906	1569142.	-29185.	-3. 42E-05	0. 00	4. 67E+11	281. 8860	149299.	0. 00
29. 2000	-0. 00919	1432320.	-27813.	-1. 88E-05	0. 00	4. 68E+11	289. 7577	151373.	0. 00
29. 6000	-0. 00924	1302164.	-26408.	-4. 76E-06	0. 00	4. 68E+11	295. 4820	153446.	0. 00
30. 0000	-0. 00923	1178807.	-24981.	7. 97E-06	0. 00	4. 68E+11	299. 1758	155520.	0. 00
30. 4000	-0. 00917	1062335.	-23541.	1. 95E-05	0. 00	4. 68E+11	300. 9559	157594.	0. 00
30. 8000	-0. 00905	952791.	-22096.	2. 98E-05	0. 00	4. 68E+11	300. 9380	159667.	0. 00
31. 2000	-0. 00888	850173.	-20656.	3. 90E-05	0. 00	4. 68E+11	299. 2364	161741.	0. 00
31. 6000	-0. 00867	754445.	-19227.	4. 73E-05	0. 00	4. 68E+11	295. 9627	163814.	0. 00

Lpile Run 3 ft shaft. lp90									
32.0000	-0.00843	665530.	-17818.	5.46E-05	0.00	4.68E+11	291.2256	165888.	0.00
32.4000	-0.00815	583321.	-16435.	6.10E-05	0.00	4.68E+11	285.1301	167962.	0.00
32.8000	-0.00784	507677.	-15084.	6.65E-05	0.00	4.68E+11	277.7772	170035.	0.00
33.2000	-0.00751	438430.	-13771.	7.14E-05	0.00	4.68E+11	269.2630	172109.	0.00
33.6000	-0.00716	375384.	-12501.	7.56E-05	0.00	4.68E+11	259.6790	174182.	0.00
34.0000	-0.00678	318319.	-11280.	7.91E-05	0.00	4.68E+11	249.1110	176256.	0.00
34.4000	-0.00640	266990.	-10112.	8.21E-05	0.00	4.68E+11	237.6396	178330.	0.00
34.8000	-0.00600	221136.	-9001.	8.46E-05	0.00	4.68E+11	225.3393	180403.	0.00
35.2000	-0.00558	180471.	-7951.	8.67E-05	0.00	4.68E+11	212.2789	182477.	0.00
35.6000	-0.00516	144696.	-6965.	8.84E-05	0.00	4.68E+11	198.5213	184550.	0.00
36.0000	-0.00474	113495.	-6046.	8.97E-05	0.00	4.68E+11	184.1234	186624.	0.00
36.4000	-0.00430	86534.	-5199.	9.07E-05	0.00	4.68E+11	169.1364	188698.	0.00
36.8000	-0.00386	63470.	-4424.	9.15E-05	0.00	4.68E+11	153.6057	190771.	0.00
37.2000	-0.00342	43945.	-3597.	9.20E-05	0.00	4.68E+11	191.0716	267840.	0.00
37.6000	-0.00298	28822.	-2735.	9.24E-05	0.00	4.68E+11	168.1511	270720.	0.00
38.0000	-0.00254	17572.	-1984.	9.26E-05	0.00	4.68E+11	144.6183	273600.	0.00
38.4000	-0.00209	9655.	-1348.	9.28E-05	0.00	4.68E+11	120.5027	276480.	0.00
38.8000	-0.00165	4514.	-828.5534	9.29E-05	0.00	4.68E+11	95.8252	279360.	0.00
39.2000	-0.00120	1580.	-429.1327	9.29E-05	0.00	4.68E+11	70.6001	282240.	0.00
39.6000	-7.55E-04	273.7146	-152.0878	9.29E-05	0.00	4.68E+11	44.8353	285120.	0.00
40.0000	-3.09E-04	0.00	0.00	9.29E-05	0.00	4.68E+11	18.5346	144000.	0.00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 4:

Pile-head deflection = 1.12148123 inches  
 Computed slope at pile head = -0.00812354 radians  
 Maximum bending moment = 7827859. inch-lbs  
 Maximum shear force = -36477. lbs  
 Depth of maximum bending moment = 8.80000000 feet below pile head  
 Depth of maximum shear force = 24.00000000 feet below pile head  
 Number of iterations = 29  
 Number of zero deflection points = 2

#### Pile-head Deflection vs. Pile Length for Load Case 4

#### Boundary Condition Type 1, Shear and Moment

Shear = 0. lbs  
 Moment = 6634768. in-lbs  
 Axial Load = 135000. lbs

Lpile Run 3 ft shaft.lp9o

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	1.12148123	7827859.	-36477.
38.00000	1.12119329	7827668.	-36768.
36.00000	1.11827007	7816720.	-38002.
34.00000	1.12306432	7829738.	-40384.
32.00000	1.12630019	7815468.	-44016.
30.00000	1.13952263	7793490.	-48266.
28.00000	1.18266408	7742580.	-51564.
26.00000	1.28873788	7643301.	-55148.
24.00000	1.42431786	7545341.	-63684.
22.00000	1.61546466	7442153.	-70953.
20.00000	1.96694408	7392329.	-77332.
18.00000	3.33887207	7466681.	-93563.

Computed Values of Pile Loading and Deflection  
for Lateral Loading for Load Case Number 5

Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = -1300.0 lbs  
Applied moment at pile head = 3405399.0 in-lbs  
Axial thrust load on pile head = 71000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.7999	3405399.	-1300.	-0.00525	0.00	2.48E+11	0.00	0.00	791.7000
0.4000	0.7748	3410059.	2314.	-0.00519	0.00	2.48E+11	-77.6799	481.2158	791.7000
0.8000	0.7501	3431147.	5542.	-0.00512	0.00	2.47E+11	-160.7410	1029.	791.7000
1.2000	0.7257	3466750.	8362.	-0.00505	0.00	2.47E+11	-247.3371	1636.	791.7000
1.6000	0.7016	3514871.	10763.	-0.00499	0.00	2.46E+11	-335.8287	2298.	791.7000
2.0000	0.6778	3573473.	12737.	-0.00492	0.00	2.46E+11	-425.1711	3011.	791.7000
2.4000	0.6544	3640496.	14284.	-0.00485	0.00	2.45E+11	-513.4876	3767.	791.7000
2.8000	0.6313	3713905.	15414.	-0.00477	0.00	2.45E+11	-599.2839	4557.	791.7000
3.2000	0.6085	3791722.	16138.	-0.00470	0.00	2.44E+11	-682.3223	5382.	791.7000
3.6000	0.5861	3872033.	16477.	-0.00463	0.00	2.43E+11	-759.6406	6221.	791.7000
4.0000	0.5641	3953058.	16583.	-0.00455	0.00	2.43E+11	-779.5814	6633.	791.7000
4.4000	0.5425	4034334.	16632.	-0.00447	0.00	2.42E+11	-783.6972	6934.	791.7000
4.8000	0.5212	4115768.	16536.	-0.00439	0.00	2.41E+11	-839.3934	7730.	791.7000
5.2000	0.5004	4196075.	16184.	-0.00431	0.00	2.41E+11	-890.8005	8546.	791.7000
5.6000	0.4799	4274071.	15602.	-0.00422	0.00	2.40E+11	-935.0645	9353.	791.7000
6.0000	0.4598	4348734.	14827.	-0.00413	0.00	2.40E+11	-971.3956	10140.	791.7000
6.4000	0.4402	4419227.	13877.	-0.00405	0.00	2.39E+11	-1008.	10991.	791.7000
6.8000	0.4210	4484708.	12784.	-0.00396	0.00	2.39E+11	-1031.	11750.	791.7000
7.2000	0.4022	4544654.	11609.	-0.00387	0.00	2.39E+11	-1043.	12442.	791.7000
7.6000	0.3839	4598790.	10386.	-0.00377	0.00	2.38E+11	-1050.	13133.	791.7000
8.0000	0.3660	4646937.	9058.	-0.00368	0.00	2.38E+11	-1087.	14251.	791.7000

Lpile Run 3 ft shaft. lp90									
8. 4000	0. 3485	4688259.	7630.	-0. 00359	0. 00	2. 38E+11	-1092.	15038.	791. 7000
8. 8000	0. 3315	4722631.	6198.	-0. 00349	0. 00	2. 38E+11	-1088.	15753.	791. 7000
9. 2000	0. 3150	4750142.	4778.	-0. 00340	0. 00	2. 37E+11	-1087.	16563.	791. 7000
9. 6000	0. 2989	4770816.	3353.	-0. 00330	0. 00	2. 37E+11	-1090.	17507.	791. 7000
10. 0000	0. 2833	4784577.	1930.	-0. 00320	0. 00	2. 37E+11	-1086.	18395.	791. 7000
10. 4000	0. 2682	4791530.	548. 6275	-0. 00311	0. 00	2. 37E+11	-1073.	19209.	791. 7000
10. 8000	0. 2535	4791962.	-752. 9460	-0. 00301	0. 00	2. 37E+11	-1052.	19928.	791. 7000
11. 2000	0. 2393	4786353.	-1935.	-0. 00291	0. 00	2. 37E+11	-1023.	20527.	791. 7000
11. 6000	0. 2256	4775373.	-2957.	-0. 00282	0. 00	2. 37E+11	-985. 9760	20983.	791. 7000
12. 0000	0. 2123	4759885.	-3780.	-0. 00272	0. 00	2. 37E+11	-940. 5082	21268.	791. 7000
12. 4000	0. 1994	4740935.	-4512.	-0. 00262	0. 00	2. 37E+11	-947. 5261	22804.	791. 7000
12. 8000	0. 1871	4718362.	-5268.	-0. 00253	0. 00	2. 38E+11	-951. 2506	24406.	791. 7000
13. 2000	0. 1752	4692081.	-6035.	-0. 00243	0. 00	2. 38E+11	-951. 6322	26075.	791. 7000
13. 6000	0. 1637	4662082.	-6796.	-0. 00234	0. 00	2. 38E+11	-948. 6420	27811.	791. 7000
14. 0000	0. 1527	4628436.	-7534.	-0. 00224	0. 00	2. 38E+11	-942. 2731	29613.	791. 7000
14. 4000	0. 1422	4591289.	-8233.	-0. 00215	0. 00	2. 38E+11	-932. 5414	31482.	791. 7000
14. 8000	0. 1321	4550865.	-8878.	-0. 00206	0. 00	2. 39E+11	-919. 4862	33416.	791. 7000
15. 2000	0. 1224	4507465.	-9473.	-0. 00197	0. 00	2. 39E+11	-911. 8758	35756.	791. 7000
15. 6000	0. 1132	4461266.	-10046.	-0. 00188	0. 00	2. 39E+11	-910. 4080	38610.	791. 7000
16. 0000	0. 1044	4412302.	-10607.	-0. 00179	0. 00	2. 39E+11	-906. 5814	41690.	791. 7000
16. 4000	0. 09600	4360660.	-11143.	-0. 00170	0. 00	2. 40E+11	-900. 3842	45017.	791. 7000
16. 8000	0. 08805	4306485.	-11645.	-0. 00161	0. 00	2. 40E+11	-891. 8137	48618.	791. 7000
17. 2000	0. 08050	4249973.	-12099.	-0. 00153	0. 00	2. 40E+11	-880. 8769	52522.	791. 7000
17. 6000	0. 07337	4191378.	-12495.	-0. 00144	0. 00	2. 41E+11	-867. 5916	56762.	791. 7000
18. 0000	0. 06663	4131006.	-12822.	-0. 00136	0. 00	2. 41E+11	-851. 9871	61375.	791. 7000
18. 4000	0. 06029	4069217.	-12983.	-0. 00128	0. 00	2. 42E+11	-798. 7415	63590.	791. 7000
18. 8000	0. 05434	4007238.	-12866.	-0. 00120	0. 00	2. 42E+11	-735. 5306	64973.	791. 7000
19. 2000	0. 04877	3946526.	-12449.	-0. 00112	0. 00	2. 43E+11	-674. 1626	66355.	791. 7000
19. 6000	0. 04357	3888496.	-11742.	-0. 00104	0. 00	2. 43E+11	-614. 8753	67738.	791. 7000
20. 0000	0. 03874	3834514.	-11707.	-9. 68E-04	0. 00	2. 43E+11	-557. 9031	69120.	395. 8500
20. 4000	0. 03428	3776772.	-13304.	-8. 93E-04	0. 00	2. 44E+11	-503. 4797	70502.	0. 00
20. 8000	0. 03017	3707404.	-15597.	-8. 20E-04	0. 00	2. 45E+11	-451. 8260	71885.	0. 00
21. 2000	0. 02641	3627602.	-17326.	-7. 48E-04	0. 00	2. 45E+11	-268. 7581	48845.	0. 00
21. 6000	0. 02299	3541583.	-18543.	-6. 78E-04	0. 00	2. 46E+11	-238. 3880	49766.	0. 00
22. 0000	0. 01991	3450048.	-19620.	-6. 10E-04	0. 00	2. 47E+11	-210. 2062	50688.	0. 00
22. 4000	0. 01714	3353648.	-20567.	-5. 44E-04	0. 00	2. 48E+11	-184. 2987	51610.	0. 00
22. 8000	0. 01469	3252979.	-21395.	-4. 80E-04	0. 00	2. 51E+11	-160. 7382	52531.	0. 00
23. 2000	0. 01253	3148585.	-22116.	-4. 33E-04	0. 00	4. 65E+11	-139. 5632	53453.	0. 00
23. 6000	0. 01053	3040965.	-22737.	-4. 01E-04	0. 00	4. 66E+11	-119. 3267	54374.	0. 00
24. 0000	0. 00869	2930585.	-23263.	-3. 70E-04	0. 00	4. 66E+11	-100. 0563	55296.	0. 00
24. 4000	0. 00698	2817889.	-23700.	-3. 40E-04	0. 00	4. 66E+11	-81. 7738	56218.	0. 00
24. 8000	0. 00542	2703299.	-24051.	-3. 12E-04	0. 00	4. 66E+11	-64. 4954	57139.	0. 00
25. 2000	0. 00399	2587214.	-24321.	-2. 85E-04	0. 00	4. 67E+11	-48. 2319	58061.	0. 00
25. 6000	0. 00268	2470008.	-24516.	-2. 59E-04	0. 00	4. 67E+11	-32. 9891	58982.	0. 00
26. 0000	0. 00150	2352034.	-24640.	-2. 34E-04	0. 00	4. 67E+11	-18. 7673	59904.	0. 00
26. 4000	4. 39E-04	2233619.	-24699.	-2. 10E-04	0. 00	4. 67E+11	-5. 5623	60826.	0. 00
26. 8000	-5. 16E-04	2115068.	-24696.	-1. 88E-04	0. 00	4. 68E+11	6. 6350	61747.	0. 00
27. 2000	-0. 00137	1996663.	-24584.	-1. 67E-04	0. 00	4. 68E+11	40. 1359	141005.	0. 00
27. 6000	-0. 00212	1879175.	-24336.	-1. 47E-04	0. 00	4. 68E+11	63. 1468	143078.	0. 00
28. 0000	-0. 00278	1763136.	-23983.	-1. 28E-04	0. 00	4. 68E+11	84. 0104	145152.	0. 00
28. 4000	-0. 00335	1649026.	-23535.	-1. 11E-04	0. 00	4. 69E+11	102. 7835	147226.	0. 00
28. 8000	-0. 00384	1537278.	-23001.	-9. 46E-05	0. 00	4. 69E+11	119. 5292	149299.	0. 00
29. 2000	-0. 00426	1428279.	-22392.	-7. 94E-05	0. 00	4. 69E+11	134. 3171	151373.	0. 00
29. 6000	-0. 00461	1322370.	-21716.	-6. 53E-05	0. 00	4. 69E+11	147. 2214	153446.	0. 00

Lpile Run 3 ft shaft.lp9o									
30.0000	-0.00489	1219848.	-20983.	-5.23E-05	0.00	4.69E+11	158.3206	155520.	0.00
30.4000	-0.00511	1120970.	-20200.	-4.04E-05	0.00	4.70E+11	167.6967	157594.	0.00
30.8000	-0.00527	1025951.	-19377.	-2.94E-05	0.00	4.70E+11	175.4342	159667.	0.00
31.2000	-0.00539	934971.	-18520.	-1.94E-05	0.00	4.70E+11	181.6194	161741.	0.00
31.6000	-0.00546	848172.	-17637.	-1.03E-05	0.00	4.70E+11	186.3399	163814.	0.00
32.0000	-0.00549	765663.	-16734.	-2.03E-06	0.00	4.70E+11	189.6838	165888.	0.00
32.4000	-0.00548	687522.	-15819.	5.39E-06	0.00	4.70E+11	191.7390	167962.	0.00
32.8000	-0.00544	613797.	-14897.	1.20E-05	0.00	4.70E+11	192.5927	170035.	0.00
33.2000	-0.00536	544506.	-13973.	1.79E-05	0.00	4.70E+11	192.3310	172109.	0.00
33.6000	-0.00526	479645.	-13053.	2.32E-05	0.00	4.70E+11	191.0383	174182.	0.00
34.0000	-0.00514	419184.	-12141.	2.78E-05	0.00	4.70E+11	188.7967	176256.	0.00
34.4000	-0.00500	363071.	-11242.	3.18E-05	0.00	4.70E+11	185.6858	178330.	0.00
34.8000	-0.00484	311235.	-10360.	3.52E-05	0.00	4.70E+11	181.7824	180403.	0.00
35.2000	-0.00466	263587.	-9499.	3.81E-05	0.00	4.70E+11	177.1599	182477.	0.00
35.6000	-0.00447	220019.	-8661.	4.06E-05	0.00	4.70E+11	171.8883	184550.	0.00
36.0000	-0.00427	180410.	-7850.	4.26E-05	0.00	4.70E+11	166.0340	186624.	0.00
36.4000	-0.00406	144627.	-7069.	4.43E-05	0.00	4.70E+11	159.6592	188698.	0.00
36.8000	-0.00385	112522.	-6319.	4.56E-05	0.00	4.70E+11	152.8221	190771.	0.00
37.2000	-0.00362	83937.	-5467.	4.66E-05	0.00	4.70E+11	202.1900	267840.	0.00
37.6000	-0.00340	60010.	-4521.	4.73E-05	0.00	4.70E+11	191.6292	270720.	0.00
38.0000	-0.00317	40498.	-3628.	4.79E-05	0.00	4.70E+11	180.6297	273600.	0.00
38.4000	-0.00294	25148.	-2788.	4.82E-05	0.00	4.70E+11	169.2416	276480.	0.00
38.8000	-0.00271	13697.	-2004.	4.84E-05	0.00	4.70E+11	157.5048	279360.	0.00
39.2000	-0.00247	5875.	-1277.	4.85E-05	0.00	4.70E+11	145.4502	282240.	0.00
39.6000	-0.00224	1404.	-608.5546	4.85E-05	0.00	4.70E+11	133.0994	285120.	0.00
40.0000	-0.00201	0.00	0.00	4.85E-05	0.00	4.70E+11	120.4650	144000.	0.00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 5:

Pile-head deflection = 0.79989700 inches  
 Computed slope at pile head = -0.00525388 radians  
 Maximum bending moment = 4791962. inch-lbs  
 Maximum shear force = -24699. lbs  
 Depth of maximum bending moment = 10.80000000 feet below pile head  
 Depth of maximum shear force = 26.40000000 feet below pile head  
 Number of iterations = 27  
 Number of zero deflection points = 1

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 Pile-head Deflection vs. Pile Length for Load Case 5  
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Boundary Condition Type 1, Shear and Moment

Lpile Run 3 ft shaft.lp9o

Shear = -1300. lbs  
 Moment = 3405399. in-lbs  
 Axial Load = 71000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment In-lbs	Maximum Shear lbs
40.00000	0.79989700	4791962.	-24699.
38.00000	0.80102715	4796635.	-25514.
36.00000	0.79841888	4788727.	-27278.
34.00000	0.80054550	4795750.	-29842.
32.00000	0.80142789	4777633.	-32899.
30.00000	0.80916545	4745325.	-35579.
28.00000	0.83790407	4680009.	-36354.
26.00000	0.90863409	4566875.	-35741.
24.00000	0.99807617	4461765.	-39768.
22.00000	1.10977541	4344404.	-44195.
20.00000	1.25751573	4236872.	-46519.
18.00000	1.60898815	4061969.	-49182.
16.00000	2.51278093	4027206.	-56616.

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 Computed Values of Pile Loading and Deflection  
 for Lateral Loading for Load Case Number 6  
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Pile-head conditions are Shear and Moment (Loading Type 1)

Shear force at pile head = 1300.0 lbs  
 Applied moment at pile head = 2571372.0 in-lbs  
 Axial thrust load on pile head = 56000.0 lbs

Depth X feet	Deflect. y inches	Bending Moment in-lbs	Shear Force lbs	Slope S radians	Total Stress psi *	Bending Stiffness in-lb^2	Soil Res. p lb/inch	Soil Spr. Es*h lb/inch	Distrib. Lat. Load lb/inch
0.00	0.7622	2571372.	1300.	-0.00458	0.00	4.67E+11	0.00	0.00	791.7000
0.4000	0.7403	2587960.	4916.	-0.00455	0.00	4.67E+11	-76.5843	496.5437	791.7000
0.8000	0.7185	2621016.	8152.	-0.00453	0.00	4.67E+11	-158.5968	1059.	791.7000
1.2000	0.6969	2668653.	10985.	-0.00450	0.00	4.67E+11	-244.2179	1682.	791.7000
1.6000	0.6754	2728895.	13403.	-0.00447	0.00	4.66E+11	-331.8425	2359.	791.7000
2.0000	0.6540	2799726.	15398.	-0.00444	0.00	4.66E+11	-420.4878	3086.	791.7000
2.4000	0.6327	2879101.	16969.	-0.00441	0.00	4.66E+11	-508.2383	3856.	791.7000
2.8000	0.6116	2964999.	18125.	-0.00438	0.00	4.66E+11	-593.5918	4659.	791.7000
3.2000	0.5906	3055454.	18877.	-0.00435	0.00	4.66E+11	-676.2793	5496.	791.7000
3.6000	0.5698	3148559.	19282.	-0.00432	0.00	4.65E+11	-738.4903	6221.	791.7000
4.0000	0.5492	3242882.	19454.	-0.00427	0.00	2.43E+11	-773.2430	6759.	791.7000
4.4000	0.5288	3337613.	19532.	-0.00421	0.00	2.41E+11	-777.5731	7058.	791.7000
4.8000	0.5088	3432651.	19467.	-0.00414	0.00	2.40E+11	-833.0980	7860.	791.7000
5.2000	0.4891	3526717.	19145.	-0.00407	0.00	2.40E+11	-884.4010	8680.	791.7000
5.6000	0.4697	3618628.	18594.	-0.00400	0.00	2.39E+11	-928.6451	9490.	791.7000

Lpile Run 3 ft shaft. lp90									
6. 0000	0. 4507	3707364.	17849.	-0. 00392	0. 00	2. 38E+11	-965. 0399	10278.	791. 7000
6. 4000	0. 4321	3792087.	16944.	-0. 00385	0. 00	2. 38E+11	-995. 4557	11059.	791. 7000
6. 8000	0. 4138	3872094.	15924.	-0. 00377	0. 00	2. 37E+11	-1013.	11750.	791. 7000
7. 2000	0. 3959	3946984.	14831.	-0. 00369	0. 00	2. 37E+11	-1026.	12442.	791. 7000
7. 6000	0. 3783	4016453.	13684.	-0. 00361	0. 00	2. 36E+11	-1035.	13133.	791. 7000
8. 0000	0. 3612	4080291.	12404.	-0. 00353	0. 00	2. 36E+11	-1081.	14371.	791. 7000
8. 4000	0. 3445	4137432.	11000.	-0. 00344	0. 00	2. 36E+11	-1087.	15150.	791. 7000
8. 8000	0. 3281	4187742.	9590.	-0. 00336	0. 00	2. 35E+11	-1084.	15853.	791. 7000
9. 2000	0. 3122	4231301.	8190.	-0. 00327	0. 00	2. 35E+11	-1083.	16652.	791. 7000
9. 6000	0. 2967	4268122.	6782.	-0. 00319	0. 00	2. 35E+11	-1087.	17583.	791. 7000
10. 0000	0. 2816	4298120.	5374.	-0. 00310	0. 00	2. 35E+11	-1083.	18458.	791. 7000
10. 4000	0. 2669	4321383.	4005.	-0. 00301	0. 00	2. 35E+11	-1071.	19258.	791. 7000
10. 8000	0. 2527	4338189.	2713.	-0. 00292	0. 00	2. 35E+11	-1051.	19961.	791. 7000
11. 2000	0. 2389	4349000.	1537.	-0. 00283	0. 00	2. 35E+11	-1022.	20545.	791. 7000
11. 6000	0. 2255	4354470.	517. 4475	-0. 00274	0. 00	2. 34E+11	-985. 8524	20985.	791. 7000
12. 0000	0. 2125	4355443.	-307. 2531	-0. 00266	0. 00	2. 34E+11	-941. 1729	21256.	791. 7000
12. 4000	0. 2000	4352948.	-1044.	-0. 00257	0. 00	2. 34E+11	-949. 0189	22776.	791. 7000
12. 8000	0. 1879	4346805.	-1810.	-0. 00248	0. 00	2. 35E+11	-953. 6076	24361.	791. 7000
13. 2000	0. 1762	4336907.	-2590.	-0. 00239	0. 00	2. 35E+11	-954. 8833	26010.	791. 7000
13. 6000	0. 1650	4323226.	-3368.	-0. 00230	0. 00	2. 35E+11	-952. 8111	27724.	791. 7000
14. 0000	0. 1541	4305809.	-4129.	-0. 00221	0. 00	2. 35E+11	-947. 3772	29503.	791. 7000
14. 4000	0. 1437	4284781.	-4855.	-0. 00212	0. 00	2. 35E+11	-938. 5908	31345.	791. 7000
14. 8000	0. 1337	4260346.	-5531.	-0. 00204	0. 00	2. 35E+11	-926. 4841	33251.	791. 7000
15. 2000	0. 1242	4232782.	-6162.	-0. 00195	0. 00	2. 35E+11	-919. 8488	35556.	791. 7000
15. 6000	0. 1150	4202242.	-6776.	-0. 00186	0. 00	2. 35E+11	-919. 3956	38367.	791. 7000
16. 0000	0. 1063	4168736.	-7382.	-0. 00178	0. 00	2. 35E+11	-916. 5965	41396.	791. 7000
16. 4000	0. 09795	4132331.	-7969.	-0. 00169	0. 00	2. 36E+11	-911. 4380	44665.	791. 7000
16. 8000	0. 09002	4093144.	-8526.	-0. 00161	0. 00	2. 36E+11	-903. 9167	48198.	791. 7000
17. 2000	0. 08249	4051349.	-9041.	-0. 00153	0. 00	2. 36E+11	-894. 0394	52022.	791. 7000
17. 6000	0. 07536	4007174.	-9503.	-0. 00145	0. 00	2. 36E+11	-881. 8251	56169.	791. 7000
18. 0000	0. 06861	3960900.	-9900.	-0. 00136	0. 00	2. 37E+11	-867. 3053	60674.	791. 7000
18. 4000	0. 06226	3912864.	-10161.	-0. 00128	0. 00	2. 37E+11	-824. 7677	63590.	791. 7000
18. 8000	0. 05628	3864044.	-10169.	-0. 00121	0. 00	2. 37E+11	-761. 7898	64973.	791. 7000
19. 2000	0. 05068	3815892.	-9878.	-0. 00113	0. 00	2. 38E+11	-700. 5570	66355.	791. 7000
19. 6000	0. 04545	3769819.	-9299.	-0. 00105	0. 00	2. 38E+11	-641. 3209	67738.	791. 7000
20. 0000	0. 04058	3727190.	-9390.	-9. 76E-04	0. 00	2. 38E+11	-584. 3304	69120.	395. 8500
20. 4000	0. 03607	3680199.	-11114.	-9. 02E-04	0. 00	2. 38E+11	-529. 8340	70502.	0. 00
20. 8000	0. 03192	3620981.	-13533.	-8. 28E-04	0. 00	2. 39E+11	-478. 0681	71885.	0. 00
21. 2000	0. 02812	3550728.	-15367.	-7. 56E-04	0. 00	2. 39E+11	-286. 1621	48845.	0. 00
21. 6000	0. 02466	3473863.	-16668.	-6. 86E-04	0. 00	2. 40E+11	-255. 6961	49766.	0. 00
22. 0000	0. 02154	3391088.	-17827.	-6. 17E-04	0. 00	2. 41E+11	-227. 4243	50688.	0. 00
22. 4000	0. 01874	3303055.	-18856.	-5. 51E-04	0. 00	2. 42E+11	-201. 4436	51610.	0. 00
22. 8000	0. 01625	3210363.	-19767.	-4. 89E-04	0. 00	2. 69E+11	-177. 8359	52531.	0. 00
23. 2000	0. 01404	3113558.	-20569.	-4. 44E-04	0. 00	4. 66E+11	-156. 3396	53453.	0. 00
23. 6000	0. 01198	3013143.	-21270.	-4. 13E-04	0. 00	4. 66E+11	-135. 7400	54374.	0. 00
24. 0000	0. 01008	2909592.	-21874.	-3. 82E-04	0. 00	4. 66E+11	-116. 0679	55296.	0. 00
24. 4000	0. 00831	2803358.	-22386.	-3. 53E-04	0. 00	4. 66E+11	-97. 3483	56218.	0. 00
24. 8000	0. 00669	2694874.	-22811.	-3. 25E-04	0. 00	4. 66E+11	-79. 6008	57139.	0. 00
25. 2000	0. 00520	2584548.	-23153.	-2. 98E-04	0. 00	4. 67E+11	-62. 8393	58061.	0. 00
25. 6000	0. 00383	2472768.	-23417.	-2. 72E-04	0. 00	4. 67E+11	-47. 0729	58982.	0. 00
26. 0000	0. 00259	2359896.	-23607.	-2. 47E-04	0. 00	4. 67E+11	-32. 3054	59904.	0. 00
26. 4000	0. 00146	2246273.	-23729.	-2. 23E-04	0. 00	4. 67E+11	-18. 5356	60826.	0. 00
26. 8000	4. 48E-04	2132217.	-23787.	-2. 01E-04	0. 00	4. 68E+11	-5. 7578	61747.	0. 00
27. 2000	-4. 62E-04	2018023.	-23769.	-1. 79E-04	0. 00	4. 68E+11	13. 5864	141005.	0. 00

Lpile Run 3 ft shaft. lp90									
27. 6000	-0. 00127	1904135.	-23645.	-1. 59E-04	0. 00	4. 68E+11	37. 9523	143078.	0. 00
28. 0000	-0. 00199	1791117.	-23409.	-1. 40E-04	0. 00	4. 68E+11	60. 1849	145152.	0. 00
28. 4000	-0. 00262	1679481.	-23072.	-1. 22E-04	0. 00	4. 69E+11	80. 3348	147226.	0. 00
28. 8000	-0. 00317	1569691.	-22643.	-1. 06E-04	0. 00	4. 69E+11	98. 4599	149299.	0. 00
29. 2000	-0. 00363	1462166.	-22132.	-9. 03E-05	0. 00	4. 69E+11	114. 6245	151373.	0. 00
29. 6000	-0. 00403	1357277.	-21547.	-7. 59E-05	0. 00	4. 69E+11	128. 8987	153446.	0. 00
30. 0000	-0. 00436	1255354.	-20898.	-6. 25E-05	0. 00	4. 69E+11	141. 3573	155520.	0. 00
30. 4000	-0. 00463	1156685.	-20194.	-5. 02E-05	0. 00	4. 70E+11	152. 0790	157594.	0. 00
30. 8000	-0. 00484	1061516.	-19443.	-3. 88E-05	0. 00	4. 70E+11	161. 1460	159667.	0. 00
31. 2000	-0. 00500	970058.	-18651.	-2. 85E-05	0. 00	4. 70E+11	168. 6426	161741.	0. 00
31. 6000	-0. 00512	882482.	-17827.	-1. 90E-05	0. 00	4. 70E+11	174. 6548	163814.	0. 00
32. 0000	-0. 00519	798928.	-16978.	-1. 04E-05	0. 00	4. 70E+11	179. 2702	165888.	0. 00
32. 4000	-0. 00522	719502.	-16109.	-2. 67E-06	0. 00	4. 70E+11	182. 5761	167962.	0. 00
32. 8000	-0. 00521	644280.	-15228.	4. 29E-06	0. 00	4. 71E+11	184. 6599	170035.	0. 00
33. 2000	-0. 00518	573312.	-14339.	1. 05E-05	0. 00	4. 71E+11	185. 6084	172109.	0. 00
33. 6000	-0. 00511	506618.	-13449.	1. 60E-05	0. 00	4. 71E+11	185. 5070	174182.	0. 00
34. 0000	-0. 00502	444197.	-12561.	2. 09E-05	0. 00	4. 71E+11	184. 4393	176256.	0. 00
34. 4000	-0. 00491	386024.	-11680.	2. 51E-05	0. 00	4. 71E+11	182. 4867	178330.	0. 00
34. 8000	-0. 00478	332055.	-10811.	2. 87E-05	0. 00	4. 71E+11	179. 7282	180403.	0. 00
35. 2000	-0. 00464	282225.	-9956.	3. 19E-05	0. 00	4. 71E+11	176. 2396	182477.	0. 00
35. 6000	-0. 00448	236456.	-9120.	3. 45E-05	0. 00	4. 71E+11	172. 0937	184550.	0. 00
36. 0000	-0. 00430	194651.	-8306.	3. 67E-05	0. 00	4. 71E+11	167. 3598	186624.	0. 00
36. 4000	-0. 00412	156701.	-7515.	3. 85E-05	0. 00	4. 71E+11	162. 1032	188698.	0. 00
36. 8000	-0. 00393	122486.	-6751.	3. 99E-05	0. 00	4. 71E+11	156. 3855	190771.	0. 00
37. 2000	-0. 00374	91873.	-5874.	4. 10E-05	0. 00	4. 71E+11	208. 6998	267840.	0. 00
37. 6000	-0. 00354	66069.	-4894.	4. 18E-05	0. 00	4. 71E+11	199. 7104	270720.	0. 00
38. 0000	-0. 00334	44866.	-3958.	4. 24E-05	0. 00	4. 71E+11	190. 2976	273600.	0. 00
38. 4000	-0. 00313	28047.	-3068.	4. 28E-05	0. 00	4. 71E+11	180. 5155	276480.	0. 00
38. 8000	-0. 00293	15387.	-2226.	4. 30E-05	0. 00	4. 71E+11	170. 4080	279360.	0. 00
39. 2000	-0. 00272	6653.	-1433.	4. 31E-05	0. 00	4. 71E+11	160. 0091	282240.	0. 00
39. 6000	-0. 00251	1606.	-690. 6380	4. 31E-05	0. 00	4. 71E+11	149. 3427	285120.	0. 00
40. 0000	-0. 00231	0. 00	0. 00	4. 32E-05	0. 00	4. 71E+11	138. 4231	144000.	0. 00

\* This analysis computed pile response using nonlinear moment-curvature relationships. Values of total stress due to combined axial and bending stresses are computed only for elastic sections only and do not equal the actual stresses in concrete and steel. Stresses in concrete and steel may be interpolated from the output for nonlinear bending properties relative to the magnitude of bending moment developed in the pile.

#### Output Summary for Load Case No. 6:

Pile-head deflection = 0. 76224234 inches  
 Computed slope at pile head = -0. 00457890 radians  
 Maximum bending moment = 4355443. inch-lbs  
 Maximum shear force = -23787. lbs  
 Depth of maximum bending moment = 12. 00000000 feet below pile head  
 Depth of maximum shear force = 26. 80000000 feet below pile head  
 Number of iterations = 52  
 Number of zero deflection points = 1



-----  
Pile-head Deflection vs. Pile Length for Load Case 6  
-----

Boundary Condition Type 1, Shear and Moment

Shear = 1300. lbs  
Moment = 2571372. in-lbs  
Axial Load = 56000. lbs

Pile Length feet	Pile Head Deflection inches	Maximum Moment in-lbs	Maximum Shear lbs
40.00000	0.76224234	4355443.	-23787.
38.00000	0.76265095	4365481.	-24776.
36.00000	0.76052259	4357428.	-26625.
34.00000	0.76208148	4360746.	-29272.
32.00000	0.76223531	4337644.	-32328.
30.00000	0.76922827	4292137.	-34790.
28.00000	0.79392642	4204056.	-35207.
26.00000	0.86165705	4063393.	-33956.
24.00000	0.94611764	3937918.	-36543.
22.00000	1.05007772	3802199.	-40421.
20.00000	1.18249744	3682326.	-42188.
18.00000	1.49122066	3470191.	-43746.
16.00000	2.15999627	3356915.	-48145.

-----  
Summary of Pile-head Responses for Conventional Analyses  
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Definitions of Pile-head Loading Conditions:

Load Type 1: Load 1 = Shear, V, lbs, and Load 2 = Moment, M, in-lbs  
Load Type 2: Load 1 = Shear, V, lbs, and Load 2 = Slope, S, radians  
Load Type 3: Load 1 = Shear, V, lbs, and Load 2 = Rot. Stiffness, R, in-lbs/rad.  
Load Type 4: Load 1 = Top Deflection, y, inches, and Load 2 = Moment, M, in-lbs  
Load Type 5: Load 1 = Top Deflection, y, inches, and Load 2 = Slope, S, radians

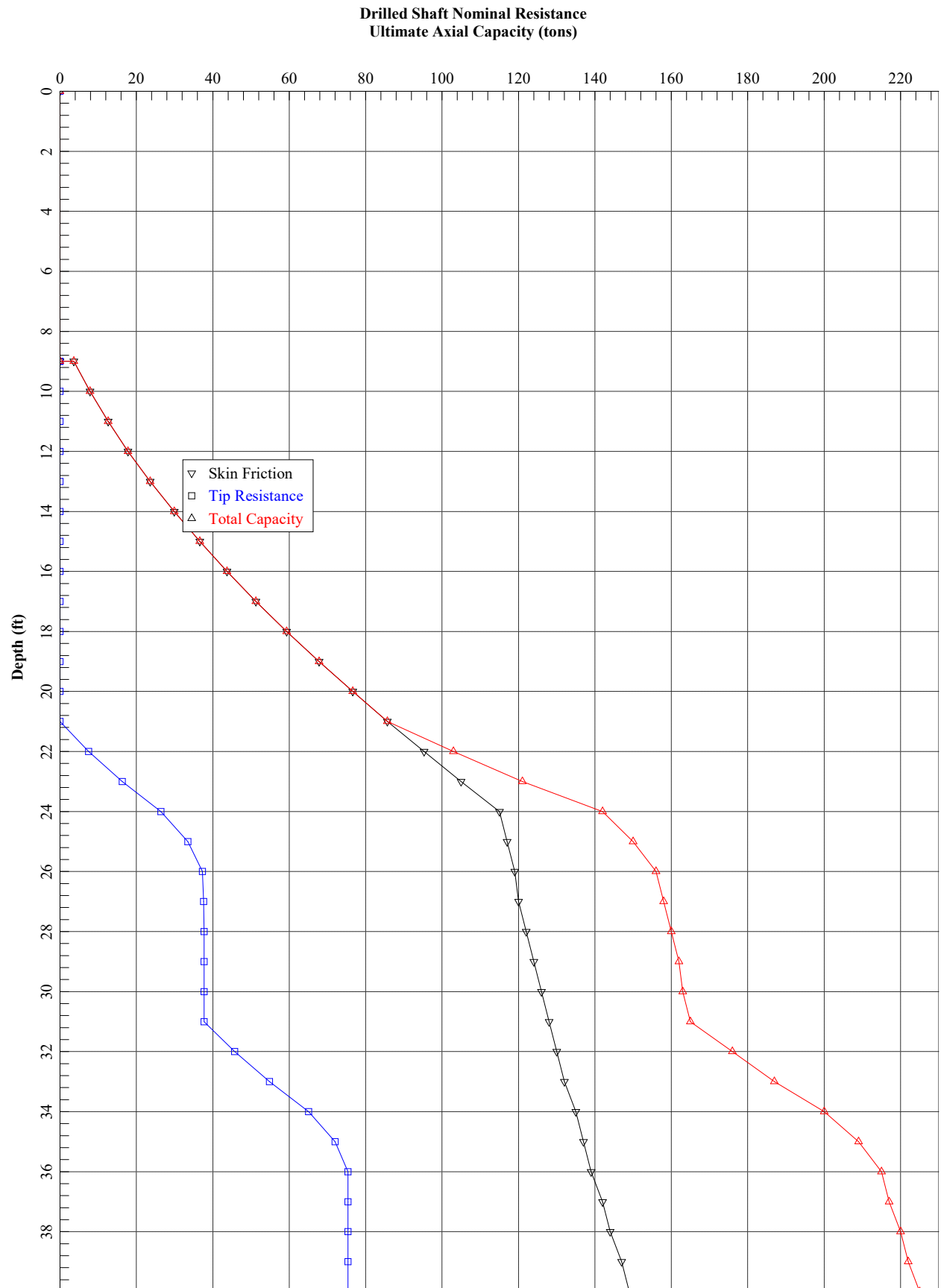
Load Case No.	Load Type 1	Pile-head Load 1	Load Type 2	Pile-head Load 2	Axial Loading lbs	Pile-head Deflection inches	Pile-head Rotation radians	Max Shear in Pile lbs	Max Moment in Pile in-lbs
1	V, lb	0.00	M, in-lb	5014935.	104000.	0.9667	-0.00673	-30520.	6342342.
2	V, lb	-1300.	M, in-lb	5497571.	116000.	0.9888	-0.00699	-31444.	6666195.
3	V, lb	1300.	M, in-lb	449695.	-8000.	0.5920	-0.00287	23227.	3200930.
4	V, lb	0.00	M, in-lb	6634768.	135000.	1.1215	-0.00812	-36477.	7827859.
5	V, lb	-1300.	M, in-lb	3405399.	71000.	0.7999	-0.00525	-24699.	4791962.
6	V, lb	1300.	M, in-lb	2571372.	56000.	0.7622	-0.00458	-23787.	4355443.

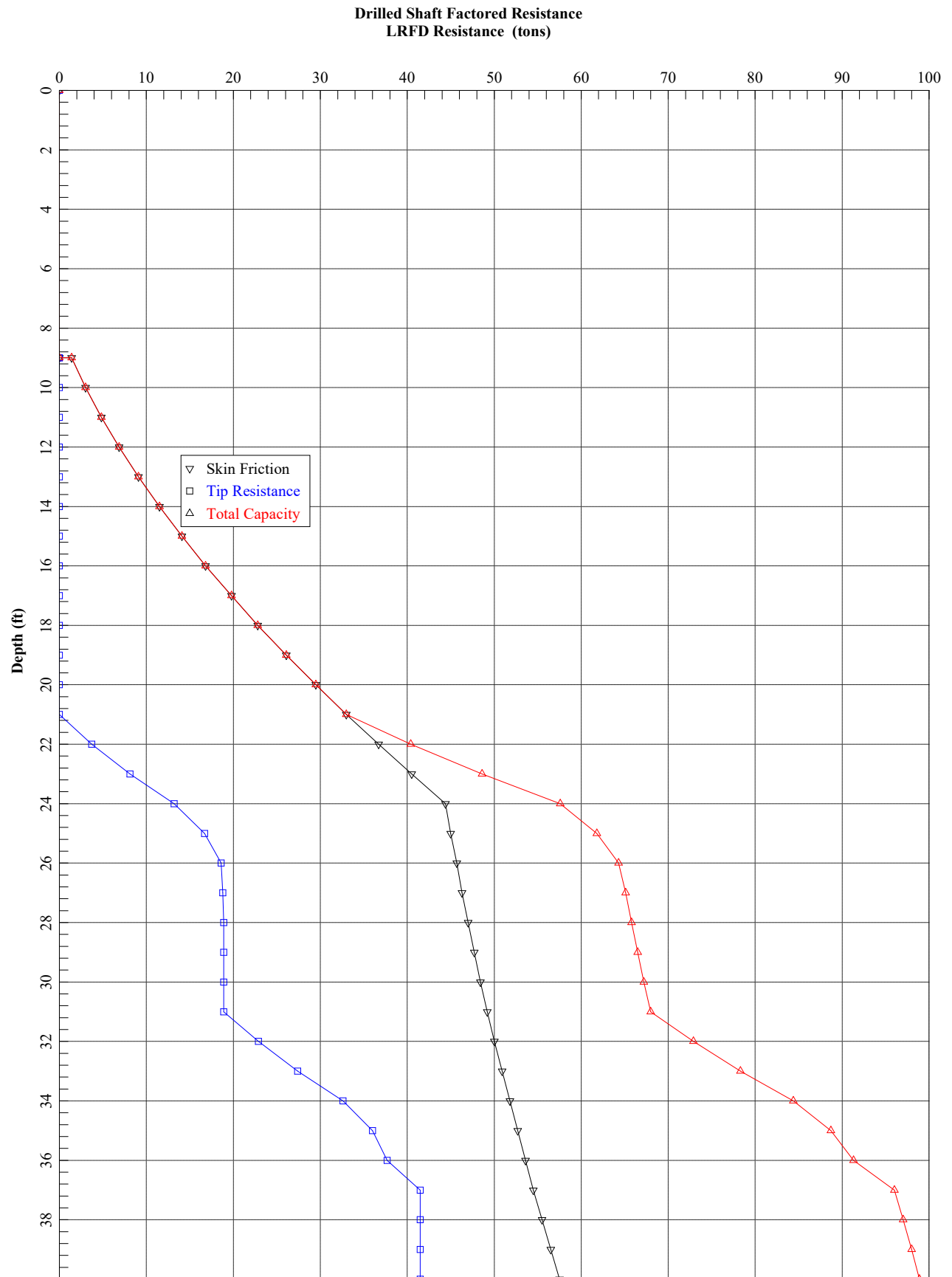
Lpile Run 3 ft shaft.lp9o

Maximum pile-head deflection = 1.1214812250 inches

Maximum pile-head rotation = -0.0081235381 radians = -0.465444 deg.

The analysis ended normally.





Shaft LRFD.sf8o

SHAFT for Windows, Version 2017.8.2

Serial Number : 161217426

VERTICALLY LOADED DRILLED SHAFT ANALYSIS  
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Path to file locations : C:\Users\fscaramalmadrona\Desktop\FER\Temp files\  
Name of input data file : Shaft LRFD.sf8d  
Name of output file : Shaft LRFD.sf8o  
Name of plot output file : Shaft LRFD.sf8p  
Name of runtime file : Shaft LRFD.sf8r

Time and Date of Analysis

Date: February 21, 2018 Time: 14:39:33

Rolling Road Platform Extension

PROPOSED DEPTH = 40.0 FT

NUMBER OF LAYERS = 6

WATER TABLE DEPTH = 21.0 FT.

SOIL INFORMATION

LAYER NO 1----SAND

Shaft LRFD.sf8o

AT THE TOP

SIDE FRICTION PROCEDURE, BETA METHOD	
SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01 (*)
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.000E+00

AT THE BOTTOM

SIDE FRICTION PROCEDURE, BETA METHOD	
SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01 (*)
INTERNAL FRICTION ANGLE, DEG.	= 0.300E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.400E+01
LRFD RESISTANCE FACTOR (SIDE FRICTION)	= 0.385E+00
LRFD RESISTANCE FACTOR (TIP RESISTANCE)	= 0.500E+00

LAYER NO 2----SAND

AT THE TOP

SIDE FRICTION PROCEDURE, BETA METHOD	
SKIN FRICTION COEFFICIENT- BETA	= 0.120E+01 (*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.400E+01

AT THE BOTTOM

SIDE FRICTION PROCEDURE, BETA METHOD	
SKIN FRICTION COEFFICIENT- BETA	= 0.112E+01 (*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.800E+01
LRFD RESISTANCE FACTOR (SIDE FRICTION)	= 0.385E+00
LRFD RESISTANCE FACTOR (TIP RESISTANCE)	= 0.500E+00

LAYER NO 3----SAND

AT THE TOP

SIDE FRICTION PROCEDURE, BETA METHOD	
SKIN FRICTION COEFFICIENT- BETA	= 0.112E+01 (*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.800E+01

AT THE BOTTOM

SIDE FRICTION PROCEDURE, BETA METHOD	
SKIN FRICTION COEFFICIENT- BETA	= 0.881E+00 (*)
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.210E+02
LRFD RESISTANCE FACTOR (SIDE FRICTION)	= 0.385E+00
LRFD RESISTANCE FACTOR (TIP RESISTANCE)	= 0.500E+00

LAYER NO 4----SAND

AT THE TOP

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.210E+02

AT THE BOTTOM

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.280E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.120E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11

Shaft LRFD.sf8o

DEPTH, FT	= 0.270E+02
LRFD RESISTANCE FACTOR (SIDE FRICTION)	= 0.385E+00
LRFD RESISTANCE FACTOR (TIP RESISTANCE)	= 0.500E+00

LAYER NO 5----SAND

AT THE TOP

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.270E+02

AT THE BOTTOM

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.320E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.125E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.370E+02
LRFD RESISTANCE FACTOR (SIDE FRICTION)	= 0.385E+00
LRFD RESISTANCE FACTOR (TIP RESISTANCE)	= 0.500E+00

LAYER NO 6----SAND

AT THE TOP

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00
INTERNAL FRICTION ANGLE, DEG.	= 0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	= 0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	= 0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	= 0.100E+11
DEPTH, FT	= 0.370E+02

AT THE BOTTOM

SIDE FRICTION PROCEDURE: Ko METHOD	
LATERAL EARTH-PRESSURE COEFFICIENT - Ko	= 0.250E+00



Shaft LRFD.sf8o

INTERNAL FRICTION ANGLE, DEG.	=	0.340E+02
BLOWS PER FOOT FROM STANDARD PENETRATION TEST	=	0.000E+00
SOIL UNIT WEIGHT, LB/CU FT	=	0.130E+03
MAXIMUM LOAD TRANSFER FOR SOIL, LB/SQ FT	=	0.100E+11
DEPTH, FT	=	0.530E+02
LRFD RESISTANCE FACTOR (SIDE FRICTION)	=	0.385E+00
LRFD RESISTANCE FACTOR (TIP RESISTANCE)	=	0.550E+00

(\*) ESTIMATED BY THE PROGRAM BASED ON OTHER PARAMETERS

INPUT DRILLED SHAFT INFORMATION

-----

MINIMUM SHAFT DIAMETER	=	3.000	FT.
MAXIMUM SHAFT DIAMETER	=	3.000	FT.
RATIO BASE/SHAFT DIAMETER	=	0.000	FT.
ANGLE OF BELL	=	0.000	DEG.
IGNORED TOP PORTION	=	5.000	FT.
IGNORED BOTTOM PORTION	=	3.000	FT.
ELASTIC MODULUS, $E_c$	=	0.290E+08	LB/SQ IN

VARY SHAFT LENGTH FOR INITIAL DIAMETER

-----

MAXIMUM SHAFT LENGTH	=	40.000	FT.
MINIMUM SHAFT LENGTH	=	26.000	FT.
SHAFT LENGTH INCREMENT	=	5.000	FT.

COMPUTATION RESULTS

-----

- CASE ANALYZED	:	1
VARIATION LENGTH	:	1

VARIATION DIAMETER : 1

# DRILLED SHAFT INFORMATION

-----

DIAMETER OF STEM = 3.000 FT.  
 DIAMETER OF BASE = 3.000 FT.  
 END OF STEM TO BASE = 0.000 FT.  
 ANGLE OF BELL = 0.000 DEG.  
 IGNORED TOP PORTION = 5.000 FT.  
 IGNORED BOTTOM PORTION = 3.000 FT.  
 AREA OF ONE PERCENT STEEL = 10.180 SQ.IN.  
 ELASTIC MODULUS,  $E_c$  = 0.290E+08 LB/SQ IN  
 VOLUME OF UNDERREAM = 0.000 CU.YDS.  
 SHAFT LENGTH = 40.000 FT.

# PREDICTED RESULTS

-----

QS = ULTIMATE SIDE RESISTANCE;  
 QB = ULTIMATE BASE RESISTANCE;  
 WT = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);  
 QU = TOTAL ULTIMATE RESISTANCE;  
 LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR  
 TO THE ULTIMATE SIDE RESISTANCE;  
 LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR  
 TO THE ULTIMATE BASE RESISTANCE  
 LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
9.0	2.36	3.64	0.00	3.64	1.40	0.00	1.40
10.0	2.62	7.84	0.00	7.84	3.02	0.00	3.02
11.0	2.88	12.58	0.00	12.58	4.84	0.00	4.84
12.0	3.14	17.85	0.00	17.85	6.87	0.00	6.87
13.0	3.40	23.61	0.00	23.61	9.09	0.00	9.09
14.0	3.67	29.86	0.00	29.86	11.50	0.00	11.50
15.0	3.93	36.57	0.00	36.57	14.08	0.00	14.08
16.0	4.19	43.74	0.00	43.74	16.84	0.00	16.84
17.0	4.45	51.33	0.00	51.33	19.76	0.00	19.76
18.0	4.71	59.35	0.00	59.35	22.85	0.00	22.85
19.0	4.97	67.76	0.00	67.76	26.09	0.00	26.09
20.0	5.24	76.57	0.00	76.57	29.48	0.00	29.48
21.0	5.50	85.74	0.00	85.74	33.01	0.00	33.01

Shaft LRFD.sf8o							
22.0	5.76	95.28	7.47	102.75	36.68	3.73	40.42
23.0	6.02	105.16	16.26	121.43	40.49	8.13	48.62
24.0	6.28	115.38	26.43	141.82	44.42	13.22	57.64
25.0	6.55	117.00	33.48	150.48	45.04	16.74	61.78
26.0	6.81	118.65	37.25	155.90	45.68	18.63	64.31
27.0	7.07	120.34	37.59	157.93	46.33	18.80	65.13
28.0	7.33	122.06	37.71	159.77	46.99	18.85	65.85
29.0	7.59	123.82	37.71	161.53	47.67	18.85	66.52
30.0	7.85	125.61	37.71	163.32	48.36	18.85	67.22
31.0	8.12	127.77	37.71	165.48	49.19	18.85	68.05
32.0	8.38	129.97	45.71	175.68	50.04	22.85	72.89
33.0	8.64	132.22	54.85	187.07	50.90	27.42	78.33
34.0	8.90	134.52	65.13	199.65	51.79	32.57	84.35
35.0	9.16	136.86	71.99	208.85	52.69	35.99	88.68
36.0	9.43	139.24	75.42	214.66	53.61	37.71	91.32
37.0	9.69	141.68	75.42	217.09	54.54	41.48	96.02
38.0	9.95	144.15	75.42	219.57	55.50	41.48	96.98
39.0	10.21	146.68	75.42	222.10	56.47	41.48	97.95
40.0	10.47	149.25	75.42	224.67	57.46	41.48	98.94

#### AXIAL LOAD VS SETTLEMENT CURVES

-----

#### RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1560E-01	0.1027E-04	0.7332E-03	0.1000E-04
0.7802E-01	0.5134E-04	0.3666E-02	0.5000E-04
0.1560E+00	0.1027E-03	0.7332E-02	0.1000E-03
0.7802E+01	0.5134E-02	0.3666E+00	0.5000E-02
0.1170E+02	0.7702E-02	0.5499E+00	0.7500E-02
0.1560E+02	0.1027E-01	0.7332E+00	0.1000E-01
0.3902E+02	0.2567E-01	0.1833E+01	0.2500E-01
0.7233E+02	0.5125E-01	0.3666E+01	0.5000E-01
0.9973E+02	0.7673E-01	0.5499E+01	0.7500E-01
0.1171E+03	0.1020E+00	0.7332E+01	0.1000E+00
0.1658E+03	0.2530E+00	0.1818E+02	0.2500E+00
0.1871E+03	0.5036E+00	0.3423E+02	0.5000E+00
0.1918E+03	0.6288E+00	0.3934E+02	0.6250E+00
0.2006E+03	0.9041E+00	0.4827E+02	0.9000E+00
0.2284E+03	0.1805E+01	0.7655E+02	0.1800E+01

Shaft LRFD.sf8o

RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.2107E-01	0.1036E-04	0.1047E-02	0.1000E-04
0.1053E+00	0.5182E-04	0.5237E-02	0.5000E-04
0.2107E+00	0.1036E-03	0.1047E-01	0.1000E-03
0.1053E+02	0.5182E-02	0.5237E+00	0.5000E-02
0.1580E+02	0.7773E-02	0.7856E+00	0.7500E-02
0.2107E+02	0.1036E-01	0.1047E+01	0.1000E-01
0.5269E+02	0.2591E-01	0.2619E+01	0.2500E-01
0.9642E+02	0.5167E-01	0.5237E+01	0.5000E-01
0.1308E+03	0.7728E-01	0.7856E+01	0.7500E-01
0.1489E+03	0.1026E+00	0.1047E+02	0.1000E+00
0.1844E+03	0.2535E+00	0.2560E+02	0.2500E+00
0.2062E+03	0.5042E+00	0.4735E+02	0.5000E+00
0.2109E+03	0.6293E+00	0.5213E+02	0.6250E+00
0.2161E+03	0.9045E+00	0.5732E+02	0.9000E+00
0.2403E+03	0.1805E+01	0.8145E+02	0.1800E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1016E-01	0.1017E-04	0.4190E-03	0.1000E-04
0.5081E-01	0.5087E-04	0.2095E-02	0.5000E-04
0.1016E+00	0.1017E-03	0.4190E-02	0.1000E-03
0.5081E+01	0.5087E-02	0.2095E+00	0.5000E-02
0.7622E+01	0.7631E-02	0.3142E+00	0.7500E-02
0.1016E+02	0.1017E-01	0.4190E+00	0.1000E-01
0.2541E+02	0.2544E-01	0.1047E+01	0.2500E-01
0.4831E+02	0.5083E-01	0.2095E+01	0.5000E-01
0.6870E+02	0.7618E-01	0.3142E+01	0.7500E-01
0.8523E+02	0.1015E+00	0.4190E+01	0.1000E+00
0.1471E+03	0.2526E+00	0.1077E+02	0.2500E+00
0.1681E+03	0.5031E+00	0.2112E+02	0.5000E+00
0.1726E+03	0.6283E+00	0.2654E+02	0.6250E+00
0.1850E+03	0.9037E+00	0.3922E+02	0.9000E+00
0.2165E+03	0.1805E+01	0.7165E+02	0.1800E+01

- CASE ANALYZED : 2  
 VARIATION LENGTH : 2  
 VARIATION DIAMETER : 1

Shaft LRFD.sf8o

DRILLED SHAFT INFORMATION

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DIAMETER OF STEM = 3.000 FT.  
 DIAMETER OF BASE = 3.000 FT.  
 END OF STEM TO BASE = 0.000 FT.  
 ANGLE OF BELL = 0.000 DEG.  
 IGNORED TOP PORTION = 5.000 FT.  
 IGNORED BOTTOM PORTION = 3.000 FT.  
 AREA OF ONE PERCENT STEEL = 10.180 SQ.IN.  
 ELASTIC MODULUS,  $E_c$  = 0.290E+08 LB/SQ IN  
 VOLUME OF UNDERREAM = 0.000 CU.YDS.  
 SHAFT LENGTH = 35.000 FT.

PREDICTED RESULTS

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QS = ULTIMATE SIDE RESISTANCE;  
 QB = ULTIMATE BASE RESISTANCE;  
 WT = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);  
 QU = TOTAL ULTIMATE RESISTANCE;  
 LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR  
 TO THE ULTIMATE SIDE RESISTANCE;  
 LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR  
 TO THE ULTIMATE BASE RESISTANCE  
 LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
9.0	2.36	3.64	0.00	3.64	1.40	0.00	1.40
10.0	2.62	7.84	0.00	7.84	3.02	0.00	3.02
11.0	2.88	12.58	0.00	12.58	4.84	0.00	4.84
12.0	3.14	17.85	0.00	17.85	6.87	0.00	6.87
13.0	3.40	23.61	0.00	23.61	9.09	0.00	9.09
14.0	3.67	29.86	0.00	29.86	11.50	0.00	11.50
15.0	3.93	36.57	0.00	36.57	14.08	0.00	14.08
16.0	4.19	43.74	0.00	43.74	16.84	0.00	16.84
17.0	4.45	51.33	0.00	51.33	19.76	0.00	19.76
18.0	4.71	59.35	0.00	59.35	22.85	0.00	22.85
19.0	4.97	67.76	0.00	67.76	26.09	0.00	26.09
20.0	5.24	76.57	0.00	76.57	29.48	0.00	29.48
21.0	5.50	85.74	0.00	85.74	33.01	0.00	33.01
22.0	5.76	95.28	7.47	102.75	36.68	3.73	40.42
23.0	6.02	105.16	16.26	121.43	40.49	8.13	48.62
24.0	6.28	115.38	26.43	141.82	44.42	13.22	57.64

Shaft LRFD.sf8o							
25.0	6.55	117.00	33.48	150.48	45.04	16.74	61.78
26.0	6.81	118.65	37.25	155.90	45.68	18.63	64.31
27.0	7.07	120.34	37.59	157.93	46.33	18.80	65.13
28.0	7.33	122.06	37.71	159.77	46.99	18.85	65.85
29.0	7.59	123.82	37.71	161.53	47.67	18.85	66.52
30.0	7.85	125.61	37.71	163.32	48.36	18.85	67.22
31.0	8.12	127.77	37.71	165.48	49.19	18.85	68.05
32.0	8.38	129.97	45.71	175.68	50.04	22.85	72.89
33.0	8.64	132.22	54.85	187.07	50.90	27.42	78.33
34.0	8.90	134.52	65.13	199.65	51.79	32.57	84.35
35.0	9.16	136.86	71.99	208.85	52.69	35.99	88.68

#### AXIAL LOAD VS SETTLEMENT CURVES

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#### RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1448E-01	0.1023E-04	0.6999E-03	0.1000E-04
0.7240E-01	0.5116E-04	0.3499E-02	0.5000E-04
0.1448E+00	0.1023E-03	0.6999E-02	0.1000E-03
0.7240E+01	0.5116E-02	0.3499E+00	0.5000E-02
0.1086E+02	0.7674E-02	0.5249E+00	0.7500E-02
0.1448E+02	0.1023E-01	0.6999E+00	0.1000E-01
0.3621E+02	0.2558E-01	0.1750E+01	0.2500E-01
0.6716E+02	0.5108E-01	0.3499E+01	0.5000E-01
0.9265E+02	0.7649E-01	0.5249E+01	0.7500E-01
0.1088E+03	0.1018E+00	0.6999E+01	0.1000E+00
0.1543E+03	0.2526E+00	0.1736E+02	0.2500E+00
0.1746E+03	0.5031E+00	0.3268E+02	0.5000E+00
0.1790E+03	0.6282E+00	0.3755E+02	0.6250E+00
0.1874E+03	0.9035E+00	0.4607E+02	0.9000E+00
0.2140E+03	0.1804E+01	0.7307E+02	0.1800E+01

#### RESULT FROM UPPER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1954E-01	0.1031E-04	0.9999E-03	0.1000E-04
0.9772E-01	0.5157E-04	0.4999E-02	0.5000E-04
0.1954E+00	0.1031E-03	0.9999E-02	0.1000E-03
0.9772E+01	0.5157E-02	0.4999E+00	0.5000E-02

Shaft LRFD.sf8o

0.1466E+02	0.7735E-02	0.7499E+00	0.7500E-02
0.1954E+02	0.1031E-01	0.9999E+00	0.1000E-01
0.4888E+02	0.2578E-01	0.2500E+01	0.2500E-01
0.8951E+02	0.5144E-01	0.4999E+01	0.5000E-01
0.1215E+03	0.7697E-01	0.7499E+01	0.7500E-01
0.1384E+03	0.1023E+00	0.9999E+01	0.1000E+00
0.1718E+03	0.2530E+00	0.2444E+02	0.2500E+00
0.1926E+03	0.5036E+00	0.4519E+02	0.5000E+00
0.1972E+03	0.6287E+00	0.4976E+02	0.6250E+00
0.2021E+03	0.9038E+00	0.5471E+02	0.9000E+00
0.2251E+03	0.1804E+01	0.7775E+02	0.1800E+01

RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.9435E-02	0.1015E-04	0.3999E-03	0.1000E-04
0.4717E-01	0.5075E-04	0.2000E-02	0.5000E-04
0.9435E-01	0.1015E-03	0.3999E-02	0.1000E-03
0.4717E+01	0.5075E-02	0.2000E+00	0.5000E-02
0.7076E+01	0.7613E-02	0.3000E+00	0.7500E-02
0.9435E+01	0.1015E-01	0.3999E+00	0.1000E-01
0.2359E+02	0.2538E-01	0.9999E+00	0.2500E-01
0.4486E+02	0.5072E-01	0.2000E+01	0.5000E-01
0.6381E+02	0.7602E-01	0.3000E+01	0.7500E-01
0.7917E+02	0.1013E+00	0.3999E+01	0.1000E+00
0.1368E+03	0.2522E+00	0.1028E+02	0.2500E+00
0.1565E+03	0.5027E+00	0.2016E+02	0.5000E+00
0.1609E+03	0.6278E+00	0.2534E+02	0.6250E+00
0.1727E+03	0.9031E+00	0.3743E+02	0.9000E+00
0.2028E+03	0.1804E+01	0.6839E+02	0.1800E+01

- CASE ANALYZED : 3  
 VARIATION LENGTH : 3  
 VARIATION DIAMETER : 1

DRILLED SHAFT INFORMATION

-----

DIAMETER OF STEM = 3.000 FT.  
 DIAMETER OF BASE = 3.000 FT.  
 END OF STEM TO BASE = 0.000 FT.

Shaft LRFD.sf8o

ANGLE OF BELL = 0.000 DEG.  
 IGNORED TOP PORTION = 5.000 FT.  
 IGNORED BOTTOM PORTION = 3.000 FT.  
 AREA OF ONE PERCENT STEEL = 10.180 SQ.IN.  
 ELASTIC MODULUS,  $E_c$  = 0.290E+08 LB/SQ IN  
 VOLUME OF UNDERREAM = 0.000 CU.YDS.  
 SHAFT LENGTH = 30.000 FT.

#### PREDICTED RESULTS

-----

QS = ULTIMATE SIDE RESISTANCE;  
 QB = ULTIMATE BASE RESISTANCE;  
 WT = WEIGHT OF DRILLED SHAFT (UPLIFT CAPACITY ONLY);  
 QU = TOTAL ULTIMATE RESISTANCE;  
 LRFD QS = TOTAL SIDE FRICTION USING LRFD RESISTANCE FACTOR  
 TO THE ULTIMATE SIDE RESISTANCE;  
 LRFD QB = TOTAL BASE BEARING USING LRFD RESISTANCE FACTOR  
 TO THE ULTIMATE BASE RESISTANCE  
 LRFD QU = TOTAL CAPACITY WITH LRFD RESISTANCE FACTOR.

LENGTH (FT)	VOLUME (CU.YDS)	QS (TONS)	QB (TONS)	QU (TONS)	LRFD QS (TONS)	LRFD QB (TONS)	LRFD QU (TONS)
9.0	2.36	3.64	0.00	3.64	1.40	0.00	1.40
10.0	2.62	7.84	0.00	7.84	3.02	0.00	3.02
11.0	2.88	12.58	0.00	12.58	4.84	0.00	4.84
12.0	3.14	17.85	0.00	17.85	6.87	0.00	6.87
13.0	3.40	23.61	0.00	23.61	9.09	0.00	9.09
14.0	3.67	29.86	0.00	29.86	11.50	0.00	11.50
15.0	3.93	36.57	0.00	36.57	14.08	0.00	14.08
16.0	4.19	43.74	0.00	43.74	16.84	0.00	16.84
17.0	4.45	51.33	0.00	51.33	19.76	0.00	19.76
18.0	4.71	59.35	0.00	59.35	22.85	0.00	22.85
19.0	4.97	67.76	0.00	67.76	26.09	0.00	26.09
20.0	5.24	76.57	0.00	76.57	29.48	0.00	29.48
21.0	5.50	85.74	0.00	85.74	33.01	0.00	33.01
22.0	5.76	95.28	7.47	102.75	36.68	3.73	40.42
23.0	6.02	105.16	16.26	121.43	40.49	8.13	48.62
24.0	6.28	115.38	26.43	141.82	44.42	13.22	57.64
25.0	6.55	117.00	33.48	150.48	45.04	16.74	61.78
26.0	6.81	118.65	37.25	155.90	45.68	18.63	64.31
27.0	7.07	120.34	37.59	157.93	46.33	18.80	65.13
28.0	7.33	122.06	37.71	159.77	46.99	18.85	65.85
29.0	7.59	123.82	37.71	161.53	47.67	18.85	66.52
30.0	7.85	125.61	37.71	163.32	48.36	18.85	67.22



AXIAL LOAD VS SETTLEMENT CURVES

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RESULT FROM TREND (AVERAGED) LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1303E-01	0.1019E-04	0.3666E-03	0.1000E-04
0.6515E-01	0.5097E-04	0.1833E-02	0.5000E-04
0.1303E+00	0.1019E-03	0.3666E-02	0.1000E-03
0.6515E+01	0.5097E-02	0.1833E+00	0.5000E-02
0.9773E+01	0.7645E-02	0.2750E+00	0.7500E-02
0.1303E+02	0.1019E-01	0.3666E+00	0.1000E-01
0.3258E+02	0.2548E-01	0.9165E+00	0.2500E-01
0.6035E+02	0.5090E-01	0.1833E+01	0.5000E-01
0.8313E+02	0.7624E-01	0.2750E+01	0.7500E-01
0.9726E+02	0.1015E+00	0.3666E+01	0.1000E+00
0.1351E+03	0.2521E+00	0.9092E+01	0.2500E+00
0.1477E+03	0.5023E+00	0.1712E+02	0.5000E+00
0.1499E+03	0.6274E+00	0.1967E+02	0.6250E+00
0.1542E+03	0.9025E+00	0.2413E+02	0.9000E+00
0.1679E+03	0.1803E+01	0.3827E+02	0.1800E+01

RESULT FROM UPPER-BOUND LINE

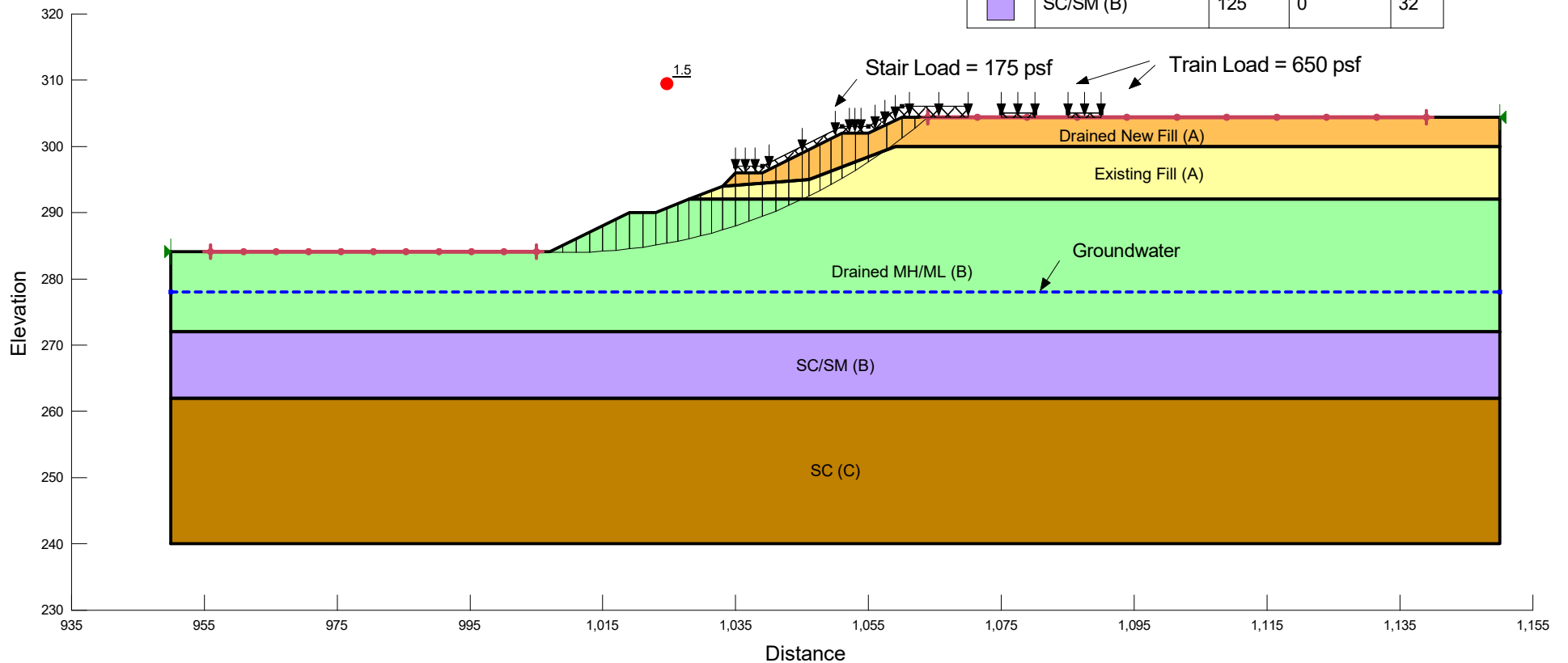
TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.1755E-01	0.1026E-04	0.5237E-03	0.1000E-04
0.8777E-01	0.5130E-04	0.2619E-02	0.5000E-04
0.1755E+00	0.1026E-03	0.5237E-02	0.1000E-03
0.8777E+01	0.5130E-02	0.2619E+00	0.5000E-02
0.1317E+02	0.7695E-02	0.3928E+00	0.7500E-02
0.1755E+02	0.1026E-01	0.5237E+00	0.1000E-01
0.4390E+02	0.2565E-01	0.1309E+01	0.2500E-01
0.8027E+02	0.5119E-01	0.2619E+01	0.5000E-01
0.1088E+03	0.7662E-01	0.3928E+01	0.7500E-01
0.1233E+03	0.1018E+00	0.5237E+01	0.1000E+00
0.1484E+03	0.2523E+00	0.1280E+02	0.2500E+00
0.1593E+03	0.5026E+00	0.2367E+02	0.5000E+00
0.1617E+03	0.6276E+00	0.2607E+02	0.6250E+00
0.1643E+03	0.9027E+00	0.2866E+02	0.9000E+00
0.1764E+03	0.1803E+01	0.4073E+02	0.1800E+01

## RESULT FROM LOWER-BOUND LINE

TOP LOAD TON	TOP MOVEMENT IN.	TIP LOAD TON	TIP MOVEMENT IN.
0.8516E-02	0.1013E-04	0.2095E-03	0.1000E-04
0.4258E-01	0.5063E-04	0.1047E-02	0.5000E-04
0.8516E-01	0.1013E-03	0.2095E-02	0.1000E-03
0.4258E+01	0.5063E-02	0.1047E+00	0.5000E-02
0.6387E+01	0.7594E-02	0.1571E+00	0.7500E-02
0.8516E+01	0.1013E-01	0.2095E+00	0.1000E-01
0.2129E+02	0.2531E-01	0.5237E+00	0.2500E-01
0.4046E+02	0.5060E-01	0.1047E+01	0.5000E-01
0.5750E+02	0.7585E-01	0.1571E+01	0.7500E-01
0.7123E+02	0.1011E+00	0.2095E+01	0.1000E+00
0.1218E+03	0.2518E+00	0.5384E+01	0.2500E+00
0.1361E+03	0.5021E+00	0.1056E+02	0.5000E+00
0.1380E+03	0.6271E+00	0.1327E+02	0.6250E+00
0.1441E+03	0.9023E+00	0.1961E+02	0.9000E+00
0.1595E+03	0.1803E+01	0.3582E+02	0.1800E+01

**Project Name: Rolling Road Platform**  
**Project no.: JD185036**  
**Long Term Slope Stability**  
**Method: Spencer**

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
<span style="color: green;">■</span>	Drained MH/ML (B)	120	0	28
<span style="color: orange;">■</span>	Drained New Fill (A)	120	50	32
<span style="color: yellow;">■</span>	Existing Fill (A)	120	0	28
<span style="color: brown;">■</span>	SC (C)	130	0	34
<span style="color: purple;">■</span>	SC/SM (B)	125	0	32



File Name: Slope Stability - Stair.gsz

Note: Data point shown is randomly placed to show factor of safety value only, and does not represent center of critical surface. Actual coordinates of center of critical surface: (1,009.5425, 366.42607) ft

# SLOPE/W Analysis - Drained

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## File Information

File Version: 9.00  
Created By: Madrona, Fernanda S  
Last Edited By: Madrona, Fernanda S  
Revision Number: 22  
Date: 02/19/2018  
Time: 11:00:48 AM  
Tool Version: 9.0.3.15488  
File Name: Slope Stability - Stair.gsz  
Directory: N:\Projects\2018\JD185036\Working Files\Calculations-Analyses\Slope Stability\  
Last Solved Date: 02/19/2018  
Last Solved Time: 11:01:02 AM

## Project Settings

Unit System: U.S. Customary Units

## Analysis Settings

### SLOPE/W Analysis - Drained

Description: Rolling Road Platform

Kind: SLOPE/W

Method: Spencer

#### Settings

PWP Conditions from: Piezometric Line

Apply Phreatic Correction: No

Use Staged Rapid Drawdown: No

Unit Weight of Water: 62.430189 pcf

#### Slip Surface

Direction of movement: Right to Left

Use Passive Mode: No

Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: No

Tension Crack Option: (none)

#### Distribution

F of S Calculation Option: Constant

#### Advanced

##### Geometry Settings

Minimum Slip Surface Depth: 0.1 ft

Number of Slices: 30

##### Factor of Safety Convergence Settings

Maximum Number of Iterations: 100

Tolerable difference in F of S: 0.001

Solution Settings

Search Method: Root Finder

Tolerable difference between starting and converged F of S: 3

Maximum iterations to calculate converged lambda: 20

Max Absolute Lambda: 2

## Materials

### Drained New Fill (A)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Cohesion': 50 psf

Phi': 32 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

### Existing Fill (A)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Cohesion': 0 psf

Phi': 28 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

### Drained MH/ML (B)

Model: Mohr-Coulomb

Unit Weight: 120 pcf

Cohesion': 0 psf

Phi': 28 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

### SC/SM (B)

Model: Mohr-Coulomb

Unit Weight: 125 pcf

Cohesion': 0 psf

Phi': 32 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

### SC (C)

Model: Mohr-Coulomb

Unit Weight: 130 pcf

Cohesion': 0 psf

Phi': 34 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

## Slip Surface Entry and Exit

Left Type: Range

Left-Zone Left Coordinate: (956, 284.1) ft

Left-Zone Right Coordinate: (1,005, 284.1) ft

Left-Zone Increment: 10

Right Type: Range

Right-Zone Left Coordinate: (1,063.8655, 304.4) ft

Right-Zone Right Coordinate: (1,139, 304.4) ft

Right-Zone Increment: 10

Radius Increments: 4

## Slip Surface Limits

Left Coordinate: (950, 284.1) ft

Right Coordinate: (1,150, 304.4) ft

## Piezometric Lines

### Piezometric Line 1

#### Coordinates

	X	Y
Coordinate 1	950 ft	278 ft
Coordinate 2	1,150 ft	278 ft

## Surcharge Loads

### Surcharge Load 1

Surcharge (Unit Weight): 175 pcf

Direction: Vertical

#### Coordinates

	X	Y
	1,035 ft	297 ft
	1,039 ft	297 ft
	1,051 ft	303 ft
	1,055 ft	303 ft
	1,060 ft	306 ft

	1,070 ft	306 ft
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## Surcharge Load 2

Surcharge (Unit Weight): 650 pcf

Direction: Vertical

### Coordinates

	X	Y
	1,075 ft	305 ft
	1,080 ft	305 ft

## Surcharge Load 3

Surcharge (Unit Weight): 650 pcf

Direction: Vertical

### Coordinates

	X	Y
	1,085 ft	305 ft
	1,090 ft	305 ft

## Points

	X	Y
Point 1	950 ft	284.1 ft
Point 2	1,007 ft	284.1 ft
Point 3	1,019 ft	290 ft
Point 4	1,023 ft	290 ft
Point 5	1,035 ft	296 ft
Point 6	1,039 ft	296 ft
Point 7	1,051 ft	302 ft
Point 8	1,055 ft	302 ft
Point 9	1,060 ft	304.4 ft
Point 10	1,150 ft	304.4 ft
Point 11	1,033 ft	294 ft
Point 12	1,046 ft	295 ft
Point 13	1,059 ft	300 ft
Point 14	1,150 ft	300 ft
Point 15	950 ft	240 ft
Point 16	1,150 ft	240 ft
Point 17	1,150 ft	292 ft
Point 18	1,028 ft	292 ft
Point 19	1,150 ft	272 ft
Point 20	950 ft	272 ft
Point 21	1,150 ft	262 ft

Point 22	950 ft	262 ft
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## Regions

	Material	Points	Area
Region 1	Drained MH/ML (B)	1,20,19,17,18,4,3,2	3,477.3 ft <sup>2</sup>
Region 2	Drained New Fill (A)	14,10,9,8,7,6,5,11,12,13	486 ft <sup>2</sup>
Region 3	Existing Fill (A)	14,13,12,11,18,17	837 ft <sup>2</sup>
Region 4	SC (C)	15,16,21,22	4,400 ft <sup>2</sup>
Region 5	SC/SM (B)	19,20,22,21	2,000 ft <sup>2</sup>

## Current Slip Surface

Slip Surface: 552

Factor of Safety: 1.5

Volume: 289.30634 ft<sup>3</sup>

Weight: 34,716.761 lbf

Resisting Moment: 1,738,816.5 lbf·ft

Activating Moment: 1,175,350 lbf·ft

Resisting Force: 19,372.711 lbf

Activating Force: 13,087.969 lbf

Slip Rank: 1 of 605 slip surfaces

Exit: (1,005, 284.1) ft

Entry: (1,063.8655, 304.4) ft

Radius: 82.451296 ft

Center: (1,009.5425, 366.42607) ft

## Slip Slices

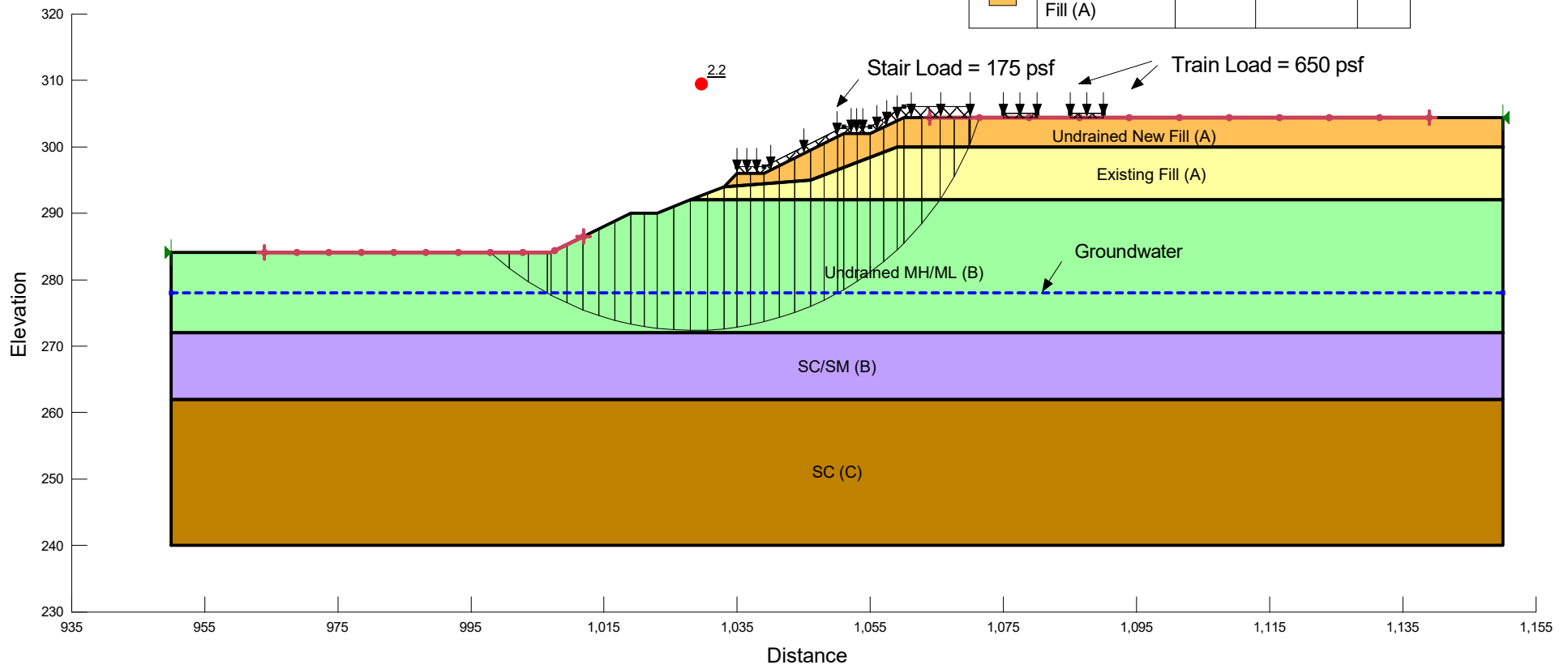
	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength
Slice 1	1,006 ft	284.05699 ft	-378.13914 psf	6.1443331 psf	3.2669998 psf	0 psf
Slice 2	1,008 ft	283.99527 ft	-374.28585 psf	83.478791 psf	44.386461 psf	0 psf
Slice 3	1,010 ft	283.98211 ft	-373.46399 psf	218.53484 psf	116.19704 psf	0 psf
Slice 4	1,012 ft	284.01747 ft	-375.67208 psf	341.79216 psf	181.73412 psf	0 psf
Slice 5	1,014 ft	284.10144 ft	-380.91404 psf	453.89305 psf	241.33922 psf	0 psf
Slice 6	1,016 ft	284.23415 ft	-389.19917 psf	555.41055 psf	295.31703 psf	0 psf
Slice 7	1,018 ft	284.41584 ft	-400.54226 psf	646.85668 psf	343.9398 psf	0 psf
Slice 8	1,020 ft	284.64684 ft	-414.96369 psf	667.39211 psf	354.85868 psf	0 psf
Slice	1,022 ft	284.92757	-432.48967	620.79845 psf	330.08439 psf	0 psf



9		ft	psf			
Slice 10	1,023.8333 ft	285.22709 ft	-451.18871 psf	614.49614 psf	326.7334 psf	0 psf
Slice 11	1,025.5 ft	285.53815 ft	-470.60844 psf	647.34239 psf	344.19805 psf	0 psf
Slice 12	1,027.1667 ft	285.8849 ft	-492.2561 psf	674.91744 psf	358.85997 psf	0 psf
Slice 13	1,028.8333 ft	286.2678 ft	-516.16061 psf	697.37228 psf	370.79942 psf	0 psf
Slice 14	1,030.5 ft	286.68738 ft	-542.35452 psf	714.84536 psf	380.09002 psf	0 psf
Slice 15	1,032.1667 ft	287.1442 ft	-570.87417 psf	727.46362 psf	386.79927 psf	0 psf
Slice 16	1,034 ft	287.69264 ft	-605.11331 psf	801.44336 psf	426.13499 psf	0 psf
Slice 17	1,036 ft	288.34211 ft	-645.65982 psf	981.60965 psf	521.93111 psf	0 psf
Slice 18	1,038 ft	289.04872 ft	-689.77351 psf	888.89586 psf	472.63431 psf	0 psf
Slice 19	1,040.0041 ft	289.81574 ft	-737.65887 psf	844.89195 psf	449.23702 psf	0 psf
Slice 20	1,042.0123 ft	290.64521 ft	-789.44309 psf	846.74229 psf	450.22086 psf	0 psf
Slice 21	1,044.0205 ft	291.53772 ft	-845.16243 psf	841.68954 psf	447.53427 psf	0 psf
Slice 22	1,045.5123 ft	292.23645 ft	-888.78439 psf	834.18416 psf	443.54358 psf	0 psf
Slice 23	1,046.8333 ft	292.89553 ft	-929.93054 psf	823.48086 psf	437.85254 psf	0 psf
Slice 24	1,048.5 ft	293.76494 ft	-984.20836 psf	806.35357 psf	428.7458 psf	0 psf
Slice 25	1,050.1667 ft	294.68361 ft	-1,041.561 psf	784.68132 psf	417.22246 psf	0 psf
Slice 26	1,052 ft	295.75627 ft	-1,108.5274 psf	709.31107 psf	377.14738 psf	0 psf
Slice 27	1,054 ft	296.99739 ft	-1,186.0107 psf	582.31046 psf	309.61996 psf	0 psf
Slice 28	1,056.3497 ft	298.56877 ft	-1,284.1119 psf	506.84979 psf	269.49681 psf	0 psf
Slice 29	1,058.8497 ft	300.35825 ft	-1,395.83 psf	462.02561 psf	288.70564 psf	50 psf
Slice 30	1,060.9664 ft	301.9879 ft	-1,497.5691 psf	376.76227 psf	235.42719 psf	50 psf
Slice 31	1,062.8991 ft	303.57955 ft	-1,596.9361 psf	239.40852 psf	149.59904 psf	50 psf

**Project Name: Rolling Road Platform**  
**Project no.: JD185036**  
**Short Term Slope Stability**  
**Method: Spencer**

Color	Name	Unit Weight (pcf)	Cohesion' (psf)	Phi' (°)
<span style="display:inline-block; width:15px; height:15px; background-color:yellow; border:1px solid black;"></span>	Existing Fill (A)	120	0	28
<span style="display:inline-block; width:15px; height:15px; background-color:blue; border:1px solid black;"></span>	SC (C)	130	0	34
<span style="display:inline-block; width:15px; height:15px; background-color:green; border:1px solid black;"></span>	SC/SM (B)	125	0	32
<span style="display:inline-block; width:15px; height:15px; background-color:lightblue; border:1px solid black;"></span>	Undrained MH/ML (B)	120	1,000	0
<span style="display:inline-block; width:15px; height:15px; background-color:orange; border:1px solid black;"></span>	Undrained New Fill (A)	120	50	30



File Name: Slope Stability - Stair.gsz

Note: Data point shown is randomly placed to show factor of safety value only, and does not represent center of critical surface. Actual coordinates of center of critical surface: (1,028.2594, 317.39384) ft

# SLOPE/W Analysis - Undrained

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## File Information

File Version: 9.00  
Created By: Madrona, Fernanda S  
Last Edited By: Madrona, Fernanda S  
Revision Number: 22  
Date: 02/19/2018  
Time: 11:00:48 AM  
Tool Version: 9.0.3.15488  
File Name: Slope Stability - Stair.gsz  
Directory: N:\Projects\2018\JD185036\Working Files\Calculations-Analyses\Slope Stability\  
Last Solved Date: 02/19/2018  
Last Solved Time: 11:01:02 AM

## Project Settings

Unit System: U.S. Customary Units

## Analysis Settings

### SLOPE/W Analysis - Undrained

Description: Rolling Road Platform

Kind: SLOPE/W

Method: Spencer

#### Settings

PWP Conditions from: Piezometric Line

Apply Phreatic Correction: No

Use Staged Rapid Drawdown: No

Unit Weight of Water: 62.430189 pcf

#### Slip Surface

Direction of movement: Right to Left

Use Passive Mode: No

Slip Surface Option: Entry and Exit

Critical slip surfaces saved: 1

Optimize Critical Slip Surface Location: No

Tension Crack Option: (none)

#### Distribution

F of S Calculation Option: Constant

#### Advanced

##### Geometry Settings

Minimum Slip Surface Depth: 0.1 ft

Number of Slices: 30

##### Factor of Safety Convergence Settings

Maximum Number of Iterations: 100

Tolerable difference in F of S: 0.001  
Solution Settings  
Search Method: Root Finder  
Tolerable difference between starting and converged F of S: 3  
Maximum iterations to calculate converged lambda: 20  
Max Absolute Lambda: 2

## Materials

### Existing Fill (A)

Model: Mohr-Coulomb  
Unit Weight: 120 pcf  
Cohesion': 0 psf  
Phi': 28 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

### SC/SM (B)

Model: Mohr-Coulomb  
Unit Weight: 125 pcf  
Cohesion': 0 psf  
Phi': 32 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

### SC (C)

Model: Mohr-Coulomb  
Unit Weight: 130 pcf  
Cohesion': 0 psf  
Phi': 34 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

### Undrained MH/ML (B)

Model: Mohr-Coulomb  
Unit Weight: 120 pcf  
Cohesion': 1,000 psf  
Phi': 0 °  
Phi-B: 0 °  
Pore Water Pressure  
Piezometric Line: 1

### Undrained New Fill (A)

Model: Mohr-Coulomb  
Unit Weight: 120 pcf  
Cohesion': 50 psf

Phi': 30 °

Phi-B: 0 °

Pore Water Pressure

Piezometric Line: 1

## Slip Surface Entry and Exit

Left Type: Range

Left-Zone Left Coordinate: (964, 284.1) ft

Left-Zone Right Coordinate: (1,011.9147, 286.51639) ft

Left-Zone Increment: 10

Right Type: Range

Right-Zone Left Coordinate: (1,063.8655, 304.4) ft

Right-Zone Right Coordinate: (1,139, 304.4) ft

Right-Zone Increment: 10

Radius Increments: 4

## Slip Surface Limits

Left Coordinate: (950, 284.1) ft

Right Coordinate: (1,150, 304.4) ft

## Piezometric Lines

### Piezometric Line 1

#### Coordinates

	X	Y
Coordinate 1	950 ft	278 ft
Coordinate 2	1,150 ft	278 ft

## Surcharge Loads

### Surcharge Load 1

Surcharge (Unit Weight): 175 pcf

Direction: Vertical

#### Coordinates

	X	Y
	1,035 ft	297 ft
	1,039 ft	297 ft
	1,051 ft	303 ft
	1,055 ft	303 ft
	1,060 ft	306 ft

	1,070 ft	306 ft
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## Surcharge Load 2

Surcharge (Unit Weight): 650 pcf

Direction: Vertical

### Coordinates

	X	Y
	1,075 ft	305 ft
	1,080 ft	305 ft

## Surcharge Load 3

Surcharge (Unit Weight): 650 pcf

Direction: Vertical

### Coordinates

	X	Y
	1,085 ft	305 ft
	1,090 ft	305 ft

## Points

	X	Y
Point 1	950 ft	284.1 ft
Point 2	1,007 ft	284.1 ft
Point 3	1,019 ft	290 ft
Point 4	1,023 ft	290 ft
Point 5	1,035 ft	296 ft
Point 6	1,039 ft	296 ft
Point 7	1,051 ft	302 ft
Point 8	1,055 ft	302 ft
Point 9	1,060 ft	304.4 ft
Point 10	1,150 ft	304.4 ft
Point 11	1,033 ft	294 ft
Point 12	1,046 ft	295 ft
Point 13	1,059 ft	300 ft
Point 14	1,150 ft	300 ft
Point 15	950 ft	240 ft
Point 16	1,150 ft	240 ft
Point 17	1,150 ft	292 ft
Point 18	1,028 ft	292 ft
Point 19	1,150 ft	272 ft
Point 20	950 ft	272 ft
Point 21	1,150 ft	262 ft

Point 22	950 ft	262 ft
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## Regions

	Material	Points	Area
Region 1	Undrained MH/ML (B)	1,20,19,17,18,4,3,2	3,477.3 ft <sup>2</sup>
Region 2	Undrained New Fill (A)	14,10,9,8,7,6,5,11,12,13	486 ft <sup>2</sup>
Region 3	Existing Fill (A)	14,13,12,11,18,17	837 ft <sup>2</sup>
Region 4	SC (C)	15,16,21,22	4,400 ft <sup>2</sup>
Region 5	SC/SM (B)	19,20,22,21	2,000 ft <sup>2</sup>

## Current Slip Surface

Slip Surface: 394

Factor of Safety: 2.2

Volume: 1,167.6257 ft<sup>3</sup>

Weight: 140,115.08 lbf

Resisting Moment: 3,654,971 lbf·ft

Activating Moment: 1,646,061.6 lbf·ft

Resisting Force: 69,480.554 lbf

Activating Force: 31,289.476 lbf

Slip Rank: 1 of 605 slip surfaces

Exit: (997.93362, 284.1) ft

Entry: (1,071.379, 304.4) ft

Radius: 45.034807 ft

Center: (1,028.2594, 317.39384) ft

## Slip Slices

	X	Y	PWP	Base Normal Stress	Frictional Strength	Cohesive Strength
Slice 1	999.3507 ft	282.91196 ft	-306.65475 psf	711.57712 psf	0 psf	1,000 psf
Slice 2	1,002.1848 ft	280.7165 ft	-169.59178 psf	929.35876 psf	0 psf	1,000 psf
Slice 3	1,005.019 ft	278.85454 ft	-53.349105 psf	1,105.2697 psf	0 psf	1,000 psf
Slice 4	1,006.718 ft	277.84641 ft	9.5885298 psf	1,197.355 psf	0 psf	1,000 psf
Slice 5	1,008.2 ft	277.0955 ft	56.468317 psf	1,339.8259 psf	0 psf	1,000 psf
Slice 6	1,010.6 ft	275.98639 ft	125.70979 psf	1,583.9843 psf	0 psf	1,000 psf
Slice 7	1,013 ft	275.04225 ft	184.65258 psf	1,804.4337 psf	0 psf	1,000 psf
Slice 8	1,015.4 ft	274.2522 ft	233.97576 psf	2,003.1091 psf	0 psf	1,000 psf
Slice	1,017.8 ft	273.60786	274.20206	2,181.4748 psf	0 psf	1,000 psf

9		ft	psf			
Slice 10	1,020 ft	273.1346 ft	303.74813 psf	2,267.6202 psf	0 psf	1,000 psf
Slice 11	1,022 ft	272.80759 ft	324.16302 psf	2,266.8525 psf	0 psf	1,000 psf
Slice 12	1,024.25 ft	272.55543 ft	339.90562 psf	2,313.7944 psf	0 psf	1,000 psf
Slice 13	1,026.75 ft	272.40172 ft	349.50175 psf	2,403.9891 psf	0 psf	1,000 psf
Slice 14	1,029.25 ft	272.3873 ft	350.40221 psf	2,475.9829 psf	0 psf	1,000 psf
Slice 15	1,031.75 ft	272.51202 ft	342.61542 psf	2,529.8853 psf	0 psf	1,000 psf
Slice 16	1,034 ft	272.73779 ft	328.52075 psf	2,633.9839 psf	0 psf	1,000 psf
Slice 17	1,036 ft	273.04086 ft	309.59983 psf	2,843.0929 psf	0 psf	1,000 psf
Slice 18	1,038 ft	273.43698 ft	284.87022 psf	2,753.5152 psf	0 psf	1,000 psf
Slice 19	1,040.1667 ft	273.97855 ft	251.05999 psf	2,710.4446 psf	0 psf	1,000 psf
Slice 20	1,042.5 ft	274.68755 ft	206.79673 psf	2,709.43 psf	0 psf	1,000 psf
Slice 21	1,044.8333 ft	275.53856 ft	153.66815 psf	2,689.6034 psf	0 psf	1,000 psf
Slice 22	1,047.0207 ft	276.46845 ft	95.614846 psf	2,653.4524 psf	0 psf	1,000 psf
Slice 23	1,049.0621 ft	277.46818 ft	33.201468 psf	2,602.2687 psf	0 psf	1,000 psf
Slice 24	1,050.5414 ft	278.26113 ft	-16.302441 psf	2,555.9083 psf	0 psf	1,000 psf
Slice 25	1,052 ft	279.14292 ft	-71.35241 psf	2,443.345 psf	0 psf	1,000 psf
Slice 26	1,054 ft	280.46052 ft	-153.61049 psf	2,242.3985 psf	0 psf	1,000 psf
Slice 27	1,056 ft	281.9399 ft	-245.96891 psf	2,091.5068 psf	0 psf	1,000 psf
Slice 28	1,058 ft	283.60247 ft	-349.76305 psf	1,984.9949 psf	0 psf	1,000 psf
Slice 29	1,059.5 ft	284.96426 ft	-434.77994 psf	1,888.7596 psf	0 psf	1,000 psf
Slice 30	1,061.363 ft	286.92687 ft	-557.30645 psf	1,643.2948 psf	0 psf	1,000 psf
Slice 31	1,064.089 ft	290.20391 ft	-761.89249 psf	1,186.5543 psf	0 psf	1,000 psf
Slice 32	1,066.5389 ft	293.76049 ft	-983.93046 psf	949.08251 psf	504.63612 psf	0 psf



Slice 33	1,068.7127 ft	297.76049 ft	-1,233.6512 psf	589.55719 psf	313.47312 psf	0 psf
Slice 34	1,069.8998 ft	300.24326 ft	-1,388.6507 psf	359.16368 psf	207.36325 psf	50 psf
Slice 35	1,070.6895 ft	302.44326 ft	-1,525.9971 psf	79.229108 psf	45.742947 psf	50 psf