

DISTRICT FRONT END

APPENDIX A
Specifications

**PRIMARY SEDIMENTATION BASIN NO.1
SCUM SKIMMER SYSTEM UPGRADE**

**THE MATTABASSETT DISTRICT
CROMWELL, CONNECTICUT**

**BIDDING/CONTRACT DOCUMENTS
AND TECHNICAL SPECIFICATIONS**

**MAY 2022
BID CONTRACT NO. 2022-26
ISSUED FOR BIDDING**

20950A

**THE MATTABASSETT DISTRICT
CROMWELL, CONNECTICUT**

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AND TECHNICAL SPECIFICATIONS**

FOR

**PRIMARY SEDIMENTATION BASIN NO.1
SCUM SKIMMER SYSTEM UPGRADE**

BID CONTRACT NO. 2022-26

MAY 2022



Prepared By:

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Middletown, Connecticut 06457
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CONSENT OF SURETY TO FINAL PAYMENT

To: _____ (Owner)

From: _____ (Contractor)

CONTRACT TITLE: _____

BOND NUMBER: _____

In accordance with the provisions of the Contract between the Owner and the Contractor as indicated above, the _____ (Surety Company) on the bond of the Contractor hereby approves of the final payment to the Contractor, and agrees that final payment to the Contractor shall not relieve the Surety Company of any of its obligations to the Owner as set forth in the said Surety Company's Bond.

IN WITNESS WHEREOF, the Surety Company has hereunto set its hand this _____ day of _____, 20__.

Surety Company Name

Signature of Authorized Representative

Attest: (Seal)

Printed Name and Title

Note: Power of Attorney should be attached in instances where same applies.

END OF SECTION

SECTION 00836
CONTRACTOR'S AFFIDAVIT

STATE OF _____

COUNTY OF _____

Before me, the undersigned, a _____

(Notary Public, Justice of Peace, Alderman)

in and for said County and State personally appeared, _____

(Individual, Partner or duly

_____ who being duly sworn according to law

(Authorized Representative of Corporate Contractor)

deposes and says that the cost of all the Work, and outstanding claims and indebtedness of whatever nature arising out of the performance of the contract between

(Owner)

and _____ of _____

(Contractor)

dated _____ for the construction of the _____

(Agreement Date)

(Project)

_____ and necessary appurtenant installations have been paid in full.

(Individual, Partner, or duly authorized representative of corporate contractor)

Sworn to and subscribed before me

This _____ day of _____, 20__

END OF SECTION

SECTION 00837CONTRACTOR'S RELEASE

KNOW ALL MEN BY THESE PRESENTS that _____
 _____ (Contractor)
 of _____, County of _____ and State of _____
 do hereby acknowledge that _____ has this day had, and received of
 _____ (Contractor)
 and from _____ the sum of One Dollar and other valuable considerations in
 _____ (Owner)
 full and complete satisfaction and payment of all sums of money owed, payable and belonging to
 _____ by any means whatsoever, for on account of a Contract
 _____ (Contractor)
 Agreement between _____ and _____
 _____ (Owner) _____ (Contractor)
 dated _____ for _____
 _____ (Agreement Date) _____ (Project)

NOW, THEREFORE, the said _____
 _____ (Contractor)

(for myself, my heirs, executors and administrators) (for itself, its successors and assigns)
 do/does, by these presents remise, release, quit-claim and forever discharge _____
 _____ (Owner)
 , of and from all claims and demands, arising from or in connection
 with the said contract dated _____, and of and from all, and all manner of action
 _____ (Agreement Date)
 and actions, cause and causes of action and actions, suits, debts, dues, duties, sum and sums of
 money, accounts, reckonings, bonds, bills, specialties, covenants, contracts, agreements,
 promises, variances, damages, judgments, extents, executions, claims and demand, whatsoever in
 law or equity, or otherwise, against _____ its successors and assigns, which (I,
 _____ (Owner)
 my heirs, executors, or administrators) (it, its successors and assigns) ever had, now have or
 which (I, my heirs, executors, or administrators) (it, its successors and assigns) hereafter can,
 shall or may have, for, upon or by reason of any matter, cause, or thing whatsoever; from the
 beginning of recorded time to the date of these presents.

IN WITNESS WHEREOF, _____
(Contractor)

has caused these presents to be duly executed this _____ day of _____ 20_____

Signed, Sealed and Delivered in the presence of:

(Individual -Contractor) (seal)

(Partnership - Contractor) (seal)

_____ By _____ (seal)
(Partner)

Attested:

(Corporation)

_____ By _____
(Secretary) (President or Vice President)

(Corp. Seal)

END OF SECTION



SECTION 00838

CERTIFICATE OF SUBSTANTIAL COMPLETION

Owner:	Owner's Contract No.:
Contractor:	Contractor's Project No.:
Engineer:	Engineer's Project No.:
Project:	Contract Name:

This [preliminary] [final] Certificate of Substantial Completion applies to:

- All Work The following specified portions of the Work:

Date of Substantial Completion

The Work to which this Certificate applies has been inspected by authorized representatives of Owner, Contractor, and Engineer, and found to be substantially complete. The Date of Substantial Completion of the Work or portion thereof designated above is hereby established, subject to the provisions of the Contract pertaining to Substantial Completion. The date of Substantial Completion in the final Certificate of Substantial Completion marks the commencement of the contractual correction period and applicable warranties required by the Contract.

A punch list of items to be completed or corrected is attached to this Certificate. This list may not be all-inclusive, and the failure to include any items on such list does not alter the responsibility of the Contractor to complete all Work in accordance with the Contract.

The responsibilities between Owner and Contractor for security, operation, safety, maintenance, heat, utilities, insurance, and warranties upon Owner's use or occupancy of the Work shall be as provided in the Contract, except as amended as follows: [Note: Amendments of contractual responsibilities recorded in this Certificate should be the product of mutual agreement of Owner and Contractor; see Paragraph 15.03.D of the General Conditions.]

Amendments to Owner's responsibilities: None As follows

Amendments to Contractor's responsibilities: None As follows:

The following documents are attached to and made a part of this Certificate: [punch list; others]

This Certificate does not constitute an acceptance of Work not in accordance with the Contract Documents, nor is it a release of Contractor's obligation to complete the Work in accordance with the Contract.

EXECUTED BY ENGINEER:		RECEIVED:	RECEIVED:
By: _____	By: _____	By: _____	
(Authorized signature)	Owner (Authorized Signature)	Contractor (Authorized Signature)	
Title: _____	Title: _____	Title: _____	
Date: _____	Date: _____	Date: _____	

SECTION 00839

WAIVER OF LIEN - MATERIALS AND LABOR

STATE OF _____

COUNTY OF _____

To: _____ (Owner)

WHEREAS, _____ (the undersigned) have been employed by _____ (Contractor) on the _____ (Project Name) to furnish the following:

_____ (description of material and services).

NOW THEREFORE, the undersigned, for good and valuable considerations do hereby waive and release any and all lien, or right of lien, or claim to lien on said above project and premises under the Law, in relation to Mechanics' Liens Law, on account of labor and materials, or both, furnished by the undersigned to or on account of the said contract for the said project and premises only so far as that portion of work which has been included in our requisition dated _____ and all prior requisitions.

THIS WAIVER AND RELEASE is being made to the undersigned in the amount of \$ _____ which sum the undersigned certifies to be the balance due the undersigned for all labor, materials or both, furnished by the undersigned to or on account of the said contract as included on his requisition dated _____.

GIVEN UNDER our hand and seal, this _____ day of _____, 20 __.

By: _____

Manufacturer, Supplier or Subcontractor Name

Signature of Authorized Representative

Printed Name and Title

END OF SECTION

SECTION 00841

WORK CHANGE DIRECTIVE

Work Change Directive No.

Date of Issuance: _____ Effective Date: _____
 Owner: _____ Owner's Contract No.: _____
 Contractor: _____ Contractor's Project No.: _____
 Engineer: _____ Engineer's Project No.: _____
 Project: _____ Contract Name: _____

Contractor is directed to proceed promptly with the following change(s):

Description:

Attachments: *[List documents supporting change]*

Purpose for Work Change Directive:

Directive to proceed promptly with the Work described herein, prior to agreeing to changes on Contract Price and Contract Time, is issued due to: *[check one or both of the following]*

- Non-agreement on pricing of proposed change.
- Necessity to proceed for schedule or other Project reasons.

Estimated Change in Contract Price and Contract Times (non-binding, preliminary):

Contract Price \$ _____ [increase] [decrease].
 Contract Time _____ days [increase] [decrease].

Basis of estimated change in Contract Price:

- Lump Sum Unit Price
- Cost of the Work Other

RECOMMENDED:

AUTHORIZED BY:

RECEIVED:

By: _____	By: _____	By: _____
Engineer (Authorized Signature)	Owner (Authorized Signature)	Contractor (Authorized Signature)
Title: _____	Title: _____	Title: _____
Date: _____	Date: _____	Date: _____

Approved by Funding Agency (if applicable)

By: _____ Date: _____
 Title: _____

SECTION 00842

CHANGE ORDER

Change Order No. _____

Date of Issuance:

Effective Date:

Owner:

Owner's Contract No.:

Contractor:

Contractor's Project No.:

Engineer:

Engineer's Project No.:

Project:

Contract Name:

The Contract is modified as follows upon execution of this Change Order:

Description:

Attachments: *[List documents supporting change]*

CHANGE IN CONTRACT PRICE	CHANGE IN CONTRACT TIMES <i>[note changes in Milestones if applicable]</i>
Original Contract Price: \$ _____	Original Contract Times: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: \$ _____	[Increase] [Decrease] from previously approved Change Orders No. ___ to No. ___: Substantial Completion: _____ Ready for Final Payment: _____ days
Contract Price prior to this Change Order: \$ _____	Contract Times prior to this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
[Increase] [Decrease] of this Change Order: \$ _____	[Increase] [Decrease] of this Change Order: Substantial Completion: _____ Ready for Final Payment: _____ days or dates
Contract Price incorporating this Change Order: \$ _____	Contract Times with all approved Change Orders: Substantial Completion: _____ Ready for Final Payment: _____ days or dates

RECOMMENDED:

ACCEPTED:

ACCEPTED:

By: _____
Engineer (if required)

By: _____
Owner (Authorized Signature)

By: _____
Contractor (Authorized Signature)

Title: _____

Title: _____

Title: _____

Date: _____

Date: _____

Date: _____

Approved by Funding Agency (if applicable)

By: _____
Title: _____

Date: _____

Contractor's Application for Payment No.

	Application Period:	Application Date:
To (Owner):	From (Contractor):	Via (Engineer):
Project:	Contract:	
Owner's Contract No.:	Contractor's Project No.:	Engineer's Project No.:

**Application For Payment
Change Order Summary**

Approved Change Orders	Number	Additions	Deductions		
				1. ORIGINAL CONTRACT PRICE	\$ _____
				2. Net change by Change Orders	\$ _____
				3. Current Contract Price (Line 1 ± 2)	\$ _____
				4. TOTAL COMPLETED AND STORED TO DATE (Column F total on Progress Estimates).....	\$ _____
				5. RETAINAGE:	
				a. X _____ Work Completed.....	\$ _____
				b. X _____ Stored Material.....	\$ _____
				c. Total Retainage (Line 5.a + Line 5.b).....	\$ _____
				6. AMOUNT ELIGIBLE TO DATE (Line 4 - Line 5.c)	\$ _____
				7. LESS PREVIOUS PAYMENTS (Line 6 from prior Application)	\$ _____
				8. AMOUNT DUE THIS APPLICATION	\$ _____
				9. BALANCE TO FINISH, PLUS RETAINAGE (Column G total on Progress Estimates + Line 5.c above).....	\$ _____
TOTALS					
				NET CHANGE BY CHANGE ORDERS	

Contractor's Certification

The undersigned Contractor certifies, to the best of its knowledge, the following:

(1) All previous progress payments received from Owner on account of Work done under the Contract have been applied on account to discharge Contractor's legitimate obligations incurred in connection with the Work covered by prior Applications for Payment;

(2) Title to all Work, materials and equipment incorporated in said Work, or otherwise listed in or covered by this Application for Payment, will pass to Owner at time of payment free and clear of all Liens, security interests, and encumbrances (except such as are covered by a bond acceptable to Owner indemnifying Owner against any such Liens, security interest, or encumbrances); and

(3) All the Work covered by this Application for Payment is in accordance with the Contract Documents and is not defective.

Contractor Signature

By: _____ Date: _____

Payment of: \$ _____
(Line 8 or other - attach explanation of the other amount)

is recommended by: _____ (Engineer) _____ (Date)

Payment of: \$ _____
(Line 8 or other - attach explanation of the other amount)

is approved by: _____ (Owner) _____ (Date)

Approved by: _____
Funding or Financing Entity (if applicable) _____ (Date)

Progress Estimate - Lump Sum Work

Contractor's Application

For (Contract):				Application Number:				
Application Period:				Application Date:				
			Work Completed		E	F		G
	A	B	C	D	Materials Presently Stored (not in C or D)	Total Completed and Stored to Date (C + D + E)	% (F / B)	Balance to Finish (B - F)
Specification Section No.	Description	Scheduled Value (\$)	From Previous Application (C+D)	This Period				
		Totals						

Progress Estimate - Unit Price Work

Contractor's Application

For (Contract):						Application Number:					
Application Period:						Application Date:					
A					B	C	D	E	F		
Item			Contract Information			Estimated Quantity Installed	Value of Work Installed to Date	Materials Presently Stored (not in C)	Total Completed and Stored to Date (D + E)	% (F / B)	Balance to Finish (B - F)
Bid Item No.	Description		Item Quantity	Units	Unit Price	Total Value of Item (\$)					
Totals											

Stored Material Summary

Contractor's Application

For (Contract):								Application Number:						
Application Period:								Application Date:						
Bid Item No.	A		B		C			D		E	Subtotal Amount Completed and Stored to Date (D + E)	F		G
	Supplier Invoice No.	Submittal No. (with Specification Section No.)	Storage Location	Description of Materials or Equipment Stored	Stored Previously		Amount Stored this Month (\$)	Incorporated in Work		Materials Remaining in Storage (\$) (D + E - F)				
					Date Placed into Storage (Month/Year)	Amount (\$)		Date (Month/Year)	Amount (\$)					
Totals														

SECTION 01010ASUMMARY OF WORKPART 1 - GENERAL1.1 DESCRIPTION

A. Work Included: The proposed work under this Contract includes the following at The Mattabassett District Water Pollution Control Facility at 245 Main Street in Cromwell, Connecticut:

1. Construction of:
 - a. New automatic scum skimmer system for all 3 bays of the Primary Sedimentation Basin No.1.
 - b. Removal and reinstallation of roll up doors, fascia and flashing for Sedimentation Basin No. 1 for installation of new fall protection connection hooks.
 - c. Removal and installation of new pipe sleeves between bay walls in Sedimentation basin No. 1
 - d. Equipment systems, instrumentation, control and electrical systems, as indicated on the Drawings.
 - e. Other appurtenances as shown on the Drawings and specified herein.
2. Demolition of:
 - a. 16-inch diameter scum tubes and manual actuators in all three bays of Sedimentation Basin No.1.
3. Remove and/or relocate equipment as indicated on the Drawings.
4. SI/AESS Programming Services, as defined in Division 13 and contract drawings, will be provided by NIC Systems Inc. Cromwell, CT under Bid Item No.2.

B. Related Work Specified Elsewhere:

1. Coordination: Section 01050
2. Construction Schedules: Section 01310.
3. Quality Coordination Meetings: Various sections of the Specifications, including those outlined below.
 - a. Pre-Startup Meeting (Section 01800)
 - b. Pre-Instrumentation Meeting (Section 13410)
 - c. Pre-Electrical Meeting (Section 16010)

C. Removals, Relocations and Rearrangements

1. Examine the existing site for the work of all trades which will influence the cost of the work under the bid. This work shall include removals, relocations and rearrangements which may interfere with, disturb or complicate the performance of the work under the bid involving systems, equipment and related service lines, which shall continue to be utilized as part of the finished project. The Contractor is responsible for all coordination in this regard.
2. Provide in the bid a sufficient amount to include all removals, relocations, rearrangements and reconnections herein specified, necessary or required to

provide approved operation and coordination of the combined new and existing systems and equipment.

PART 2 - PRODUCTS

Not Applicable.

PART 3 - EXECUTION

3.1 MAINTAIN EXISTING WORKS

A. Existing Operations:

1. The existing WWTF provides influent pumping, mechanical fine screening, primary treatment, secondary treatment and disinfection of wastewater. Sludge is presently thickened and dewatered and incinerated onsite.
2. Typical raw sewerage influent flows to the WWTF are as follows:
 - a. Minimum: 10.00-mgd;
 - b. Annual Average: 35.00-mgd;
 - c. Maximum Month: 55.0-mgd;
 - d. Peak Hour: 110.0-mgd
 - e. Contractor shall be required to convey the entire range of influent flows for the duration of the project.
 - f. Sedimentation Basin No. 1 and 2 are in operation through ≤ 55 MGD of flows; when flows exceed ≥ 55 MGD, three sedimentation basins are used. During high wet weather conditions owner will require all four basins with Sedimentation Basin 3 and 4 being used for chemical enhanced primary treatment. Contractor shall remove all tools/equipment etc. in Basin 1 and 2 during high wet weather events to convey the entire range of influent flows for the duration of the project.
 - g. Based on Contractor's request and dry weather conditions (< 55 MGD) Owner will consider bypassing plant flow to Basins 3 and 4 for work to be completed in Basin No.1 and portions of Basin No.2.

B. Routine laboratory analyses are performed in conjunction with treatment.

Treatment plant maintenance equipment and vehicles are stored on the premises.

1. Utilities include municipal water, electric power, telephone and fuel oil.

C. Maintain Treatment:

1. State and federal regulations require that at all times during construction work under this contract, the treatment facility remain operational (i.e. provide secondary treatment as well as sludge handling, dewatering and disposal) throughout construction, until such time as the new facilities are accepted and on-line.
2. The Contractor shall provide, maintain and operate all temporary facilities such as dams, pumping equipment, conduits, and all other labor and equipment necessary to intercept the sewage, sludge and supernatant flow before it reaches the points where it would interfere with the work, and carry it past the work such that essential treatment processes remain operational and effective.

3. The Contractor's operations shall not hinder the delivery, storage and use of materials and supplies, nor hinder staff duties, nor disrupt utility service.
 4. The Owner must have access to the existing plant and equipment at all times unless a specific exception is granted by the Owner.
- D. Minimize Interference
1. The Contractor shall at all times conduct their operations so as to interfere as little as possible with existing works. The Contractor shall develop a program, in cooperation with the Owner, Engineer, and interested officials, which shall provide for the construction and putting into service of the new works in the most orderly manner possible. This program shall be adhered to except as deviations therefrom are expressly permitted.
 2. Work of connecting with, cutting into, and reconstructing existing pipes or structures shall be planned to interfere with the operation of the existing facilities for the shortest possible time and when the demands on the facilities best permit such interference. It may be necessary to work outside of normal working hours to minimize interference. Before starting work which will interfere with the operation of existing facilities, the Contractor shall do all possible preparatory work and shall see that all tools, materials, and equipment are made ready and at hand.
 3. Any demolition of existing concrete, ductwork or equipment in the Grease Control Building and Primary pipe Tunnel shall require the Contractor to keep dust from entering the rest of the building. Contractor shall provide temporary measures as required to control the exposure of dust to the treatment plant personnel and the remainder of the facility. The Contractor shall provide for continuous safe passage around work for treatment facility personnel.
 4. The Contractor shall not use the Owner's bathrooms or kitchen facilities.
 5. The Contractor shall limit their personnel to the proposed work areas and limits of work.
 6. The Contractor shall limit parking of workers and subcontractors inside the Facility. On-site speed limit is 10 MPH.

3.2 CONSTRUCTION SEQUENCE

- A. Construction of the proposed skimmer system will disrupt the existing treatment facility structures and operations. To maintain treatment and to minimize disruption, the construction must be divided into phases or sequenced appropriately. The construction sequence phases and dates must allow the facility to maintain treatment as specified in paragraph 3.1,A and B. Refer to paragraph 3.1,B,5. The Contractor may deviate from this construction sequencing as outlined in paragraph 3.2,C.
- B. The Contractor shall submit to the Engineer for review and acceptance a complete schedule of their proposed sequence of construction operations prior to commencing any work. This schedule shall include the Contractor's plans for doing the work. The sequencing plan and schedule shall clearly identify critical timeframes for taking facilities offline and for placing facilities into service, including sufficient time required for new equipment and/or processes to be tested and proven reliable before proceeding to the next item. This reliability testing is above and beyond any specified demonstration and site acceptance testing.
- C. The Contractor shall submit to the Engineer a written request to deviate from the

- above sequence with adequate supporting information to demonstrate to the Engineer that the continuity and degree of treatment will not be adversely affected.
- D. The Contractor shall include the cost of all temporary facilities required to maintain treatment during the construction period in their lump-sum bid price. The cost shall include the cost for all labor, tools, equipment and materials necessary.
 - E. It shall be recognized that certain interruptions of, and disruptions to, the treatment processes and present plant operations will be required to complete the work of this Contract. Scheduled interruptions requiring interruption or bypassing of treatment process shall be kept to a minimum frequency and duration. Such interruptions shall be coordinated by the Contractor and the Owner using the Contractor's proposed work schedule, but shall not affect the facilities ability to maintain treatment as described above.
 - F. The Contractor shall notify the Owner a minimum of seven (7) days in advance of any work which may affect or disrupt the operation of the existing facilities and two (2) calendar weeks in advance of removing tanks from service. Once the interruption occurs the Contractor must maintain a workforce on-site to complete the work in the agreed upon time.
 - G. Any work by the Contractor which requires the mechanical or electrical isolation of an existing piece of equipment, process or system shall be coordinated with the Engineer. Any and all isolation of electrical or mechanical equipment or process shall be accomplished in strict accordance with applicable codes and standards and the stricter of the Contractor's or Owner's lock-out/tag-out procedures.
 - H. The Contractor shall have all materials and equipment on-site, and shall receive the Owner's approval, prior to initiating work which requires any part of the existing wastewater treatment plant to be off-line.
 - I. Limited down-time of certain existing process units is specified in this specification. Should the Contractor fail to complete the Work within the down-time specified and should the Owner incur any actual costs directly or indirectly as a result thereof that would otherwise not have incurred had the Contractor successfully completed the Work within the specified down-time, the Contractor agrees to pay the Owner such actual incurred costs. Such costs may include, but not be limited to, Owner's actual costs of any additional maintenance and operations labor, material, equipment, and chemical costs, or any other related actual costs incurred in order for the Owner to keep the existing plant in normal operating condition.
 - J. The Contractor shall allow in the Bid reasonable time to accommodate operations at the existing wastewater treatment plant, including the need for the Owner to respond to emergencies. The Contractor shall not be eligible for additional compensation due to interruptions of the Contractor's schedule, in order for the Owner to respond to routine conditions.

END OF SECTION

SECTION 01045CUTTING, CORING AND PATCHINGPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included - This section establishes general requirements pertaining to cutting, excavating, coring, fitting, and patching of the Work required to:
1. Make alterations to existing structures.
 2. Make the parts fit properly.
 3. Replace work not conforming to requirements of the Contract Documents.
 4. Contractor is responsible for all cutting, coring, and rough and finish patching. Contractor shall coordinate the work of any and all subcontracting trades performing the work.
 5. Contractor is responsible for reviewing with the Owner and Engineer and receiving permission to proceed prior to cutting and coring and patching.
- B. Related Work Specified Elsewhere:
1. Pipe Sleeves and Seals are specified in Section 15092.
- C. Quality Assurance:
1. Perform all cutting, coring and patching in strict accordance with pertinent requirements of these Specifications, and in the event no such requirements are determined, in conformance with the Engineer's written direction.
- D. Submittals: In accordance with the requirements specified in Section 01340. Provide the following information at least 30 days prior to cutting or coring:
- a. Identification and qualifications of cutting/coring subcontractor(s) including: company name, business address contact information, or if by Contractor, indicated as such.
 - b. Key plan and schedule of cuts/cores indicating the: location of the cut/core, size (i.e., wall, floor, roof, etc.), equipment to be used and identification of any potential obstructions or embedded conduits and wiring.
2. Request for the Engineer's consent to proceed:
 - a. Prior to cutting which affects structural safety, submit written request to the Engineer for permission to proceed with cutting.
 - b. Should conditions of the work, or schedule, indicate a required change of materials or methods for cutting and patching, Contractor shall notify the Engineer and secure written permission prior to proceeding.

PART 2 - PRODUCTS2.1 MATERIALS

- A. Materials for replacement of work shall be equal to those of adjacent construction and shall comply with the pertinent sections of these Specifications.
- B. Concrete and grout for rough patching shall be as specified in Divisions 3 and 4.

PART 3 - EXECUTION

3.1 CONDITIONS

- A. Inspection:
 - 1. Inspect existing conditions, including elements subject to movement or damage during cutting, excavating, coring, backfilling, and patching.
 - 2. After uncovering the work, inspect conditions affecting installation of new work.
- B. Discrepancies:
 - 1. If uncovered conditions are not as anticipated, immediately notify the Engineer and secure needed directions.
 - 2. Do not proceed in areas of discrepancy until all such discrepancies have been fully resolved.

3.2 PREPARATION PRIOR TO CUTTING AND CORING

- A. Provide all required protection including, but not necessarily limited to, shoring, bracing and support to maintain structural integrity of the work.
- B. All cutting and coring shall be performed in such a manner as to limit the extent of patching.
- C. All holes cut through concrete and masonry walls or slabs shall be core drilled unless otherwise approved. No structural members shall be cut without approval of the Engineer and all such cutting shall be done in a manner directed by Engineer. No holes may be drilled in beams or other structural members without obtaining prior approval. All work shall be performed by mechanics skilled in this type of work.
- D. If holes are cored through floor slabs they shall be drilled from below.
- E. The Contractor shall determine from Owner's information, logical deduction and field testing if there are embedded electrical conduits, wiring or piping in the coring locations and shall readjust locations if possible to avoid coring through them. If concealed embedded conduit and piping are damaged, or severed, the coring contractor shall immediately notify the Contractor, Owner and Engineer to determine impact of the damage and develop and implement a plan to repair the damage and reactive the lines.
- F. If embedded concealed conduit, wiring or pipe is damaged or severed and all reasonable steps were taken by the Contractor to identify embedded items, and alternate routing was investigated, the repair work will be compensated by the Owner through a Change Order. If it was reasonable to expect an embedded item could have been present at the location, the Contractor shall repair at no additional cost to the Owner.

3.3 CORING

- A. Coring shall be performed with an approved non-impact rotary tool with diamond core drills. Size of holes shall be suitable for pipe, conduit, sleeves, equipment or mechanical seals to be installed.
- B. All equipment shall conform to OSHA standards and specifications pertaining to plugs, noise and fume pollution, wiring and maintenance.
- C. Provide protection for existing equipment, utilities and critical areas against water or

other damage caused by drilling operation.

- D. Slurry or tailings resulting from coring operations shall be vacuumed or otherwise removed from the area following drilling. Slurry or tailings shall not be allowed to enter floor drains.
- E. Work area (e.g., adjacent walls, floors, ceilings, pipes, conduits, etc.) shall be cleaned to remove splash residues from coring operation.

3.4 CUTTING

- A. Cutting shall be performed with a concrete wall saw and diamond saw blades of proper size.
- B. Provide for control of slurry generated by sawing operation on both sides of wall.
- C. When cutting a reinforced concrete wall, the cutting shall be done so as not to damage bond between the concrete and reinforcing steel left in structure. Cut shall be made so that steel neither protrudes nor is recessed from face of the cut.
- D. Adequate bracing of area to be cut shall be installed prior to start of cutting. Check area during sawing operations for partial cracking and provide additional bracing as required to prevent a partial release of cut area during sawing operations.
- E. Provide equipment of adequate size to remove cut panel.
- F. Slurry or tailings resulting from cutting operations shall be vacuumed or otherwise removed from the area following drilling. Slurry or tailings shall not be allowed to enter floor drains.
- G. Work area (e.g., adjacent walls, floors, ceilings, pipes, conduits, etc.) shall be cleaned to remove splash residues from cutting operation.

3.5 PERFORMANCE

- A. Perform all required excavating and backfilling as required under pertinent sections of these specifications. Perform cutting, coring and demolition by methods which will prevent damage to other portions of the work and will provide proper surfaces to receive installation of repair and/or new work. Perform fitting and adjustment of products to provide finished installation complying with the specified tolerances and finishes.
- B. Coring or cutting which exposes cut surfaces of reinforcing steel or structural steel shall be coated. Coating shall be 10 mil (dry film thickness) applied in two 5 mil (dry film thickness) coats of a single component moisture cured coal tar urethane or two part coal tar epoxy corrosion barrier. Alternately the exposed steel can be cut back two inches from the surface and a non-shrink grout applied over the steel flush to the concrete core or cut surface.
- C. Rough patching shall be such as to bring the cut or cored area flush with existing construction unless otherwise shown.
- D. Finish patching shall match existing surfaces as approved.

END OF SECTION

SECTION 01050COORDINATIONPART 1 - GENERAL1.1 DESCRIPTION

- A. Contractor is required to work in close proximity to Owner's existing facilities. The Contractor, under this Contract, will be responsible for coordinating construction activities with Owner to ensure that services, facilities, and safe working conditions are maintained.
- B. Other Construction Contractors will be interfacing with this Contract and working within the work area and in the vicinity of this Contract. The Contractor, under this contract, shall act as Construction Coordinator and shall coordinate construction activities with other Contractors working for Owner.
- C. Any damage to existing structures, equipment and property, accepted equipment or structures, and property or work in progress by others; as a result of the Contractor's or their subcontractor's operations shall be made good by the Contractor at no additional cost to the Owner.
- D. Sedimentation Basin No. 1 and 2 are in operation through ≤ 55 MGD of flows; when flows exceed ≥ 55 MGD, three sedimentation basins are used. During high wet weather conditions owner will require all four basins with Sedimentation Basin 3 and 4 being used for chemical enhanced primary treatment. Contractor shall remove all tools/equipment etc. in Basin 1 and 2 during high wet weather events to convey the entire range of influent flows for the duration of the project.
- E. Based on Contractor's request and dry weather conditions (< 55 MGD) Owner will consider bypassing plant flow to Basins 3 and 4 for work to be completed in Basin No.1 and portions of Basin No.2.

1.2 COORDINATION WITH OTHERS

- A. The Contractor shall provide the Owner & Engineer with a construction schedule indicating the times to perform the work required. The Contractor shall update the schedule when required and give the facility one week notice before the start of any work. The Contractor shall provide the facility personnel enough time to obtain materials and perform the work required of them. The Contractor shall daily communicate with the Engineer and Owner concerning updating the schedule, job progress, delay or early starts that affect the treatment process, facility staffing, etc.
- B. The Contractor shall be responsible for explicitly notifying all equipment suppliers, electrical subcontractor, and the instrumentation supplier that they are required to coordinate their work with the instrumentation supplier by providing operating sequences, input/out specifications with wiring diagrams for all equipment, and that they shall review and comment on each other's shop drawings to ensure that all interfaces are compatible.

1.3 CONTRACTOR'S USE OF PREMISES

- A. Contractor shall have use of the premises within the limits shown on the Drawings and as defined below.
 - 1. Wastewater Treatment Facilities
 - a. Restricted access: A record of all personnel entering and exiting the site shall be kept at all times. This includes all deliveries and activities after hours.
- B. Contractor work hours will be limited to 7:00AM to 3:30 PM, Monday through Friday. Any work outside these hours will require permission of the Owner and adequate notice.
- C. Contractor shall maintain access and utilities to the Wastewater Treatment Facility and all other adjacent facilities at all times. Whenever access is cut off in one direction, an alternative route for accessing all equipment and tankage must be maintained.
- D. Contractor shall coordinate delivery schedules, site access, and other construction-related activities with any other contractors that may be hired by the Owner during the course of construction.
- E. Contractor shall assume full responsibility for security of all of their, and their subcontractors, materials and equipment stored on the site.
- F. If directed by the Owner, Contractor shall move any stored items which interfere with operations of Owner.
- G. Obtain and pay for use of additional storage or work areas if needed to perform the Work.
- H. Contractor shall not have access to Owners lunch room, toilet or locker room facilities at any time and shall provide all necessary facilities.
- I. The General Contractor shall furnish, install, maintain and pay for adequate temporary chemical type toilet accommodations, for all persons employed on the work and located where approved by the Engineer. The accommodations shall be in proper enclosures and in accordance with Municipal Ordinances and shall be maintained in proper, safe and sanitary conditions and suitably heated when requested. Relocate temporary toilet facilities as required to facilitate the construction.

END OF SECTION

SECTION 01150AMEASUREMENT AND PAYMENTPART 1 - GENERAL1.1 DESCRIPTION

- A. For lump sum items, payment shall be made to the Contractor in accordance with an accepted Progress Schedule and Schedule of Values on the basis of actual work completed.
- B. For unit-price items, payment shall be based on the actual amount of work accepted and for the actual amount of materials in place, as shown by the final measurements.
 - 1. All units of measurement shall be standard United States convention as applied to the specific items of work by tradition and as interpreted by the Engineer.
 - 2. At the end of each day's work, the Contractor's Superintendent or other authorized representative of the Contractor shall determine the quantities of unit price work accomplished and/or completed during the work day.
 - 3. These completed forms will provide the basis of the Engineer's monthly quantity estimate upon which payment will be made. Items not appearing on Progress Reports will not be included for payment. Items appearing on forms not properly signed by the Contractor will not be included for payment.
 - 4. After the work is completed and before final payment is made there for, the Engineer will make final measurements to determine the quantities of various items of work accepted as the basis for final settlement.

1.2 SCOPE OF PAYMENT

- A. Payments to the Contractor will be made for the actual quantities of the Contract items performed and accepted in accordance with the Contract Documents. Upon completion of the construction, if these actual quantities show either an increase or decrease from the quantities given in the Bid Form, the Contract unit prices will still prevail.
- B. The Contractor shall accept compensation, as herein provided, in full payment for furnishing all materials, labor, tools, equipment, and incidentals necessary to the completed work and for performing all work contemplated and embraced by the Contract; also for all loss or damage arising from the nature of the Work, or from the action of the elements, or from any unforeseen difficulties which may be encountered during the prosecution of the Work and until its final acceptance by the Engineer, and for all risks of every description connected with the prosecution of the work, except as provided herein, also for all expenses incurred in consequence of the suspension of the work as herein authorized.
- C. The payment of any partial estimate or of any retained percentage except by and under the approved final invoice, in no way shall affect the obligation of the Contractor to repair or renew any defective parts of the construction or to be responsible for all damage due to such defects.

1.3 PAYMENT FOR INCREASED OR DECREASED QUANTITIES

A. When alterations in the quantities of work not requiring supplemental agreements, as hereinbefore provided for, are ordered and performed, the Contractor shall accept payment in full at the Contract price for the actual quantities of work done. No allowance will be made for anticipated profits. Increased or decreased work involving supplemental agreements will be paid for as stipulated in such agreements.

1.4 OMITTED ITEMS

A. Should any items contained in the bid form be found unnecessary for the proper completion of the work contracted, the Engineer may eliminate such items from the Contract, and such action shall in no way invalidate the Contract, and no allowance will be made for items so eliminated in making final payment to the Contractor.

1.5 PARTIAL PAYMENTS

A. Partial payments shall be made monthly as the work progresses.

1.6 PAYMENT FOR MATERIAL DELIVERED

A. When requested by the Contractor and at the discretion of the Owner, payment may be made for all or part of the value of acceptable, non-perishable materials and equipment which are to be incorporated into bid items, have not been used, and have been delivered to the construction site or placed in storage places acceptable to the Owner. Payment shall be subject to the provisions of the General and Supplementary Conditions.

B. No payment shall be made upon fuels, supplies, lumber, false work, or other materials, or on temporary structures or other work of any kind which are not a permanent part of the Contract.

1.7 FINAL PAYMENT

A. The Engineer will make, as soon as practicable after the entire completion of the project, a final quantity invoice of the amount of the Work performed and the value of such Work. Owner shall make final payments of the sum found due less retainages subject to the provisions of the General and Supplementary Conditions.

1.8 INCIDENTAL WORK

A. Incidental work items for which separate payment is not made include (but are not limited to) the following items:

1. Clearing, grubbing and stripping
2. Dust control
3. Clean-up
4. Erosion control
5. Loam, seeding, grading, liming, fertilization, mulching and watering
6. Coordination with the Owner, Utilities and others, including related inspection cost (refer to Section 01050)
7. Traffic control plan and regulation
8. Project Signs
9. Routine flag person services
10. Project record documents

11. Materials testing
12. Construction schedules, bonds, insurance, shop drawings, warranties, guarantees, certifications, and other submittals required by the Contract Documents
13. Maintenance of all existing sewers flows and repair of existing sewer pipes
14. Final cleaning of sewers, force mains and storm drains
15. Removal and disposal of existing sewer structures and pipe as and where indicated in the Drawings
16. Temporary utilities for construction and to maintain existing service during construction
17. Temporary utility services to buildings as required to maintain service during construction
18. Quality assurance testing
19. Temporary construction and other facilities not to be permanently incorporated into the Work necessary for construction sequencing and maintenance of operations
20. Weather protection
21. Permits not otherwise paid for or provided by the Owner
22. Visits to the Project site or elsewhere by personnel or agents of the Contractor, including manufacturer's representatives, as may be required
23. On-site and other facilities acceptable to Engineer for the storage of materials, supplies and equipment to be incorporated into the Work
24. Facilities start-up services required by the Contract Documents
25. Mobilization/demobilization
26. Pipe markings
27. Pavement markings
28. Removal of existing pavement
29. Earthwork (except ledge)
30. Preconstruction photos and videos
31. Construction administration and insurance

1.9 DESCRIPTION OF PAY ITEMS

- A. The following sections describe the measurement of and payment for the work to be done under the respective items listed in the Bid Form.
- B. Each unit or lump sum price stated in the Bid Form shall constitute full compensation, as herein specified, for each item of the work completed.

Item No. 1: Primary Sedimentation Basin No.1 Scum Skimmer Upgrade:

- A. Method of Payment: Payment of the lump sum price for Item 1 shall be full compensation for furnishing all labor, materials, tools, and equipment required and for upgrading of the treatment facilities, complete as indicated on the Drawings and as specified and all its' appurtenances in its entirety, except that work included for payment under other items.

Item No. 2: SI/AESS Scope of Work

A. Method of Measurement:

1. Cash Allowance for NIC to provide the scope of work included in Appendix A. The allowance to be included and carried in the bid schedule.

B. Basis of Payment:

1. The payment shall cover the cost charged to the Contractor by the pre-selected SI/AESS Services. The Owner has pre-selected and pre-negotiated the cost of the control system services specified in Division 13 and contract drawings. A cash allowance has been carried for SI/AESS Services from NIC Systems Corporation, Cromwell, CT (see Appendix) . Payment of the cash allowance shall be full compensation for establishing and paying fees to NIC for the work performed in Division 13 and as indicated in the Drawings and as specified. The Contractor shall note that all coordination costs shall be included in Bid Item 1.

SECTION 01200PROJECT MEETINGSPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included: To enable orderly review during progress of the work, and to provide for systematic discussion of problems, the Engineer will conduct project meetings throughout the construction period.
- B. Related work described elsewhere: The Contractor's relations with their subcontractors and materials suppliers and discussions relative thereto, are the Contractor's responsibility and are not part of project meetings content.

1.2 QUALITY ASSURANCE

- A. Persons designated by the Contractor to attend and participate in the project meetings shall have all required authority to commit the Contractor to solutions agreed upon in the project meetings.

1.3 SUBMITTALS

- A. Agenda items: To the maximum extent practicable, advise the Engineer at least 24 hours in advance of project meetings regarding all items to be added to the agenda.
- B. Minutes: The Engineer will compile minutes of each project meeting and will furnish a copy to the Contractor. The Contractor may make and distribute such other copies as they wish.

PART 2 - PRODUCTS

(No products are required in this Section.)

PART 3 - EXECUTION3.1 MEETING SCHEDULE

- A. Except as noted below for Preconstruction Meeting, project meetings will be held monthly. Coordinate as necessary to establish mutually acceptable schedule for meetings.

3.2 MEETING LOCATION

- A. Meetings will be held at the job site unless the Owner and/or Engineer determine that virtual meetings are applicable and appropriate for any reason (e.g., COVID, Safety and Health Plan, etc.).
 - 1. If meetings are required by Owner/Engineer to be held virtually, Engineer will host the meetings via Microsoft Teams. All required meeting attendees are responsible for providing hardware necessary to view, share, be heard and hear content of the meeting.

3.3 PRECONSTRUCTION MEETING

- A. Preconstruction meeting will be scheduled within twenty days after the Effective Date of the Agreement, but before the Contractor starts work at the site. Provide attendance by authorized representatives of the Contractor and all major subcontractors. The Engineer will advise other interested parties and request their attendance.
- B. Minimum agenda: Distribute data on, and discuss:
 - 1. Identification of key project personnel for Owner, Engineer, Contractor, funding/regulatory Agencies.
 - 2. Responsibilities of Owner, Engineer, Resident Project Representative, Contractor.
 - 3. Channels and procedures for communications.
 - 4. Construction schedule, including sequence of critical work.
 - 5. Easements, permits.
 - 6. Contract Documents, including distribution of required copies of original documents and revisions.
 - 7. Processing of Shop Drawings and other data submitted to the Engineer for review.
 - 8. Processing of field decisions and Change Orders.
 - 9. Rules and regulations governing performance of the Work, including funding/regulatory Agency requirements.
 - 10. Procedures for safety and first aid, security, quality control, housekeeping, and other related matters.

3.4 PROJECT MEETINGS

- A. Attendance: To the maximum extent practicable, assign the same person or persons to represent the Contractor at project meetings throughout progress of the Work. The Superintendent shall attend. Subcontractors, materials suppliers, and others may be invited to attend those project meetings in which their aspects of the Work are involved.
- B. Minimum agenda:
 - 1. Review, revise as necessary, and approved minutes of previous meeting.
 - 2. Review progress of the Work since last meeting, including status of submittals for approval.
 - 3. Review schedule of work to be accomplished prior to next meeting.
 - 4. Discuss monthly partial payment request.
 - 5. Review status of change order requests and Work Directive Changes.
 - 6. Identify problems which impede planned progress.
 - 7. Develop corrective measures and procedures to regain planned schedule.
 - 8. Complete other current business.

END OF SECTION

SECTION 01310CONSTRUCTION SCHEDULES – SHORT FORMPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included: Within ten (10) days after the effective date of the Agreement between Owner and Contractor submit to the Engineer an estimated progress schedule as specified herein.
- B. Form of Schedules:
 - 1. Narrative: Completely describe the construction methods to be employed.
 - 2. Network Analysis System:
 - a. Provide a separate horizontal schedule line for each trade or operation and show concurrent and preceding activities.
 - b. Present in chronological order the beginning of each trade or operation showing duration and float time.
 - c. Scale: Identify key dates and allow space for updating and revision.
 - 3. Mathematical Analysis:
 - a. A mathematical analysis shall accompany the network diagram. A computer printout will be acceptable.
 - b. Information shall be included on activity numbers, duration, early start, late start, etc. and float times.
- C. Content of Schedules:
 - 1. Provide complete sequence of construction by activity:
 - a. Shop Drawings, Project Data and Samples:
 - i. Submittal dates.
 - ii. Dates reviewed copies will be required.
 - b. Decision dates for:
 - i. Products specified by allowances.
 - ii. Selection of finishes.
 - c. Estimated product procurement and delivery dates.
 - d. Dates for beginning and completion of each element of construction.
 - 2. Identify work of separate phases and logically grouped activities.
 - 3. Show the projected percentage of completion for each item of work as of the first day of each month.
 - 4. Provide separate sub-schedules, if requested by the Engineer, showing submittals, review times, procurement schedules, and delivery dates.
 - 5. Schedule sheets shall be printed in color on 11"x17" paper, unless a smaller size paper is allowed by the Engineer.
- D. Updating:
 - 1. Show all changes occurring since previous submission.
 - 2. Indicate progress of each activity, show completion dates.
 - 3. Include:
 - a. Major changes in scope.
 - b. Activities modified since previous updating.

- c. Revised projections due to changes.
- d. Other identifiable changes.
- 4. Provide narrative report, including:
 - a. Discussion of problem areas, including current and anticipated delay factors.
 - b. Corrective action taken or proposed.
 - c. Description of revisions that may affect schedules.
 - d. Description of activities to be performed in the next 6-week period.
 - e. Updated list of key shop drawings, project data and samples to be submitted in the next 6-week period.

1.2 SUBMITTALS

- A. Submit updated schedules with each progress payment request.
- B. Submit 4 copies of initial and updated schedules to the Engineer.

END OF SECTION

SECTION 01320SAFETY AND HEALTH PLANPART 1 - GENERAL1.1 DESCRIPTION

A. Work Included:

1. The Contractor shall be solely responsible for initiating, maintaining and supervising all safety precautions and programs in connection with the work, as outlined herein and in the General and Special Conditions of the Contract Documents. Within 10 days after the effective date of the Agreement between Owner and Contractor, submit to the Engineer a Safety and Health Plan as specified herein. Refer to submittals section below.
2. Contractor shall comply with all applicable Laws and Regulations related to the safety of persons or property, or for the protection of persons or property from damage, injury, illness, or loss; and shall erect and maintain all necessary safeguards for such safety and protection.
3. Contractor shall designate a qualified and experienced safety representative (OSHA defined "Competent Person") at the site whose duties and responsibilities shall be the prevention of accidents and maintaining and supervising of safety precautions and programs, including a "Job Hazards Analysis".
4. The Contractor shall be solely responsible to provide all labor, equipment, and utilities sufficient to ensure no construction noise, particulates, or odors, are allowed to accumulate to levels which adversely affect health or work in, or near the construction area.

B. Content of Safety and Health Plan:

1. Prepare complete safety and health plan in accordance with the requirements of CFR Title 29 Part 1926 - Safety and Health Regulations for Construction.
 - a. Provide documentation that Contractor's hazardous communication program is up to date.
 - b. Provide documentation that Contractor's safety training is up to date.
 - c. Prepare a project specific Safety and Health Plan addressing construction safety and protection, including but not limited to excavations, fall protection, egress, as well as provisions for construction in hazardous environmental conditions, confined space entry, electrically-classified spaces, chemical storage/handling, biological hazards, etc., at the project site.
2. Safety provisions for confined space entry shall follow the requirements of CFR Title 29 Part 1926, Subpart AA – Confined Spaces in Construction and will be incorporated into the Safety and Health Plan.
 - a. The Owner has provided Table 1 at the end of this section listing confined space locations which may be encountered during the execution of this Contract. The Contractor is required to perform a site evaluation to

- identify all hazards and potential hazards in work areas whether included in Table 1 or not, prior to control of site.
- b. The Contractor shall be responsible for all aspects of construction site safety including development of appropriate confined space entry procedures. The plan shall include, but not necessarily be limited to, the following:
 - i. Definitions
 - ii. Confined Space Evaluations
 - iii. Equipment Selection
 - iv. Confined Space Entry Training Documentation
 - v. Permit Required Confined Space Entry Requirements
 - vi. Testing (Monitoring) and Ventilation
 - vii. Confined Space Entry Permit Form
 - viii. Rescue and Emergency Procedures
 - ix. Emergency Contact Information
 - c. The Contractor shall inform the Owner and Engineer's representative whenever work will be performed in a confined space and the permit space program that the Contractor will follow.
 - d. The Contractor shall inform the Owner and Engineer's representative of any hazards confronted or created during entry operations, either through a briefing or during the entry operation.
 - e. The Contractor will coordinate entry operations with the Owner when both Owner personnel and Contractor personnel will be working in or near permit spaces.
 - f. The Owner, Engineer, their representatives, independent testing laboratories and government agencies, when inspecting the site, shall be supplied by the Contractor proper safety equipment when entry into a confined space is required.
3. The Owner has provided Table 2 at the end of this section listing the spaces that are considered "classified" per NFPA 820 (Standard for Fire Protection in Wastewater Treatment and Collection Facilities) where the Contractor may be required to carry out work tasks. The Contractor is required to perform a site evaluation to identify all hazards and potential hazards in work areas whether included in Table 2 or not, prior to control of site. Contractor shall implement appropriate safety precautions and/or construction practices to comply with classification requirements. Contractor shall ensure that all employees and subcontractors working in these areas have received appropriate training and are properly equipped in accordance with Contractor's Safety and Health Plan.
- C. Updating:
1. Contractor shall be responsible for updating the Safety and Health Plan as appropriate throughout the course of the construction period.

1.2 SUBMITTALS

- A. Submit the Contractor's site-specific Safety and Health Plan to the Engineer, in accordance with Section 01340. Submit hardcopy submittals, if required.
- B. Submit updated Safety and Health Plans as necessary during the course of the project.
- C. The Safety and Health Plan is provided "for information only" to inform the Owner,

Engineer and Resident Project Representative of the project specific safety program requirements; however, if the Safety and Health Plan incomplete (e.g., missing elements relevant to the project work), inadequate (e.g., outdated qualifications) or not project-specific, it will be returned “revise and resubmit”. Delays related to an incomplete Safety and Health Plan are the responsibility of the Contractor.

- D. The Contractor will overview the plan with the Owner (and staff), Engineer prior to work beginning at the project site, and subsequently when/if the safety plan is updated.
- E. Contractor's most current Safety and Health Plan shall be available at the construction site throughout the construction project.

1.3 ON-SITE COORDINATION MEETINGS

- A. Contractor shall review key aspects of Safety and Health Plan at the Pre-Construction Meeting, and subsequent on-site safety informational meeting.
- B. Contractor shall report to Engineer and Owner at each progress meeting concerning compliance with the Safety and Health Plan for the most recent construction period and new considerations and requirements for the upcoming period.
- C. Contractor shall hold weekly on-site coordination meetings with Resident Project Representative and Owner to ensure that Owner's staff is aware of key Safety and Health Plan requirements of the current phase of construction.

1.4 OWNER’S CONFINED SPACE ENTRY PROGRAM INFORMATION

- A. A copy of the Owner’s Confined Space Entry Program is available for viewing at the facility and is not included herein.

SITE-SPECIFIC INFORMATION

- A. Refer to Tables 1 and 2 below for site specific information, excluding items such as manholes, handholes, etc.

**TABLE 1
MATTABASSETT WPCF
CONFINED SPACES LISTING**

Confined Space Location	Hazard Description
Primary Sedimentation Basins	Possible lack of oxygen or presence of explosive or hazardous gases - Hydrogen Sulfide.
Primary Scum Well	Possible lack of oxygen or presence of explosive or hazardous gases - Hydrogen Sulfide.

Note: This list has been provided by the Owner based upon their knowledge of the site and may not include all site hazards. Its intent is to aid the Contractor in determining the magnitude of effort needed to fulfill the safety and health requirements of this Contract.

**TABLE 2
MATTABASSETT WPCF
CLASSIFIED SPACES LISTING (NFPA 820)**

Location	NFPA 820 Classification
Primary Sedimentation Basins	Class 1, Division 1

Note: This list has been provided by the Owner based upon their knowledge of the site and may not include all site hazards. Its intent is to aid the Contractor in determining the magnitude of effort needed to fulfill the safety and health requirements of this Contract.

END OF SECTION

SECTION 01340SUBMITTALSPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included:
 - 1. Submit all shop drawings, operations and maintenance manuals, Manufacturers' certificates, project data, and samples required by the Specifications.
- B. Related Work Specified Elsewhere:
 - 1. Construction Schedules: Section 01310
 - 2. Project Record Documents: Section 01720
 - 3. General Conditions: Section 00700.
- C. Submittals: This project shall utilize:
 - 1. Submittals – Electronic via Email/FTP with Hard Copy for Record
 - a. The Contractor shall submit to the Engineer an electronic submittal of shop drawings and O&M Manuals in portable document format (PDF) transmitted via email or file transfer protocol (FTP). The Engineer shall return an electronic PDF of the submittal review comments to the Contractor for distribution to subcontractors, suppliers and manufacturers. The electronic submittals shall serve as the electronic record of the project.
 - b. In addition, completed shop drawings and completed operations and maintenance (O&M) manuals shall be provided in hard copy (paper) format, for the record, in accordance with the following requirements.
 - i. Shop drawings and O&M manuals shall be considered “completed” once an action code of “0” or “1” has been attained, as specified below, unless otherwise directed by the Engineer.
 - ii. Once completed, the Contractor shall provide three hard copy sets (for Owner, Engineer and Resident Project Representative, respectively).
 - iii. Hard copy submittals shall be updated on a monthly basis, for those submittals completed during the preceding month.

1.2 SHOP DRAWINGS

- A. Shop Drawings are required for each and every element of the work.
- B. Shop Drawings are generally defined as all fabrication and erection drawings, diagrams, brochures, schedules, bills of material, manufacturers data, spare parts lists, and other data prepared by the Contractor, their subcontractors, suppliers, or manufacturers which illustrate the manufacturer, fabrication, construction, and installation of the work, or a portion thereof.
- C. The Contractor shall provide a completed Contractor Submittal Certification Form (copy provided for Contractor's use at the end of this Specification Section) which shall be attached to every copy of every shop drawing and signed by the Contractor and Manufacturer (where applicable). Shop Drawings shall show the principal dimensions, weight, structural and operating features, space required, clearances, type and/or brand of finish or shop coat, grease fittings, etc., depending on the subject of the drawing. When it is customary to do so, when the dimensions are of particular importance, or when so specified, the drawings shall be certified by the manufacturer or fabricator as correct for the work.

1. Each shop drawing submittal shall include a complete copy of the relevant specification section markup up to reflect “compliance” or “deviation” on an item-by-item basis.
- D. Shop Drawings shall be submitted as a complete package by specification section, unless otherwise reviewed and approved by the Engineer. It is the intent that all information, materials and samples associated with each specification section be included as a single submittal for the Engineer's review. Any deviation from this requirement, shall be requested in writing with an anticipated shop drawing breakdown/schedule prior to any associated submittal. An exception to this requirement are shop drawings for reinforcing steel, miscellaneous metals and structural steel, which shall be submitted separately for each structure unless otherwise permitted by the Engineer.
- E. The Contractor shall be responsible for the prompt and timely submittal of all shop and working drawings so that there shall be no delay to the work due to the absence of such drawings.
- F. No material or equipment shall be purchased or fabricated especially for the Contract until the required shop and working drawings have been submitted as hereinabove provided and reviewed for conformance to the Contract requirements. All such materials and equipment and the work involved in their installation or incorporation into the Work shall then be as shown in and represented by said drawings.
- G. Until the necessary review has been made, the Contractor shall not proceed with any portion of the work (such as the construction of foundations), the design or details of which are dependent upon the design or details of work, materials, equipment or other features for which review is required.
- H. All shop and working drawings shall be submitted to the Engineer by and/or through the Contractor, who shall be responsible for obtaining shop and working drawings from their subcontractors and returning reviewed drawings to them. Shop drawings shall be formatted to standard paper sizes to enable the Owner to maintain a permanent record of the submissions. Approved standard sizes shall be: (a) 24 inches by 36 inches; (b) 11 inches by 17 inches, and (c) 11 inches by 8-1/2 inches. Provision shall be made in preparing the shop drawings to provide a binding margin on the left hand side of the sheet. Shop drawings submitted other than as specified herein may be returned for resubmittal without being reviewed.
- I. Only drawings which have been checked and corrected by the fabricator should be submitted to the Contractor by their subcontractors and vendors. Prior to submitting drawings to the Engineer, the Contractor shall check thoroughly all such drawings to confirm that the subject matter thereof conforms to the Drawings and Specifications in all respects. All drawings which are correct shall be marked with the date, checker's name, and indication of the Contractor's approval, and then shall be submitted to the Engineer.
- J. If a shop drawing shows any deviation from the Contract requirements, the Contractor shall make specific mention of the deviations in the transmittal. Shop Drawings that contain significant deviations that are not brought to the attention of the Engineer may be subject to rejection.
- K. Should the Contractor submit equipment that requires modifications to the structures, piping, electrical conduit, wires and appurtenances, layout, etc., detailed on the Drawings, Contractor shall also submit details of the proposed modifications. If such

equipment and modifications are accepted, the Contractor, at no additional cost to the Owner, shall do all work necessary to make such modifications.

- L. A maximum of two submissions of each Shop Drawing will be reviewed, checked, and commented upon without charge to the Contractor. Any additional submissions which are ordered by the Engineer to fulfill the stipulations of the Drawings and Specifications, and which are required by virtue of the Contractor's neglect or failure to comply with the requirements of the Drawings and Specifications, or to make those modifications and/or corrections ordered by the Engineer in the review of the first two submissions of each Shop Drawing, will be reviewed and checked as deemed necessary by the Engineer, and the cost of such review and checking, as determined by the Owner, and based upon Engineer's documentation of time and rates established for additional services in the Owner-Engineer Agreement for this Project, may be deducted from the Contractor to make all modifications and/or corrections as may be required by the Engineer in an accurate, complete, and timely fashion. Resubmittals for the sole purpose of providing written responses to review comments will not be considered a resubmittal counting towards the two submission limit.
- M. Shop Drawings that include drawings or other material that is illegible or too small may be returned without review.

1.3 SAMPLES

- A. The Contractor shall submit samples when requested by the Engineer to establish conformance with the specifications, and as necessary to define color selections available. Submittals of "samples" shall be documented through the electronic submittal process by including a photograph of the item(s) and indicating the date the sample was mailed and/or delivered.

1.4 OPERATION AND MAINTENANCE MANUALS

- A. Operation and Maintenance (O&M) Manuals are required for certain elements of the project, as specified herein.
- B. The Contractor shall provide a completed Operation and Maintenance Manual Certification Form (copy provided for Contractor's use at the end of this Specification Section) which shall be attached to every copy of every Manual and signed by the Contractor and Manufacturer.
- C. Each hard copy of an O&M Manual shall be provided in a stand-alone binder or shall be suitable for insertion into a 3-ring binder. Include the General Contractor's and Manufacturer's representative's contact information on the front cover. O&M manuals must be appropriate for the project and customized for the project. If a Manufacturer's standard O&M manual is included in the submittal, all non-applicable content must be removed or crossed out.
- D. O&M Manuals shall contain the following operational information:
 - 1. Safety Precautions: List personnel hazards, equipment or product safety precautions for all operating conditions.
 - 2. Operator Prestart: Include all procedures required to set up and prepare each system, equipment or component for use.
 - 3. Startup Procedures: Provide a narrative description for all startup operating procedures, include all control sequences.
 - 4. Shutdown Procedures: Provide a narrative description for all shutdown operating procedures, include all control sequences.

5. Post-Shutdown Procedures: Provide a narrative description for all post-shutdown operating procedures, include all control sequences.
 6. Normal Operating Procedures: Provide a narrative description of normal operating procedures. Include control diagrams with data to explain operation and control of systems and specific equipment.
 7. Emergency Operations: Include emergency procedures for equipment malfunctions to permit a short period of continued operation or to shut down the equipment to prevent further damage to systems and equipment. Include emergency shutdown instructions for fire, explosion, spills, or other foreseeable contingencies. Provide guidance on emergency operations of all utility systems including valve locations and portions of systems controlled.
 8. Operator Service Requirements: Include instructions for services to be performed by the operator such as lubrication, adjustment, inspection, alignment, spare parts installation and gage reading or recording.
 9. Environmental Conditions: Include a list of environmental conditions (temperature, humidity, and other relevant data) which are best suited for each product or piece of equipment and describe conditions under which the equipment should not be allowed to run.
- E. O&M Manuals shall contain the following maintenance information:
1. Lubrication Data: Include a table showing recommended lubricants for specific temperature ranges and applications. Also, include charts with a schematic diagram of the equipment showing lubrication points, recommended types and grades of lubricants, capacities and a lubrication schedule showing service interval frequency
 2. Preventative Maintenance Plan: Include the manufacturer's schedule for routine preventive maintenance, inspections, tests and adjustments required to ensure proper and economical operation as well as to ensure minimization of corrective maintenance and repair. Provide the manufacturer's projection of preventive maintenance work-hours on a daily, weekly, monthly, and annual basis including craft requirements by type of craft. For periodic calibrations, provide the manufacturer's specified frequency and procedures for each separate operation.
 3. Troubleshooting Guides: Include recommendations on procedures and instructions for correcting problems and making repairs. Provide step-by-step procedures to promptly isolate the cause of typical malfunctions. Describe clearly why the checkout is performed and what conditions are to be sought. Identify tests or inspections and test equipment required to determine whether parts and equipment may be reused or require replacement.
 4. Wiring and Control Diagrams: Provide Wiring diagrams and control diagrams. All diagrams shall be point-to-point drawings of wiring and control circuits including factory-field interfaces. Provide a complete and accurate depiction of the actual job specific wiring and control work. On diagrams, number electrical and electronic wiring and pneumatic control tubing and the terminals for each type, identically to the actual installation numbering.
 5. Maintenance and Repair Procedures: Include instructions and list the tools required to restore products and/or equipment to proper conditions or operating standards.

6. Removal and Replacement Instructions: Include step-by-step procedures, list required tools/supplies for removal, replacement, disassembly, and assembly of components, assemblies, subassemblies, accessories, and attachments. Provide tolerances, dimensions, settings and adjustments required. Instructions shall include a combination of text and illustrations.
 7. Spare Parts and Supply Lists: Include lists of spare parts and supplies required for maintenance and repair to ensure continued service or operation without unreasonable delays. Special consideration shall be required for facilities at remote locations. List spare parts and supplies that have a long lead times to obtain.
 8. Corrective Maintenance Work Hours: Include the manufacturer's projection of corrective maintenance work-hours including craft requirements by type of craft. Corrective maintenance that requires participation of the equipment manufacturer shall be identified and tabulated separately.
- F. O&M Manuals shall contain the following additional information:
1. Parts Identification: Provide identification and coverage for all parts of each component, assembly, subassembly, and accessory of the end items subject to replacement. Include special hardware requirements, such as requirements to use high-strength bolts and nuts. Identify parts by make, model, serial number, and source of supply to allow reordering without further identification. Provide clear and legible illustrations, drawings, and exploded views to enable easy identification of the items.
 - a. When illustrations omit a part number and description, both the illustration and a separate listing shall show the index, reference, or key number which shall cross-reference the illustrated part to the listed part. Parts shown in the listings shall be grouped by components, assemblies, and subassemblies. Parts data may cover more than one model or series of equipment, components, assemblies, subassemblies, attachments, or accessories, such as a master parts catalog, in accordance with the manufacturer's standard commercial practice.
 2. Warranty Information: List and explain the various warranties and include the servicing and technical precautions prescribed by the manufacturers or contract documents to keep warranties in force. Include warranty information for all primary components included in product systems.
 3. Personnel Training Requirements: Provide information available from the manufacturers to use in training designated personnel to operate and maintain the equipment and systems properly.
 4. Testing and Special Tools: Include information on test equipment required to perform specified tests and on special tools needed for the operation, maintenance, and repair of components.
 5. Contractor Information: Provide a list that includes the name, address, and telephone number of the General Contractor and each subcontractor installing the respective product or equipment. Include local representatives and service organizations most convenient to the project site. Provide the name, address, and telephone number of the product or equipment manufacturers.

6. Written confirmation from the manufacturer that the Contractor has coordinated the equipment One Year Service Call in accordance with specification Section 01800, par. 1.1, A, 2.

1.5 MANUFACTURER'S CERTIFICATES

- A. Prior to accepting the installation, the Contractor shall submit manufacturer's certificates for each item specified.
- B. Such manufacturer's certificates shall state that the equipment has been installed under either the continuous or periodic supervision of the manufacturer's authorized representative, that it has been adjusted and initially operated in the presence of the manufacturer's authorized representative, and that it is operating in accordance with the specified requirements, to the manufacturer's satisfaction. All costs for meeting this requirement shall be included in the Contractor's bid price.

1.6 SUBMISSION REQUIREMENTS

- A. Accompany submittals with a transmittal cover sheet, containing:
 1. Date.
 2. Project title and number.
 3. Contractor's name and address.
 4. The sequential shop drawing number for each shop drawing, project data and sample submitted shall be:
 - a. Specification Section number followed by a dash and then a sequential number beginning with 01 (e.g., 16000-01).
 - b. Under limited situations when additional different pieces of equipment are submitted under the same specification section, those submittals shall be numbered sequentially (e.g. 05500-01, 05500-02, 05500-03, etc.).
 - c. Resubmittals shall include an alphabetic suffix after the corresponding sequential number (e.g., 16000-01A).
 - d. O&M submittals shall be numbered with the Specification Section number followed by a dash, the letters "OM", another dash, and then a sequential number beginning with 01 (e.g. 16000-OM-01). Resubmittals of O&Ms shall include an alphabetic suffix after the corresponding sequential number (e.g. 16000-OM-01A).
 5. Notification of deviations from Contract Documents.
 6. Other pertinent data.
- B. A completed Contractor Submittal Certification Form shall be attached to each hardcopy and electronic PDF of each shop drawing and must include:
 1. Project name
 2. Specification Section and sequential number with alphabet suffix for resubmittal
 3. Description
 4. Identification of deviations from Contract Documents.
 5. Contractor's stamp, initialed or signed, certifying review of the submittal, verification of field measurements and compliance with Contract Documents.
 6. Where specified or when requested by the Engineer, manufacturer's certification that equipment, accessories and shop painting meet or exceed the Specification requirements.
 7. Where specified, manufacturer's guarantee.

- C. Additional Requirements for Electronic Submittals:
1. Each individual shop drawing or O&M submittal shall be contained in one PDF.
 2. The first page of the PDF shall be the Contractor Submittal Certification Form as described above.
 3. The electronic PDF shall be **exactly** as submitted in the hardcopy.
 4. The electronic PDF shall include an electronic table of contents that is bookmarked for each section of the submittal.
 5. The electronic PDF shall be configured such that is fully searchable.
 6. PDF versions of 24x36 drawings shall be converted to 24 x 36 PDFs so as not to lose the clarity of the original drawing.
 7. Electronic PDF submittals that are not submitted in accordance with the requirements stated above will not be reviewed by the Engineer.
 8. Electronic submittals shall be transmitted via the protocol established in Part 1 above.

1.7 RESUBMISSION REQUIREMENTS

- A. Revise initial submittals as required and resubmit as specified for initial submittal.
- B. Indicate on submittals any changes which have been made other than those required by Engineer. All renumbering of shop drawings, relabeling of individual pieces or assemblies or relocating of pieces or assemblies to other Drawings within the submittal shall be clearly brought to the attention of the Engineer. If relabeling of individual pieces or assemblies has taken place, the labels from the previous submittal shall be indicated to assist in comparing the original and resubmitted shop drawing.
- C. All resubmittals shall include a summary of the previous submittal review comments with the vendors' written response as to how the previous comments were addressed.

1.8 ENGINEER'S REVIEW

- A. The review of shop and working drawings hereunder will be general only, and nothing contained in this specification shall relieve, diminish or alter in any respect the responsibilities of the Contractor under the Contract Documents and in particular, the specific responsibility of the Contractor for details of design and dimensions necessary for proper fitting and construction of the work as required by the Contract and for achieving the result and performance specified thereunder.
- B. The Engineer's review comments will be summarized on a Submittal Review Form, which includes an action code. A description of each action code is provided below.
 1. No Exceptions Taken (Status 0 on shop drawing log). The shop drawing complies with the Contract Document requirements. No changes or further information are required. Where appropriate, the submittal review form will be used to alert the Contractor, Owner and Field personnel of remaining items within that specification section that still needs to be submitted.
 2. Make Corrections Indicated (Status 1 on shop drawing log). The shop drawing complies with the Contract Document requirements except for minor changes, as indicated. Engineer requires that all comments will be addressed by the Contractor, unless otherwise notified in writing prior to execution of the relevant work.
 3. Conditional to Remarks (Status 2 on shop drawing log). The shop drawing potentially complies with the Contract Document requirements, contingent upon satisfactory resolution of review comments. Remarks will explicitly list

what information needs to be resubmitted. Resubmittal from the Contractor should include a cover letter or summary which indicates how each review comment has been addressed. **This action code will not be used, or will be sparingly used, for electronic submittals.**

4. Revise and Resubmit (Status 3 on shop drawing log). The shop drawing does not comply with the Contract Document requirement as submitted, but may with changes indicated and/or submission of additional information. The entire package must be resubmitted with the necessary information and a cover letter which indicates how each review comment has been addressed and where to find the information in the resubmittal.
5. Rejected (Status 4 on shop drawing log). The shop drawing does not comply with the Contract Document requirements, for the reasons indicated in the remarks, and is unacceptable.
6. For Information Only (Status 5 on shop drawing log). The shop drawing review was for information only.
7. In Review (Status 6 on shop drawing log). The shop drawing is currently under review.

CONTRACTOR SUBMITTAL CERTIFICATION FORM

PROJECT: _____ CONTRACTOR'S PROJ. NO: _____

CONTRACTOR: _____ ENGINEER'S PROJ. NO: _____

ENGINEER: _____

SHOP DRAWING NUMBER:	SPECIFICATION SECTION OR DRAWING NO:	SEQUENTIAL NUMBER (& ALPHA SUFFIX FOR RESUBMITTAL)
----------------------------	---	--

DESCRIPTION: _____

MANUFACTURER: _____

The above referenced submittal has been reviewed by the undersigned and I/we certify that the material and/or equipment meets or exceeds the project specification requirements with

- NO DEVIATIONS
or
- A COMPLETE LIST OF DEVIATIONS AS FOLLOWS^a:

By: _____ By: _____
Contractor^b

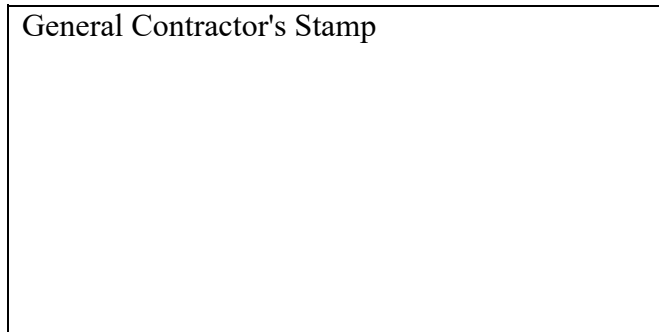
Manufacturer^c

Date: _____ Date: _____

a Any deviations not brought to the attention of the Engineer for review and concurrence shall be the responsibility of the Contractor to correct, if so directed.

b Required on all submittals

c When required by specifications Page ___ of ___



OPERATIONS AND MAINTENANCE MANUAL CERTIFICATION FORM

PROJECT: _____ CONTRACTOR'S PROJ. NO: _____

CONTRACTOR: _____ ENGINEER'S PROJ. NO: _____

ENGINEER: _____

	- OM -	
O&M NUMBER: _____	SPECIFICATION SECTION OR DRAWING NO: _____	SEQUENTIAL NUMBER (& ALPHA SUFFIX FOR RESUBMITTAL) _____

DESCRIPTION: _____

MANUFACTURER: _____

The above referenced operations and maintenance manual has been reviewed by the undersigned and I/we certify that the manual is customized as needed for this project, is suitable for mounting in a 3-ring binder, and contains the following items:

- | | |
|--|--|
| <input type="checkbox"/> Table of Contents | <input type="checkbox"/> Project-Related Design Data |
| <input type="checkbox"/> Contractor and Manufacturer Contact Information | <input type="checkbox"/> Serial Numbers |
| <input type="checkbox"/> Preventative Maintenance Schedule and Summary | <input type="checkbox"/> Maintenance and Repair Procedures |
| <input type="checkbox"/> Removal and Replacement Instructions | <input type="checkbox"/> Wiring and Control Diagrams |
| <input type="checkbox"/> Lubrication Schedule | <input type="checkbox"/> Equipment Drawings & Schematics |
| <input type="checkbox"/> Troubleshooting Information | <input type="checkbox"/> Equipment Performance Curves |
| <input type="checkbox"/> Warranty Information | <input type="checkbox"/> Parts and Service Contact Information |
| <input type="checkbox"/> Rebuild Information for All Components | <input type="checkbox"/> Manufacturer's Contact Information |
| <input type="checkbox"/> Startup, Operation and Shutdown Procedures | <input type="checkbox"/> Emergency Operations Plan |
| <input type="checkbox"/> Normal and Emergency Operations | <input type="checkbox"/> List of All Component Part Numbers |
| <input type="checkbox"/> Safety Procedures and Precautions | <input type="checkbox"/> List of Spare Parts Supplied |
| <input type="checkbox"/> Shop Drawings corrected to As-Built Conditions | <input type="checkbox"/> Testing Equipment & Special Tools |
| <input type="checkbox"/> Personnel Training Requirements | <input type="checkbox"/> Other System Specific Information |

By: _____ By: _____
Contractor^a Manufacturer^b

Date: _____ Date: _____

^a Contact information shall include name, address and telephone number.

^b Required on all Operation and Maintenance Manuals.

^c When required by Specifications. Page ___ of ___

General Contractor's Stamp

PROCESS EQUIPMENT MANUFACTURER SUBMITTAL CERTIFICATION
(Divisions 11 and 14)

Owner: _____ Date: _____

Project: _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

As an authorized representative of the equipment manufacturer, the undersigned certifies that the equipment listed above conforms to the requirements of Section 11000, Part 1.3.K. The undersigned authorized representative of the manufacturer further certifies that the equipment manufacturer or supplier has: reviewed the Construction Documents, the intended installation by the Contractor, and the intended functional and operational conditions; determined all conditions to be acceptable; and found no conditions which would cause the warranty to be void; or the equipment to function improperly, or not meet the performance requirements.

(Authorized Representative of the Manufacturer)

(Date)

END OF SECTION

SECTION 01370

SCHEDULE OF VALUESPART 1 - GENERAL1.1 DESCRIPTION

A. Work Included:

1. Provide a detailed breakdown of the Contract Sum showing values allocated to each of the various parts of the Work, as specified herein and in other provisions of the Contract Documents.

1.2 QUALITY ASSURANCE

A. Use required means to assure arithmetical accuracy of the sums described.

B. When so required by the Engineer, provide copies of the subcontracts or other data acceptable to the Engineer substantiating the sums described.

1.3 SUBMITTALS

A. The proposed schedule of values (hereinafter referred to as "SOV"), meeting the requirements outlined below, shall be submitted to the Engineer for review. The SOV shall be used as the basis for reviewing and approving payment requisitions along with determining percentages of work completed. No payment requisitions will be processed until the Engineer has taken no exceptions to the schedule of values.

B. The SOV shall consist of a detailed breakdown of all the work within the Contract Documents and shall include a sufficient number of work items to serve as an accurate basis the General Contractor's Application for Payment.

END OF SECTION

SECTION 01400
QUALITY CONTROL

PART 1 - GENERAL

1.1 REQUIREMENTS INCLUDED

- A. General Quality Control.
- B. Workmanship.
- C. Manufacturer's Instructions.
- D. Manufacturer's Certificates.
- E. Manufacturer's Field Services.
- F. Testing Laboratory Services.

1.2 RELATED REQUIREMENTS

- A. Section 01340 - Submittals: Submittal of Manufacturer's Instructions

1.3 QUALITY CONTROL

- A. Maintain quality control over suppliers, manufacturers, products, services, site conditions, and workmanship, to produce work of specified quality.

1.4 WORKMANSHIP

- A. Comply with industry standards except when more restrictive tolerances or specified requirements indicate more rigid standards or more precise workmanship.
- B. Perform work by persons qualified to produce workmanship of specified quality.
- C. Secure products in place with positive anchorage devices designed and sized to withstand stresses, vibration, and racking.

1.5 MANUFACTURERS' INSTRUCTIONS

- A. Comply with instructions in full detail, including each step in sequence. Should instructions conflict with Contract Documents, request clarification from Engineer before proceeding.

1.6 MANUFACTURERS' CERTIFICATES

- A. When required by individual Specifications Section, submit manufacturer's certificate that products meet or exceed specified requirements.

1.7 MANUFACTURERS' FIELD SERVICES

- A. When specified in respective Specification Sections, require supplier and/or manufacturer to provide qualified personnel to observe field conditions, conditions of surfaces and installation, quality of workmanship, start-up of equipment, test, adjust and balance of equipment as applicable, and to make appropriate recommendations.
- B. Representative shall submit written report to Engineer listing observations and recommendations.

1.8 TESTING LABORATORY SERVICES

- A. Owner will employ and pay for services of an Independent Testing Laboratory to

perform inspections, tests, and other services wherever an Independent Testing Laboratory is required by individual specification sections listed in paragraph 1.2 above, unless otherwise indicated.

- B. Services will be performed in accordance with requirements of governing authorities and with specified standards.
- C. Reports will present observations and test results and indicate compliance or non-compliance with specified standards and with Contract Documents. Independent Testing Laboratory will submit one copy of each report directly to each of the following: Engineer, Resident Project Representative, Contractor. Reports will be submitted within 5 days of obtaining test results. If test results indicate deficiencies, Independent Testing Laboratory shall telephone or email results to Engineer, Resident Project Representative and Contractor within 24 hours.
- D. Contractor shall cooperate with Independent Testing Laboratory personnel; furnish tools, samples of materials, design mix, equipment, storage and assistance as requested.
- E. Payment for Independent Testing Laboratory services shall be as follows:
 - 1. General: Where testing is the Owner's responsibility, payment will be made as stated below unless other requirements are given in Specification Sections. Testing which is the responsibility of the Contractor will be considered an incidental item unless otherwise indicated in Section 01150, Measurement and Payment.
 - 2. Initial Testing: Owner will pay for initial tests.
 - 3. Retesting: Costs of retesting due to non-compliance will be paid by Owner. The cost of retesting will be determined by Engineer and Owner will invoice Contractor for this cost. If unpaid after 60 days, the invoice amount will be deducted from the Contract Price.
 - 4. Contractor's Convenience Testing: Inspections and tests performed for Contractor's convenience will be paid for by Contractor.

PART 2 - PRODUCTS

Not Used

PART 3 - EXECUTION

Not Used

END OF SECTION

SECTION 01600DELIVERY, STORAGE AND HANDLINGPART 1 - GENERAL1.1 DESCRIPTION

- A. This Section specifies the general requirements for the delivery, handling, storage and protection for all items required in the construction of the work. An updated delivery and storage log is required with the monthly payment requisition prior to approval. An example log is included in this section.
- B. Related Items:
 - 1. Section 01800: Equipment Start-Up, Certification and Operator Training.
 - 2. Section 11000: Equipment - General.

1.2 TRANSPORTATION AND DELIVERY

- A. Transport and handle items in accordance with manufacturer's instructions.
- B. Schedule delivery to reduce long term on-site storage prior to installation and/or operation. Under no circumstances shall equipment be delivered to the site more than 120 days prior to installation without written authorization from the Engineer.
- C. Ship equipment, material and spare parts complete except where partial disassembly is required by transportation regulations or for the protection of components.
- D. Pack spare parts in containers bearing labels clearly designating contents and pieces of equipment for which intended, including cross reference of the applicable contract specification section.
- E. Deliver spare parts at the same time as pertaining equipment. Deliver spare parts to the Owner after completion of work.
- F. Deliver products to the site in manufacturer's original sealed containers or other packing system, complete with instructions for handling, storing, unpacking, protecting and installing.
- G. Instructions for handling, storing, unpacking, protecting and installing equipment shall be included in the Equipment O&M Manuals, which shall be submitted prior to the equipment being shipped to the site. This information shall be filed in a dedicated three ring binder(s) on-site, in the Contractor trailers, accessible to the Owner and Engineer. The binder(s) shall be clearly labeled, and include dividers for each specification section. The manufacturer-provided instructions for each equipment item shall be labeled with the specification number, equipment name, and equipment number. The instructions shall also be submitted to the Engineer.
- H. Assume responsibility for equipment material and spare parts just before unloading from carrier at site.
- I. All items delivered to site shall be unloaded and placed in a manner which will not hamper the Contractors normal construction operation or those of subcontractors and other contractors and will not interfere with the flow of necessary traffic.
- J. Provide equipment and personnel to unload all items delivered to the site.
- K. Promptly inspect shipment to assure that products comply with requirements, quantities are correct, and items are undamaged. For items furnished by others (i.e.

Owner, other Contractors), perform inspection in the presence of the Engineer.
Notify the Engineer in writing of any problems.

- L. Pay all demurrage charges if failed to promptly unload items.

1.3 STORAGE AND PROTECTION

- A. Store and protect products and equipment in accordance with the manufacturer's instructions, with seals and labels intact and legible. Storage instructions shall be studied by the Contractor and reviewed with the Engineer by them. Instructions shall be carefully followed and a written record of this kept by the Contractor for each product and pieces of equipment.
- B. Arrange storage of products and equipment to permit access for inspection. Periodically, inspect to make sure products and equipment are undamaged and are maintained under specified conditions.
- C. Provide protective maintenance during storage consisting of manually exercising equipment, inspecting mechanical surfaces for signs of corrosion or other damage, lubricating, applying any coatings as recommended by the equipment manufacturer necessary for its protection and all other precautions to assure proper protection of all equipment stored and for compliance with manufactures requirements related to warranties.
- D. All mechanical and electrical equipment and instruments shall be covered with canvas and stored in a weather tight building to prevent injury. The building may be a temporary structure on the site or elsewhere, but it shall be satisfactory to the Engineer.
 - 1. All equipment shall be stored fully lubricated with oil, grease and other lubricants unless otherwise instructed by manufacturer.
 - 2. Moving parts shall be rotated at a minimum of once weekly to ensure proper lubrication and to avoid metal-to-metal "welding". Log all rotation maintenance for each piece of equipment in the written record noted above.
 - 3. Upon installation of the equipment, the Contractor shall start the equipment, at least half load, once weekly for an adequate period of time to ensure that the equipment does not deteriorate from lack of use. Log all startup for each piece of equipment in the written record noted above.
 - 4. Lubricants shall be changed upon completion of installation and as frequently as required thereafter during the period between installation and acceptance. New lubricants shall be put into the equipment at the time of acceptance.
 - 5. Prior to acceptance of the equipment, the Contractor shall have the manufacturer inspect the equipment and certify that its condition has not been detrimentally affected by the storage period. Such certifications by the manufacturer shall be deemed to mean that the equipment is judged by the manufacturer to be in condition equal to that of equipment that has been shipped, installed, tested and accepted in a minimum time period. As such, the manufacturer will guarantee the equipment equally in both instances. If such a certification is not given, the equipment shall be judged to be defective. It shall be removed and replaced at the Contractor's expense.
- E. The weather tight building shall be provided with adequate heating/cooling and ventilation as required by the manufacturer to prevent condensation. Maintain temperature and humidity within range required by manufacturer and to prevent

- condensation on the equipment being stored.
- F. Temporary heating and cooling is acceptable. Equipment shall be protected from environmental effects as required by the manufacturer and dependent on the season. Equipment that arrives on site without coating shall be protected from environmental impacts through coating or protection at the Contractor's expense. Any equipment that displays defects or corrosion from environmental impacts will not be accepted for installation.
 - G. The location of all stored material and equipment shall be reviewed with the Owner and Engineer. The Owner and Engineer may request that equipment and material be moved to an alternate location to accommodate plant maintenance and operation, or if the location is deemed unacceptable or unsuitable.

PART 2 - PRODUCTS - NOT APPLICABLE

PART 3 - EXECUTION

3.1 DELIVERY, STORAGE, AND HANDLING MONTHLY LOG

- A. An updated storage and delivery log is required with the monthly payment requisition prior to approval.
- B. The monthly log shall include the specification section, equipment description, equipment tagging, submittal approval date, date of equipment delivery, date of O&M submittal, contractor start-up sign-off, certified equipment testing date, operator training date, spare parts turnover date, required maintenance (activity and date), and equipment turnover (Owner's witness and date).

3.2 STORAGE AND PROTECTION

- A. Equipment requires acceptance and verification of the storage from the Owner, Engineer, Manufacturer and Contractor at the Engineer's discretion.
- B. Following delivery, the equipment warranty from the Manufacturer is the responsibility of the Contractor.
- C. All storage and maintenance will be the responsibility of the Contractor, conducted at the Contractor's expenses and verified by the Engineer.
- D. It is the Contractor's responsibility to coordinate all storage requirements on site as required by the Manufacturer to achieve acceptance.

Section 01600 Delivery, Storage and Handling

Specification Section	Equipment Description	Equipment Tags	Submittal Approved	Date of Equipment Delivery ¹	Date of O&M Submittal	Equipment Start-Up ²		Certified Equipment Testing	Operator Training	Spare Parts Turnover	Required Maintenance by Contractor (activity & date)	Equipment Turnover	
						Date	Witness	Date	Date	Date		Owner's Witness	Date

1. If equipment is delivered and placed in storage, all steps for Stored Equipment shall be followed and tracked separately
2. Log weekly start-ups of installed equipment, performed by Contractor, until Equipment Turnover

END OF SECTION

SECTION 01710
PROJECT CLEANING

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Maintain premises and public properties free from accumulations of waste, debris, and rubbish, caused by operations.
2. At completion of work, remove waste materials, tools, equipment, machinery and surplus materials, and clean all sight-exposed surfaces. Leave project clean and ready for use.

1.2 QUALITY ASSURANCE

- A. Requirements of Regulatory Agencies: Conduct cleaning and disposal operations in accordance with all applicable local and state laws, ordinances, and code requirements.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Use only cleaning materials recommended by manufacturer of surfaces to be cleaned.
- B. Use cleaning materials only on surfaces recommended by cleaning material manufacturers.

PART 3 - EXECUTION

3.1 PERFORMANCE

A. Cleaning During Construction:

1. Execute cleaning operations to ensure that buildings, grounds, and public properties are maintained free from accumulations of waste materials and rubbish.
2. Entirely remove and dispose of material or debris during the progress of the work that has washed into or has been placed in watercourses, ditches, gutters, drains, catch basins, or elsewhere as a result of the Contractor's operations.
3. Wet down dry materials and rubbish to lay dust and prevent blowing dust.
4. At reasonable intervals during the progress of work, clean the site and dispose of waste materials, debris, and rubbish.
5. Clean interiors of buildings, when applicable, prior to finish painting, and continue to clean on an as-needed basis until buildings are ready for occupancy.
6. Handle materials in a controlled manner with as few handlings as possible. Do not drop or throw material from heights.
7. When applicable, schedule cleaning operations so that dust and other contaminants resulting from the cleaning process will not fall on wet, newly painted surfaces.

- B. Control of Hazards:
 - 1. Store volatile wastes in covered metal containers, and remove from premises daily.
 - 2. Prevent accumulation of wastes which may create hazardous conditions.
 - 3. Provide adequate ventilation during use of volatile or noxious substances.
- C. Disposal:
 - 1. Do not burn or bury rubbish and waste materials on project site.
 - 2. Do not dispose of volatile wastes, such as mineral spirits, oil, or paint thinner, in storm or sanitary drains.
 - 3. Do not dispose of wastes into streams or waterways.
- D. Final Cleaning:
 - 1. Employ experienced workers, or professional cleaners, for final cleaning.
 - 2. Remove grease, dust, dirt, stains, labels, fingerprints, and other foreign materials, from all sight-exposed interior and exterior finished surfaces.
 - 3. Repair, patch and touch up marred surfaces to specified finishes.
 - 4. Broom clean paved surfaces.
 - 5. Rake clean non-paved surfaces of the project site.
 - 6. Restore to their original condition those portions of the site not designated for alterations by the Contract Documents.

END OF SECTION

SECTION 01720PROJECT RECORD DOCUMENTSPART 1 - GENERAL1.1 DESCRIPTION

A. Work Included:

1. Keep accurate record documents for all additions, demolition, changes of material or equipment (from that shown on the Drawings), variations in work, and any other additions or revisions to the Contract (via Change Order, Work Change Directive, Field Order or Clarification).

B. Related Work Specified Elsewhere:

1. Shop Drawings, Project Data, and Samples are specified in "General Conditions" and Section 01340, Submittals.
2. Electrical System Record Drawing requirements are outlined in Section 16010.

1.2 MAINTENANCE OF DOCUMENTS

A. Maintain at job site, one copy of:

1. Contract Drawings
2. Specifications
3. Addenda
4. Reviewed Shop Drawings
5. Change Orders
6. Any other modifications to the Contract
7. Field Test Reports

B. Store documents in files and racks specifically identified for Record Drawing use, that are apart from documents used for construction.

C. File documents in a logical manner indexed for easy reference.

D. Maintain documents in clean, dry, legible condition.

E. Do not use record documents for construction purposes.

F. Make documents available at all times for inspection by the Engineer and Owner, and by the end of the project, transmit these documents to the Engineer.

G. Failure to maintain current records, as specified herein, shall be grounds for withholding additional retainage from monthly partial payment requests.1.3 RECORDING

A. Label each document "PROJECT RECORD" in large high printed letters.

B. Keep record documents current and do not permanently conceal any work until required information has been recorded.

C. General Field Recording Issues:

1. All swing ties shall be taken from existing, permanent features such as utility poles, corners of buildings and hydrants. Porches, sheds or other house additions shall be avoided as they could be torn down. A minimum of two swing ties shall be taken. Survey grade GPS coordinates are also acceptable.
2. Stations shall be recorded to the nearest foot.
3. Inverts shall be recorded to the nearest hundredth of a foot.

4. Elevations shall be recorded to the nearest hundredth of a foot.
 5. Building dimensions shall be recorded to the nearest 1/4".
 6. Equipment and Piping shall be recorded to the nearest tenth of a foot, and the overall dimensions and layout of the equipment shall be adjusted to reflect the equipment provided.
- D. Project Record Drawings - Legibly mark Contract Drawings to record existing utilities and actual construction of all work, including but not limited to the following (where applicable):
1. Existing Utilities
 - a. Water mains and services, water main gate valves, sewer mains and services, storm drains, culverts, steam lines, gas lines, tanks and other existing utilities encountered during construction must be accurately located and shown on the Drawings. In congested areas supplemental drawings or enlargements may be required.
 - b. Show any existing utilities encountered in plan and profile and properly labeled showing size, material and type of utility. Ties shall be shown on plan. Utility shall be drawn to scale in section (horizontally and vertically) and an elevation shall be called out to the nearest hundredth of a foot.
 - c. When existing utility lines are broken and repaired, ties shall be taken to these locations.
 - d. If existing water lines are replaced or relocated, document the area involved and pipe materials, size, etc. in a note, and with ties.
 2. Gravity Sewer Line
 - a. Change sewer line slopes indicated on Drawings if inverts are changed.
 - b. Draw any new gravity lines that are added on plan and profile.
 - c. Show any field or office redesigns.
 - d. Redraw the sewer line profile if manhole inverts are redrawn.
 - e. Redraw the sewer line on plan corresponding to relocated manholes.
 3. Water Mains and Force Mains
 - a. Show ties to the location of all valves, bends (horizontal and vertical), tees and other fittings. The use of thrust blocks shall be recorded.
 - b. Revise elevations indicated on the Drawings to reflect actual construction.
 4. Yard Piping and Buried Electrical Conduit
 - a. Site piping and utilities shall be drawn to reflect the installed locations, with ties and elevation of all bends (horizontal and vertical).
 - b. Show routing for electrical conduits and pull boxes, especially in close proximity to buildings and when the conduits change direction or cross process piping.
 5. Roads
 - a. Show centerline road profile and level spot elevations.
 - b. Show pavement widths.
 - c. On road cross sections, show the pavement cross slope.
 - d. Show any deviations from the design plans.
 6. Buildings
 - a. In general, small changes to structures shall not be redrawn. If any dimensional changes were made in the field, the numerical change shall

- be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings.
- b. Show finished concrete elevations (top of slab, top of wall, top of footing, etc.). Redraw any foundation, frost wall, etc. that was modified, deepened, or altered during construction.
 - c. Adjust finished concrete horizontal dimensions that are shown on the Drawings.
 - d. Adjust structural steel elevations and horizontal dimensions that are shown on the Drawings.
 - e. Show location of anchors, construction and control joints, and waterstops, when they are different from those shown on Drawings.
 - f. Any additions or major changes shall be shown in both plan and elevation (i.e. relocated doors, opposite door swings, change in wall location, relocation of floor drains).
 - g. Show approximate location and routing of electrical conduits in walls, slabs and ceilings. Most conduits are run in groups, therefore, use range of measurements to define location for entire section of conduits.
 - h. Special circuits for computers, alarms and instrumentation shall be shown.
 - i. Show any changes in location and elevation of ductwork and devices, fuel piping and equipment, and heat piping and equipment.
 - j. Location of gravity sewer system below slabs in buildings shall be shown, if changes are made in the configuration.
 - k. If wall mounted electrical switches, control boxes, thermostats, etc. have been relocated significantly, (other side of door, or to a wall other than indicated diagrammatically on electrical plans) make the revision accordingly.
7. Utilities
- a. When encountered, additional utilities (e.g., gas, cable, telephone, fiber optic, etc.) shall be indicated on the Record Drawings.
8. Equipment Systems and Piping
- a. Show any changes to equipment systems, whether interior or exterior, for process, HVAC, plumbing, instrumentation or electrical. If any dimensional changes were made in the field, the numerical change shall be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings. Record Drawings must reflect any equipment configuration and layout changes differing from that shown on the Drawings.
 - b. Show any changes to piping systems, whether interior or exterior, for process, HVAC, plumbing and instrumentation. If any dimensional changes were made in the field, the numerical change shall be made on the Drawing and be properly labeled. Update dimensions and elevations on Drawings.
- E. Specifications and Addenda - Legibly mark up each section to record:
1. Manufacturer, trade name, catalog number, and supplier of each product and item of equipment actually installed.
 2. Changes made by Change Order, Field Order, or other method.

1.4 SUBMITTALS

- A. At the completion of the project, and prior to the release of retainage, deliver record documents to the Engineer.
 - 1. Record drawings shall be provided as a bound, red-line paper set.
 - 2. Record drawings shall be provided as a bound, red-line paper set and an electronic file (pdf format) consisting of a full scan of the bound paper set.
 - 3. Record drawings shall be provided as a bound paper set of computer generated drawings, an electronic file (pdf format) of the bound paper set, and electronic files in AutoCAD format. Ownership of the drawings and files shall pass to the Owner at the time of submittal.
 - 4. If the Contractor provides alternate or substitute equipment that requires revised arrangements from the Bidding Documents, the Contractor shall provide supplemental record drawings of these items in AutoCAD format.
- B. Accompany submittal with transmittal letter, in duplicate, containing:
 - 1. Date, project title and number.
 - 2. Contractor's name and address.
 - 3. Title and number of each record document with certification that each document is completed and accurate.
 - 4. Signature of Contractor, or their authorized representative.
- C. Failure to supply all information on the Project Record Drawings as specified in Part 1.3 may result in withholding final completion and in non-approval of final payments of the Contract. If Contract Time has elapsed, this shall be grounds for imposing liquidated damages.

1.5 QUALITY ASSURANCE

- A. All horizontal and vertical dimensions, swing-ties, and elevations shall be accurate to within one-tenth of a foot, unless greater accuracy is specified elsewhere in the Specifications (e.g., concrete elevations, weir elevations, etc.).

PART 2 - PRODUCTS – NOT APPLICABLE

PART 3 - EXECUTION

3.1 MAINTAINING AND PROVIDING RECORDS

- A. Records shall be kept current as the work progresses.
- B. Records shall be made available for review by the Owner, Engineer, Resident Project Representative and/or Funding Agency(s) upon request.
- C. Records shall be kept current as the work progresses. Failure to maintain current records, as specified herein, shall be grounds for withholding additional retainage from monthly partial payment requests. Failure to provide records shall also be grounds for withholding of final payment and, if beyond contract time, shall be grounds for imposing liquidated damages.

END OF SECTION

SECTION 01800EQUIPMENT STARTUP, TESTING AND OPERATOR TRAININGPART 1 - GENERAL1.1 DESCRIPTION

A. Work Included:

1. General: The work of this Section includes the startup, certification and operator training of equipment and control systems sufficient for a fully functional project as determined by the Engineer. The following steps are integral to this process:
 - a. Submittals, as specified in Section 01340.
 - b. Operations and Maintenance Manuals, as specified in Section 01340.
 - c. Summary of Work/ Construction Sequencing as specified in Section 01010.
 - d. Pre-Startup Meeting, as specified herein.
 - e. Factory Acceptance Testing, as specified in Division 13.
 - f. Equipment Startup, as specified herein.
 - g. Operator Training, as specified herein.
 - h. Equipment Demonstration Testing, as specified herein.
 - i. Site Acceptance Testing, as specified in Division 13.

B. General Definitions:

1. Equipment Startup shall be generally defined as the initial placing into service of the equipment by representatives of the Contractor, any subcontractors directly responsible for the equipment provided, and the equipment Manufacturer. This shall include verification of all equipment protection and safety control features (e.g., motor high temperature, seal fail, hardware interlocks, estops, etc.) and include configuration of the VFD (if applicable) prior to equipment startup.
2. Equipment Demonstration Testing shall generally be defined as the formal and scheduled demonstration of equipment/system operations in accordance with the requirements of the Contract Documents, including all required performance or acceptance testing. This formal demonstration shall be performed in the presence of the Engineer by representatives of the General Contractor, any Subcontractors directly responsible for the equipment provided, and the equipment Manufacturer.
3. Operator Training shall generally be defined as the formal and scheduled instruction of plant personnel and other Owner designated representatives in the proper operations of provided equipment, and in the techniques, methods, schedules, etc. associated with maintenance. This formal training shall be performed in the presence of the Engineer, by representatives of the Contractor, any subcontractors directly responsible for the equipment provided, and the equipment Manufacturer. Operator Training shall also include remote

assistance to plant personnel by Manufacturer representatives during the initial operations of the equipment.

- C. Related Work Specified Elsewhere:
 - 1. Process equipment/systems are specified in Division 11.
 - 2. Instrumentation and control systems are specified in Division 13.
 - 3. Electrical systems are specified in Division 16.
- D. Submittals:
 - 1. In accordance with the requirements of Section 01340.
 - 2. Contractor shall coordinate with subcontractors and Manufacturers and provide a proposed start-up, testing and training plan for each piece of equipment including detailed plans for temporary bypass pumping or temporary facilities, when required. The Manufacturer(s) shall provide the Contractor with a start-up, testing and training schedule and plan.
 - a. The startup, testing and training plan shall include a written outline description of the means and methods to be employed during the certified equipment test of each piece of equipment as well as the anticipated sequence and duration of activities.
 - b. The startup, testing and training plan shall include the name(s) and resume(s) of the duly authorized Manufacturer's Representatives proposed for the project. The qualifications of duly authorized representatives of the Manufacturer are identified in Paragraph 1.2 below.
 - c. The startup, testing and training plan shall include proof of calibration of decibel meter(s) and flow meter(s) to be used in Equipment Startup(s).
 - d. The startup, testing and training plan shall comply with the sequencing and scheduling requirements outlined in Section 01010.
 - e. The startup, testing and training plan shall identify the location and type of temporary flow meters to be utilized, where required herein.
 - f. Equipment startup and testing shall not be scheduled for Fridays without prior agreement by the Owner and Engineer.
 - g. Contractor shall assume a maximum of 2 days per week of availability by the Engineer for equipment startup, training and demonstration testing. Availability beyond this will be considered on a case-by-case basis with prior agreement by the Owner and Engineer.
 - h. Contractor shall revise and resubmit the startup, testing and training plan to reflect the discussions and requirements from the Pre-Startup Meeting.
 - i. Contractor shall submit manufacturer Operations and Maintenance Manuals, along with updated control system drawings, at least 2 months prior to Equipment Startup.
 - 3. Contractor shall submit updated system-specific startup, testing and training plans a minimum of 14 days prior to individual system starts, based on discussions at the Pre-Startup Meeting and subsequent coordination with Manufacturers, RPR and Owner (e.g., process availability, equipment status, valving, lockout/tagout, etc.). Refer to schedule and notification requirements below.
 - 4. Following successful Equipment Startup, Operator Training and Equipment Demonstration Testing, submit:

- a. Completed Equipment Startup Certification forms
 - b. Completed Operator Training forms
 - c. Completed Equipment Demonstration Testing Certification forms
- E. Pre-Startup Meeting
1. Contractor shall request a Pre-Startup Meeting a minimum of 10 days prior to any startup activities. Engineer will set the meeting date and establish the agenda for the meeting. Contractor shall submit a proposed startup, testing and training plan a minimum of 10 days prior to the Pre-Startup Meeting. If the proposed startup, testing and training plan is insufficient, the Engineer may postpone the Pre-Startup Meeting until the submitted plan is sufficient. The purpose of the Pre-Startup Meeting is to discuss the details of the Contractor's submitted startup, testing and training plan and to discuss overall startup coordination and requirements.
 2. The Pre-Startup Meeting will be held at the Project Site.
 3. Contractor shall make arrangements for appropriate individuals from the electrical subcontractor, systems integrator, and relevant Manufacturer(s) to attend. Manufacturer(s) may attend in person or via telephone/video conference.
 4. Engineer will distribute a meeting summary to all attendees.
- F. Schedules and Notifications:
1. Contractor shall provide Engineer with at least a 14 calendar day notice prior to initiating startup activities to allow necessary coordination with Engineer and Owner representatives. If startups are conducted in groups of activities, the notification shall be provided for each grouping. The actual date and time for testing and/or training will be the first mutually acceptable date and time available to all parties subsequent to receipt of the request.
 2. Contractor shall be responsible for any and all coordination necessary with the daily operations of the facility to accommodate the testing schedule.
 3. Operator Training shall follow successful Equipment Startup and must be completed prior to the equipment being put on-line for uninterrupted service. Contractor may formally request that Operator Training be conducted concurrently with the Equipment Demonstration Testing; however, this determination will be made on a case-by-case basis by the Engineer and Owner. Under no circumstances will conditions of the testing interfere with the ability of Owner's representatives to observe necessary features, to hear and understand instructions, or to ask questions. If such conditions occur, then Operator Training will not be allowed to run concurrently with Equipment Demonstration Testing.
 4. Contractor shall maintain a shared calendar for the Owner, Engineer and Contractor to document the agreed upon dates for individual Equipment Startup, Operator Training, and Equipment Demonstration Testing.

1.2 QUALITY ASSURANCE

- A. Duly authorized Manufacturer's Representatives shall meet the following criteria:
1. A direct employee of the Manufacturer;
 2. Fluent in the English language;

3. Has a minimum of 5 years of experience in the proper installation, adjustment, operation, testing, and startup of the specified model, including, but not limited to, equipment calibration, and other mechanical or electrical components of the equipment.
4. Sales personnel, marketing personnel or local representatives will not be accepted as a duly authorized representative of the Manufacturer unless the Manufacturer has certified them accordingly.

PART 2 - PRODUCTS

(NOT USED)

PART 3 - EXECUTION

3.1 EQUIPMENT STARTUP

- A. Equipment startup shall be performed by the authorized representative(s) of the Manufacturer as identified in the Submittals.
- B. The Equipment Startup shall be performed prior to Operator Training and prior to Equipment Demonstration Testing.
- C. No form of energy shall be applied to any part of the system prior to receipt by the Engineer of a certified statement of approval of the installation from the Contractor. This certification shall contain a statement by an authorized representative of the equipment Manufacturer that the equipment is ready for testing, as outlined below.
- D. As part of the Equipment Startup, the Contractor and Manufacturer shall:
 1. Verify that the equipment is installed properly and in accordance with Manufacturer's requirements and instructions, and as such, it is appropriate to apply power to the units in question.
 2. Verify that all manual and all automatic equipment protection and safety control features of the equipment function properly, including all alarms, and all activation and deactivation sequences.
 3. Verify that equipment can receive remote control signals and send remote feedback signals.
 4. Verify that the equipment can operate without excessive noise, vibration, overheating, overloading, jamming, etc. during specified conditions.
 5. Verify and document equipment capacity and amperage draws (on all power feeds) with equipment running under specified conditions.
 6. Verify and document the noise level of equipment, drives and motors, unless otherwise noted, shall not exceed 90 dBA, as measured 3 feet from the unit under free field conditions.
 - a. Each unit shall be monitored for compliance running under specified conditions with other area equipment deactivated.
 - b. Contractor shall provide certified proof of calibration for instrument utilized to measure noise level.
- E. Each piece of equipment shall be tested sufficiently to ensure that all features required to be demonstrated and/or verified during the equipment certification testing are within acceptable limits. The startup shall not be considered complete until the unit is fully capable of passing the equipment certification testing.

- F. Where multiple units are provided, each unit shall undergo startup procedures.
- G. The duly authorized representative of the Manufacturer shall provide all specialty tools, specialty testing equipment and labor necessary for the start-up of the equipment.
- H. The Contractor shall provide all power, chemical, tools, equipment, labor, water and fuel as required for Equipment Startup.
 - 1. The Contractor shall be responsible for all contacts and arrangements as necessary with the proper municipal departments and/or public utility companies to arrange for temporary and/or separate billing so that bills associated with testing and startup procedures can be easily identified.
 - 2. Contacts and arrangements with the local power company shall include, but not be limited to, all arrangements as necessary so that peak power demands incurred during testing and startup procedures will not become a part of the permanent record for determining future power demand charges for the Owner.
 - 3. All waste materials shall be disposed of by the Contractor in an environmentally acceptable manner at no additional cost to the Owner.
- I. In the event of an unsuccessful equipment start-up, Manufacturer and Contractor shall make necessary alternations, adjustments, repairs and replacements and the equipment start-up shall be repeated.
- J. The Manufacturer Representative's shall fill out the Equipment Start-Up Certification form included at the end of this Section. Startup will not be considered complete until this form has been provided to the Engineer along with the Manufacturer Representative's field report.

3.2 EQUIPMENT DEMONSTRATION TESTING

- A. Equipment Demonstration Testing shall be performed after the Equipment Startup is completed and it has been verified that equipment functions in accordance with the requirements of the Contract Documents in all aspects. Equipment Demonstration Testing shall be performed by the authorized representative(s) of the Manufacturer.
- B. Equipment Demonstration Testing shall not be scheduled concurrently with Equipment Startup without the prior approval of the Engineer.
- C. If the Engineer has arrived on-site for the scheduled Equipment Demonstration Testing and the equipment is not capable of demonstrating complete compliance with the Contract Documents, or if the Manufacturer's representative is not present, the Contractor shall be responsible for all costs to the Engineer associated with failed testing, including travel expenses. The importance of prior and proper equipment demonstrations to verify that the requirements of the Equipment Demonstration Testing will be met is stressed.
- D. At a minimum during the Equipment Demonstration Testing, the Contractor shall complete the following to the satisfaction of the Engineer:
 - 1. Demonstrate that the equipment is installed properly and in accordance with Manufacturer's requirements and instructions, and as such, it is appropriate to apply power to the units in question.
 - 2. Demonstrate all manual and all automatic equipment protection and safety control features of the equipment functions properly, including all alarm, activation and deactivation sequences.

3. Demonstrate that the equipment can operate without excessive noise, vibration, overheating, overloading, jamming, etc. during normal operating conditions.
 4. Demonstrate the full specified range of equipment operation when controlled remotely by the controls system.
 5. Other specific requirements as outlined within the individual specifications sections.
- E. Each piece of equipment shall be tested sufficiently to ensure that all features required to be demonstrated and/or verified are within acceptable limits.
- F. Where multiple units are provided, each unit shall undergo equipment certification testing procedures individually and then with multiple units on-line to verify the total systems output capacity and performance.
- G. The duly authorized representative of the Manufacturer shall provide all specialty tools, specialty testing equipment and labor necessary for the start-up and testing of the equipment.
- H. The Contractor shall provide all power, chemical, equipment, labor, water and fuel as required for startup and testing.
- I. All equipment provided on the project shall be demonstrated to function properly. Demonstration as a component of an overall system shall not relieve the Contractor of their responsibilities to demonstrate proper operation or verify specific requirements for each individual component.
- J. Minimum Testing Requirements for Instrumentation/Control Systems:
1. All instruments shall be calibrated in the presence of the Engineer.
 2. All transmitters or direct-operated receivers shall be calibrated to impose input values representing zero percent, ten percent, and eighty percent of full scale.
 3. The inputs and outputs of devices, as appropriate, shall be connected to manometers for differential pressure devices, or compared to measured levels, rates or quantities, during calibration. The receiving devices shall be adjusted to read the calibrated output of the initial calibration.
 4. After placing each measuring system in service, an actual comparison of the measured variable versus readout shall be made. For each differential pressure based measuring system, a manometer shall be connected to the connections provided in the piping, tank, or other appropriate device. Each system shall meet the manufacturer's standard accuracy.
 5. Secondary functions, such as sequencing, timing features, alarm actuation and pacing shall be adjusted during initial calibration, demonstrated after the system is placed in service and adjusted during equipment demonstration testing, as necessary.
 6. Linkage or range adjustments shall be sealed by colored lacquer in the presence of the Engineer immediately following calibration.
 7. Process calibration, such as volumetric drawdown tests on flows and level measurements, shall be conducted on all measuring systems as requested by the Engineer. Once established as being within acceptable accuracy limits, future tests which require use of the measuring device to demonstrate system operations can utilize generation of mA signals to simulate level, flow or similar variable variations.
 8. Refer to Division 13 and Section 15604 for additional details.

- K. Minimum Testing Requirements for Electrical Systems.
 - 1. Refer to Section 16000 and 16950.
- L. In the event of unsuccessful Equipment Demonstration Testing, Manufacturer and Contractor shall make necessary alternations, adjustments, repairs and replacements and the equipment testing shall be repeated.
- M. The Manufacturer Representative's shall fill out the Equipment Demonstration Testing Certification form included at the end of this Section. Equipment Demonstration Testing will not be considered complete until this form has been provided to the Engineer along with the Manufacturer representative field report.

3.3 OPERATOR TRAINING

- A. Operator Training shall be performed by the authorized representative(s) of the Manufacturer as identified in the Submittals.
- B. Unless otherwise noted within the specific specification sections, provide minimum of one day (8-hour days, not including travel time) of combined training and operational assistance for plant operators for each piece of equipment in the proper operations of provided equipment, and in the techniques, methods, schedules, etc. associated with maintenance.
- C. The level of the training and operational assistance provided shall be as required to ensure proper understanding of the equipment's operations, maintenance and warranty conditions. Should manufacturer require time in addition to the minimums indicated herein, or within the individual specification sections, to sufficiently detail the proper operations and maintenance of the equipment, it will be provided at no additional cost to Owner. Under absolutely no circumstances shall warranties become void due to Owner's failure to follow operational and maintenance procedures which were not fully detailed and described to Owner's representatives during these sessions.
- D. The manufacturer representative shall fill out the Operator Training Certification form included within this Section. Training will not be considered complete until this form has been provided to the Engineer.

EQUIPMENT START-UP CERTIFICATION

Owner: _____ Date: _____

Project _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

Specification Number: _____

As an authorized representative of the equipment manufacturer, the undersigned certifies that the equipment listed above conforms to the requirements of the Contract Documents. The undersigned authorized representative of the manufacturer further certifies that the equipment has been installed in accordance with the manufacturer's written instructions, that it is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void.

(Manufacturer's Authorized Representative/ Signature & Printed Name) (Date)

(Contractor/ Signature & Printed Name) (Date)

(Witnessed by Engineer/ Signature & Printed Name) (Date)

** Manufacturer's Representative to provide a copy of Field Report via separate transmittal **

OPERATOR TRAINING CERTIFICATION

Owner: _____ Date: _____

Project _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

Specification Number: _____

I, the undersigned Manufacturer's Authorized Representative, have trained the Owner's personnel listed below in the proper operation and maintenance of the above listed equipment.

(Manufacturer's Authorized Representative/ Signature & Printed Name)	(Date)
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(Owner's Representative/ Signature & Printed Name)	(Date)
--	--------

(Witnessed by Engineer/ Signature & Printed Name)	(Date)
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EQUIPMENT DEMONSTRATION TESTING CERTIFICATION

Owner: _____ Date: _____

Project _____

Contractor: _____

Equipment Manufacturer: _____

Equipment: _____

Specification Number: _____

This certifies that the entire equipment/system has met the requirements of Section 01800, 16950 and all other applicable requirements of the contract documents.

(Manufacturer's Authorized Representative/ Signature & Printed Name) (Date)

(Contractor/ Signature & Printed Name) (Date)

(Witnessed by Engineer/ Signature & Printed Name) (Date)

** Manufacturer's Representative to provide a copy of Field Report via separate transmittal **

END OF SECTION

SECTION 02050ADEMOLITIONPART 1 - GENERAL1.1 DESCRIPTION

A. Work Included:

1. The Contractor shall furnish all labor, materials, tools, equipment and apparatus necessary and shall do all work required to complete the demolition, removal, and alterations of existing facilities as indicated on the Drawings, as herein specified, and/or as directed by the Engineer.
2. Demolition and alteration work within occupied areas shall be accomplished with minimum interference to the occupants and to the plant which shall be in continuous operation during construction.
3. All equipment, piping, and other materials that are not to be relocated or to be returned to the Owner shall become the property of the Contractor and shall be disposed of by him, away from the site of the work and at his own expense.
4. All demolition or removal of existing structures, utilities, equipment, and appurtenances shall be accomplished without damaging the integrity of existing structures, equipment, and appurtenances to remain, to be salvaged for relocation or stored for future use.
5. Such items that are damaged shall be either repaired or replaced at the Contractor's expense to a condition at least equal to that which existed prior to the start of his work.
6. Unless otherwise indicated, all items labeled to be "removed", "demolished" or "remove/demolish" shall be removed and disposed of off site in accordance with all Local, State and Federal Regulations.
7. The Contractor shall not collect any samples of either Building Materials, Wastes, Soils, or any other site/project related materials, nor have the samples analyzed for any reason without prior written approval from the Owner or Engineer. Furthermore, the Contractor shall not hire or contract with another party or Consultant to conduct sampling of either Building Materials, Wastes, Soils, or any other site/project related materials or to conduct analytical analysis.
 - a. All sampling requests are to be directed in written format to the Owner and Engineer.
 - b. By collecting unauthorized samples, the Contractor shall assume any and all financial burden of the required corrective action.
 - c. If a sample is collected and analyzed without prior written approval from the Owner or Engineer, the Contractor shall be responsible for any and all remediation required by any applicable regulatory authority arising from or related to the samples collected and analyzed, as the validity of the materials sampled, sample locations and sampling protocols utilized cannot be confirmed by the Owner's or Engineer's independent Consultant.

- B. Related Work Specified Elsewhere: (When Applicable)
 - 1. See Summary of Work, Section 01010.

1.2 JOB CONDITIONS

- A. Condition of Structures:
 - 1. The Owner assumes no responsibility for the actual condition of structures to be demolished.
 - 2. Conditions existing at the time of inspection for bidding purposes will be maintained by the Owner as far as practicable. However, variations within the structures may occur due to Owner's removal and salvage operations prior to the start of demolition work (where applicable).

1.3 UTILITIES

- A. Utility Locations:
 - 1. Utility locations shown on the plans are approximate only, based on information supplied by the utility companies.
- B. Coordination with Utilities:
 - 1. The Contractor shall make all necessary arrangements and perform any necessary work to the satisfaction of affected utility companies and governmental divisions involved with the discontinuance or interruption of affected public utilities and services.

1.4 SUBMITTALS

- A. Schedule - Demolition:
 - 1. Submit two (2) copies of proposed methods and operations of demolition to the Engineer for review prior to the start of work. Include in the schedule the coordination for shut-off, capping and continuation of utility services as required.
 - 2. Provide a detailed sequence of demolition and removal work to ensure the uninterrupted progress of the Owner's operations.

1.5 PROTECTIONS

- A. Ensure the safe passage of persons around the area of demolition. Conduct operations to prevent injury to adjacent buildings, structures, other facilities and persons. Erect temporary, covered passageways as required by authorities having jurisdiction.
- B. Provide interior and exterior shoring, bracing, or support to prevent movement, settlement or collapse of structures to be demolished and adjacent facilities to remain.

1.6 DAMAGES

- A. The Contractor shall promptly repair damages caused by demolition operations to adjacent facilities at no cost to the Owner.

PART 2 - PRODUCTS – Not Applicable

PART 3 - PERFORMANCE

- A. Remove and dispose of non-salvageable material in accordance with all applicable local and state laws, ordinances and code requirements.

- B. Dispose of material daily as it accumulates.
- C. Carefully remove, store and protect from damage all materials to be salvaged.
- D. Buildings and Adjacent Property:
 - 1. Protect all buildings and property adjacent to equipment to be removed from damage by erecting suitable barriers or by other suitable means.
 - 2. Leave such buildings in a permanently safe and satisfactory condition.
- E. Maintaining Traffic:
 - 1. Ensure minimum interference with roads, streets, driveways, sidewalks and adjacent facilities.
 - 2. Do not close or obstruct streets, sidewalks, alleys or passageways without permission from authorities having jurisdiction.
- F. Process and electrical demolition, removal and alteration are indicated in the corresponding sections.
- G. Mechanical/Process Demolition:
 - 1. Mechanical/Process demolition in general shall consist of the dismantling and removal of existing piping, tanks, pumps, motors, equipment and other appurtenances as specified, and indicated on the Drawings.
 - 2. It shall also include, where necessary, the cutting of existing piping for the purpose of making connections thereto.
 - 3. Piping not indicated to be removed but which may interfere with construction shall be removed to the nearest solid support, capped and left in place. Where piping that is to be removed passes through the wall of existing structures, it shall be cut off and properly capped on each side of the wall.
 - 4. When piping is to be altered or removed underground, the remaining piping shall be properly capped or plugged.
 - 5. Abandoned underground piping shall be left in place unless it interferes with new structures or unless otherwise noted on the Drawings.
- H. Salvage:
 - 1. Salvaged items shall be stored on site for the Owner in an acceptable location and manner.
- I. Treatment Structure Cleaning: (unless indicated otherwise on the Drawings):
 - 1. Contractor shall give Owner 14 days minimum notice prior to beginning work in structures requiring draining and cleaning; which are to be renovated or cleaned as part of this project. The Owner will be responsible for removal and disposal of the liquid contents of the existing structures.
 - 2. When the existing treatment structures are empty of liquid (drained by the Owner), any solids and/or debris, the Contractor shall then clean the structure walls, floor and ceiling using a high-pressure steam cleaning device. The cleaning once debris is removed from the structure is part of lumpsum Bid item No.1.
 - 3. If the demolition work does not commence within the Contractor's approved project schedule, the structures may be placed back in operation by the Owner. It will then be the Contractor's responsibility to drain and clean the structures.
- J. Maintain Treatment:
 - 1. During demolition, maintain treatment as outlined in Section 01010, Summary of Work.

- K. Demolition Sequence:
 - 1. The demolition sequence is to conform the reviewed and approved project schedule, and restrictions outlined in Section 01310, Construction Schedules.
- L. Pest Control:
 - 1. Provide pest control when needed or when directed by the Engineer.
 - 2. Exterminate and prevent migration of rodents to adjoining buildings in accordance with the requirements of the state or local health department.

END OF SECTION

SECTION 09900PAININGPART 1 - GENERAL1.1 SUMMARY

- A. This Section includes surface preparation and field painting of the following surfaces of new items unless specified elsewhere to be prefinished. This includes pre-primed surfaces.
 - 1. Painting of all submerged surfaces.
 - 2. Painting of all exposed interior surfaces.
 - 3. Painting of all exposed exterior surfaces.
 - 4. Staining of exterior and interior exposed wood surfaces.
 - 5. Staining of concrete surfaces.
- B. Painting of existing items:
 - 1. Existing floors, walls and ceilings to receive surface preparation and field painting are indicated on the drawings and in the specifications.
 - a. All previously painted items located within floors, walls and ceilings indicated to be painted will also receive surface preparation and field painting.
 - 2. Any other existing items on the drawings or in this specification indicated to be painted will receive surface preparation and field painting.
- C. This Section also includes:
 - 1. Piping runs above finished ceilings shall be considered exposed and shall be painted.
 - 2. Back prime, with specified interior first coat, all surfaces of wood finish and trim which will be concealed after installation.
 - 3. All surfaces of ferrous metal fabrications built into concrete and masonry shall be shop primed or receive a primer coat in accordance with this section. All surfaces exposed to view shall receive intermediate and finish coats.
 - 4. Pipe, pump and valve identification markers.
 - 5. Skid resistant floor coating where shown on the Drawings.
 - 6. Secondary containment coatings.
 - 7. Motors and equipment which are pre-finished shall receive one top coat to provide a color matching the system color indicated in the pipe identification schedule.
 - 8. Load rating identification markings for monorails and lifting hooks.
 - 9. Paint all items modified or relocated in the existing facility.
- D. Definitions:
 - 1. Submerged surfaces are defined as:
 - a. Those surfaces which are below the maximum water surface level as indicated on the drawings, and/or extend 3-feet above the maximum water surface for uncovered tanks.
 - b. All surfaces contained within covered tanks.

- c. The full height of all partially submerged items such as sluice, slide and weir gates, piping, etc.
- d. All surfaces contained within underground vaults, structures and manholes such as valve pits, dry wells, etc.
2. Exposed interior surfaces shall be non-submerged surfaces exposed to view that are enclosed and/or protected in such a manner that they cannot be exposed to UV light or weather conditions.
3. Exposed exterior items shall be all other surfaces which don't fall under the definition of "submerged" or "exposed interior surfaces".
- E. Items not requiring surface preparation and field painting:
 1. Items and equipment that are specifically specified to receive the manufacturer's standard primer and finish coats in the factory, except as noted for color and touch-up painting.
 2. Copper, bronze, brass, chromium plate, nickel, stainless steel, aluminum or monel metals (unless otherwise noted).
 3. Unprimed galvanized metals not indicated to be painted shall remain unfinished.
 4. Face brick, decorative CMU, architectural precast concrete and tile.
 5. Concrete slabs and walls unless indicated in the finish schedule on the drawings to be painted or receive secondary containment coatings.
 6. Underside of exposed metal decks unless indicated to be painted in the finish schedule.
 7. Prefinished fiber cement siding as specified in Division 7.
 8. Acoustic tile ceilings specified in Division 9.
 9. Acoustical sound control panels or sprayed on acoustical insulation specified in Division 9.
 10. Aluminum door, windows and framing specified in Division 8.
 11. Vinyl windows specified in Division 8.
 12. Toilet partitions and screens, metal lockers and toilet bath accessories specified in Division 10.
 13. Laboratory, kitchen and office casework specified in Division 12.

1.2 REFERENCES

- A. ASTM D2247 - Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
- B. ASTM D 2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- C. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
- D. DASTM D6386 - Standard Practice for Preparation of Zinc (Hot-Dip Galvanized) Coated Iron and Steel Products for Painting
- E. Federal Test Method No. 141 - Method 6141, Stain Removal.
- F. ANSI A13.1 - Scheme for the Identification of Piping Systems.
- G. SSPC - Steel Structures Painting Council.
- H. SSPC-PA1, "Standard for Shop, Field, and Maintenance Painting."
- I. SSPC-PA2, "Measurement of Dry Paint Thickness with Magnetic Gauges."
- J. SSPC-SP1, "Solvent Cleaning."

- K. SSPC-SP2, "Hand Tool Cleaning."
- L. SSPC-SP3, "Power Tool Cleaning."
- M. SSPC-SP6, "Commercial Blast Cleaning."
- N. SSPC-SP7, "Brush Off Blast."
- O. SSPC-SP10, "Near-White Blast Cleaning."
- P. SSPC-SP16, "Brush Blast Cleaning of Non Ferrous Metals"
- Q. SSPC-PA Guide 3, Standard "A Guide to Safety in Paint Application," latest revision.
- R. VOC Standards - All coatings shall be in accordance with all applicable State and Federal VOC Standards.
 - 1. OSHA 29 CFR 1925.55 Gases, Vapors, Fumes, Dusts and Mists.
 - 2. Ozone Transportation Commission (OTC) 2005 VOC Regulation.
 - 3. 38 MRSA: Section 584A; Air Protection and Improvement Law.
- S. OSHA 29 CFR 1926.62 Lead.
- T. SSPC - Guide 61 (COH) Guide for Containing Debris Generated during Paint Removal Operations.
- U. SSPC - Guide 71 (DIS) Guide for Disposal of Lead-Contaminated Surface Preparation Debris.
- V. SSPC Publication 91-18 Industrial Lead Paint Removal Handbook.
- W. USEPA 40 CFR Part 261 Identification and Listing of Hazardous Waste.
- X. USEPA 40 CFR Part 262 Standards Applicable to Generators of Hazardous Waste.
- Y. USEPA 40 CFR Part 263 Standards Applicable to Transporters of Hazardous Waste.
- Z. USEPA 40 CFR Part 268 Land Disposal Restrictions.
- AA. USDOT 49 CFR Parts 173, 178 and 179.

1.3 SUBMITTALS

- A. Submit product data under provisions of Section 01340 including tested performance characteristics.
- B. Submit manufacturer's color chips showing the full range of colors available for each type of finish coat material specified.
- C. Submit schedule on manufacturer's letter head with list of items to be coated, type and manufacturer of shop coating and type of field coating, including primers, details on surface preparation methods, application procedures and dry mil thickness.
- D. Submit a letter from the manufacturer certifying that the products submitted are applicable for the applications indicated.
- E. Submit coating manufacturer's certification that the proposed coatings meet all state and federal VOC regulations.

1.5 QUALITY ASSURANCE

- A. The Contractor shall obtain the services of a painting contractor with 5 years experience on similar projects.
- B. All materials used on work shall be exactly as specified in brand and quality. No claim by the Contractor as to unsuitability or unavailability of any material specified, or their unwillingness to use same, or their inability to produce first class work with same, will be entertained unless such claims are made in writing and submitted to the Engineer at least seven (7) days prior to the date established for receipt of General Bids.

- C. Before purchasing materials for the work, the Contractor shall submit to the Engineer a list of the products they propose to use, and the list shall be reviewed by the Engineer with a status of no exceptions taken before commitment for materials is made.
- D. Materials selected for coating systems for each type of surface shall be the products of a single manufacturer.
- E. Include on label of all containers:
 - 1. Manufacturer's name
 - 2. Type of paint
 - 3. Manufacturer's stock number
 - 4. Color
 - 5. Instructions for reducing, where applicable
 - 6. Label analysis
 - 7. Shelf life dates
- F. Field Quality Control:
 - 1. Contractor shall request review by the Engineer, of first finished room, space or item of each color, texture and method of applications, prior to proceeding with additional painting.
 - 2. Use first acceptable room, space or item as the project standard for each color scheme.
 - 3. For spray application, when applicable, paint a surface not smaller than 100 square feet as the project standard.
 - 4. Repainting of materials failing to meet the requirements of the Specifications or Drawings, shall be performed by the Contractor, at no additional cost to the Owner.
 - 5. The number of coats and total mil thickness specified in the paint schedule are minimums. If the specified minimum film thickness is not achieved, additional coats shall be applied to achieve the total film thickness specified.
- G. Paints submitted shall meet all Federal and State regulations pertaining to Volatile Organic Compounds (VOC) compliance, and be in accordance with OTC 2005 Standards.
- H. All coating systems used for potable water applications shall be previously approved by the National Sanitation Foundation (NSF) in accordance with Standard 61. Evidence of compliance shall be an approval letter from NSF listing the submitted material.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Deliver coating materials in sealed containers with labels legible and intact.
- B. Store only acceptable project materials on the project site.
- C. All painting materials shall be stored and mixed in a single location coordinated with the Engineer. The Contractor shall not use any plumbing fixture or pipe for mixing or for disposal of any refuse. The Contractor shall carry all necessary water to the mixing room, and shall dispose of all waste outside of the building in a suitable receptacle.
- D. Restrict storage location to paint materials and related equipment and supplies.
- E. Keep storage location neat and clean.

- F. Remove all soiled and used rags, waste and trash from the storage location and building at the end of each work day.
- G. Repair all damage to the storage location, caused by painting materials and equipment at no additional cost to the Owner.
- H. Comply with all applicable health and fire codes and regulations including safety precautions recommended by the manufacturer. Storage space shall be provided with a suitable fire extinguisher fully charged at all times.
- I. Heat shall be provided in the storage area if paints are to be stored during winter months. The temperature shall be maintained above 40 degrees F at all times.

1.7 ENVIRONMENTAL REQUIREMENTS

- A. Comply with manufacturer's recommendations as to environmental conditions under which coatings and coating systems shall be applied.
- B. Do not apply coatings in areas where dust is being generated.
- C. Do not apply coatings when the air or material surface temperature is below 50 degrees Fahrenheit and unless the temperature is at least 5 degrees Fahrenheit above the dew point.
- D. Do not apply exterior coatings in frosty, damp or rainy weather or while surfaces are exposed to hot sunlight.

1.8 EXTRA MATERIALS

- A. For all materials with a shelf life of greater than 12 months, provide one gallon of each type and each color of touch-up paint shall be provided to the Owner by the Contractor in unopened containers.

PART 2 - PRODUCTS

2.3 MANUFACTURERS

- A. Tnemec Company, Inc.
- B. Sherwin Williams
- C. PPG
- D. Or equal

2.4 MATERIALS

- A. Refer to the paint schedule in Part 3 for specific products and application.

2.5 COMPONENTS

- A. All finish coats shall be compatible with shop prime coats.
- B. Turpentine shall be pure spirits of turpentine.
- C. Shellac shall be four pounds and shall meet the U.S. Government specifications as issued by the Bureau of Commerce.
- D. When metal is primed in the mill or shop as part of painting contract, use the materials specified in every case for such surfaces and use in accordance with manufacturer's directions for first or priming coat.

2.6 MIXING AND TINTING

- A. Deliver paints and enamels ready-mixed to project site.

- B. Accomplish job mixing and job tinting only when required.
- C. Mix only in mixing pails placed in suitably sized nonferrous or oxide resistant metal pans.
- D. Use only tinting colors recommended by the manufacturer for the specific type of finish.
- E. Fungicidal agents, when applicable, shall be incorporated into the paints and stains by the manufacturer.
- F. Mix and prepare paints in strict accordance with Manufacturers recommendations.

PART 3 - EXECUTION

3.1 INSPECTION

- A. Examine surfaces scheduled to receive paint and finishes for conditions that will adversely affect execution, permanence or quality of work and which cannot be put into an acceptable condition through preparatory work as included in Part 3.2, Surface Preparation.
- B. Immediately notify the Engineer in writing when a surface to be finished cannot be put into an acceptable condition.
- C. Do not proceed with surface preparation or coating application until conditions are suitable.
- D. The Contractor shall be responsible for and shall rectify, at no additional cost to the Owner any unsatisfactory finish resulting from the application of coatings on surfaces not in acceptable condition.

3.2 SURFACE PREPARATION

- A. At a minimum, all surfaces must be prepared and cleaned in accordance with the manufactures written specifications and pertaining to the intended substrate to be coated. The contractor must be fully read and understand all of these requirements and all other required product recommendations prior to commencing any work.
- B. Concrete and Masonry:
 - 1. Clean all dust, dirt, oil and efflorescence from surfaces.
 - 2. Repair cracks and concrete defects in accordance with Specification Section 03346 prior to installing coating system. Finished concrete surface to have a smooth, uniform texture.
 - 3. Etch dense and smooth concrete, or concrete that has had a hardener applied, with a five percent solution (by weight) of muriatic acid.
 - 4. Ensure concrete masonry units have a smooth, uniform texture and are free of voids and bug holes in the surface prior to installing coating systems.
 - 5. Fill concrete masonry unit surfaces with block filler in sufficient thickness to produce a final result which shall fill all voids and pin holes.
 - 6. Allow surfaces to thoroughly dry prior to application of first coat.
- C. Ferrous Metal Surfaces (Items not shop primed):
 - 1. All submerged ferrous metals shall be sandblast cleaned in accordance to SSPC-SP10 immediately prior to priming.
 - 2. All other ferrous metals shall be sandblast cleaned in accordance to SSPC-SP6 immediately prior to priming.

3. Remove dirt, oil and grease by washing surfaces with mineral spirits.
 4. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
 5. Feather edges of sound existing paint by grinding, if necessary.
 6. Clean and touch up weathered, worn or damaged shop coats of paint with the specified primer.
 7. Restore shop coats of paint with identical materials if removed for welding and fabrication.
- D. Galvanized metals indicated to be painted:
1. Solvent clean in accordance with ASTM D6386.
 2. Surfaces shall receive SSPC-SP-16 and shall be surfaced prepared in accordance with ASTM D6386.
 3. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.
 4. Restore shop coats of paint with identical materials if removed for welding and fabrication.
- E. Previously Coated Surfaces (including existing items and new items that are shop primed):
1. The areas of the coated surface that are blistered, eroded, brittle or otherwise failed shall be completely removed before beginning the specified surface preparation.
 2. The areas where the existing coating is intact shall be sanded to dull the finish.
 3. Before applying the new coating over an existing coating, a test section must be done to ensure compatibility of the new and old coatings.
 4. All other existing coatings shall be prepared as recommended by the manufacturer and as specified in this section.
 5. Ferrous metals arriving at the job site with shop primers other than the polyamide epoxy or rust inhibitive primers specified shall be provided with an intermediate coat as necessary for compatibility with specified topcoats.
 6. Special attention shall be paid to the potential for epoxy shop and intermediate coats to chalk upon exposure to sunlight. The Contractor shall follow the manufacturer's required surface protection/covering and surface preparation recommendations before any intermediate or top coats can be applied over chalked surface. Epoxy primers and intermediate coats shall be top coated no later than 45 days after the application of the epoxy coating. If topcoats are to be applied later than 45 days, the following surface preparation shall be provided:
 - a. The existing finish shall be etched by sanding with 80 grit paper or cloth.
 - b. Surfaces shall be pressure washed with 3000 to 5000 pounds of pressure.
 - c. The Engineer, at their discretion, can require the Contractor to conduct adhesion tests of the topcoats.
 7. The following shall be the minimum surface preparatory for existing surfaces that are to be painted, unless indicated otherwise:
 - a. Existing submerged ferrous metals.
 - i. Clean
 - ii. Sandblast in accordance with SSPC-SP10.

- b. Non-submerged ferrous metals.
 - i. Clean
 - ii. Sandblast in accordance with SSPC-SP6.
- c. Existing concrete floors and all surfaces to receive secondary contaminant coatings.
 - i. Clean
 - ii. Sand or shot blast to remove existing coatings and to provide an anchor profile for the new coating.
- d. Existing Concrete and Masonry
 - i. Clean
 - ii. Scrape existing paint to a sound surface.
 - iii. Sand with 80 grit paper or cloth to provide anchor profile for new coating.
 - iv. Pressure wash all existing epoxy coated surfaces.

3.3 APPLICATION

A. Workmanship:

- 1. Employ skilled workmen to insure workmanship of the highest quality.
- 2. Materials shall be applied only by craftsmen experienced in the use of the specific products involved.

B. General Requirements:

- 1. Apply all coatings under adequate illumination.
- 2. Perform no work in the rain, dew, or fog, when the temperature is below 50 degrees Fahrenheit and at least 5 degrees Fahrenheit above the dew point, or before the other coats have thoroughly dried.
- 3. Do not apply coatings until the material surfaces are thoroughly dry.
- 4. Apply paints with suitable brushes, rollers or spraying equipment.
 - a. The rate of application shall not exceed that as recommended by the paint manufacturer for the surface involved.
 - b. Keep brushes, rollers and spraying equipment clean, dry and free from contaminates and suitable for the finish required.
 - c. Make each coat a different tint from that of the preceding coat, with final coat tinted to the exact shade selected by the Engineer. Lightly sand surfaces between each coat of gloss and semi-gloss finishes, and wipe clean.
- 5. Comply with the recommendation of the product manufacturer for drying time between succeeding coats. Contractor shall follow the manufacturer's specific curing requirements for rust inhibitive primer shop coats prior to allowing top coating.
- 6. Sand and dust between each coat to remove defects visible from a distance of five feet.
- 7. Finish coats shall be smooth, free of brush marks, streaks, laps or pile up of paints and skipped or missed areas.
- 8. Inspection:
 - a. Do not apply additional coats until the completed coat has been inspected by the Engineer.

- b. Only inspected and reviewed coats will be considered in determining the number of coats applied.
- 9. Leave all parts of moldings and ornaments clean and true to details with no undue amount of paint in corners and depressions.
- 10. Make edges of paint adjoining other materials or colors clean and sharp with no overlapping.
- 11. Apply primer on all work before glazing.
- 12. Refinish entire wall where portion of finish has been damaged or is not acceptable.
- 13. Runs on face are not permitted.

3.4 PROTECTION

- A. Furnish and lay drop cloths in all rooms and areas where painting and finishing is being done to adequately protect flooring and other work from damage during the prosecution of the painting work.
- B. Remove all canopies of lighting fixtures, all electric switch plates, and similar equipment, set them carefully away, and cover adequately, protect the fixtures, etc.; replace the canopies, plate, etc. in as good condition as when found.
- C. Do not paint over any code-required labels, such as Underwriter's Laboratories and Factory Mutual, or any equipment identification, performance rating, name, or nomenclature plates.
- D. Correct and refinish all interior and exterior surfaces in the existing facility affected by the new work. Materials and their application shall be as required to most closely match the existing finishes and as specified in this Section.

3.5 CLEANING

- A. At the completion of the work of this Section, remove all paint spots and oil or grease stains, caused by this work from floors, walls, fixtures, hardware and equipment, leaving their finishes in a satisfactory condition. Remove all materials and debris and leave the site of the work in a clean condition so far as this work is concerned.

3.6 FINAL INSPECTION

- A. Protect all painted and finished surfaces against damage until the date of final acceptance of the work. The Engineer will conduct a final inspection of all painters' work. As part of the final inspection the Contractor shall demonstrate compliance with the specified film thickness with appropriate paint gauges. The Contractor shall be required to repaint, refinish, or retouch any areas found which do not comply with the requirements of this Section.

3.7 LOAD RATING IDENTIFICATIONS

- A. Provide markings indicating the load rating of all hoists, monorails and lifting hooks.
- B. Markings shall be 3-inches high stenciled letters painted adjacent to the item in a color contrasting the background color.

3.8 PAINT SCHEDULE, GENERAL

- A. The following product model and coatings system numbers are listed below to

establish the standard of quality. Equivalent products from other manufactures will be accepted provided they meet or exceed the performance of the listed products.

- B. If finish coats are compatible with the shop primer on shop primed items, the primer coats listed below are not required on shop primed items. Installer to verify that proposed field coatings are compatible with shop coatings. If the finish coats are not compatible with shop primer coat, painter to provide a polyamide epoxy intermediate coat for compatibility.
- C. Shop primed hollow metal doors and frames shall receive the primer coat listed below, regardless of compatibility.
- D. Surface prep shall be as specified within this specification section, as noted below and as required per manufacturer recommendations.
- E. When applying coats over epoxy coatings that have been in place for more than 45 days, prepare surface in accordance with the "Surface Preparation" section of this specification.
- F. When applying coats over previously painted items in an existing facility, verify the products specified below are compatible with the existing coatings. If specified coatings are not compatible, prepare surface in accordance with the "Surface Preparation" section of this spec and provide a bonding primer that is compatible with the existing and specified coatings.
- G. All film thicknesses are listed as dry film thicknesses and are the minimum required.

3.9 PAINT SCHEDULE, ARCHITECTURAL COATINGS

- A. General: This section covers painting of architectural items including but not limited to, walls, floors, ceilings, hollow metal doors and frames, wood trim, PVC trim, etc.
- B. Masonry Surfaces to Receive Epoxy: 2 finish coats over a primer.
 - 1. Surface Preparation: Clean and Dry
 - 2. Primer:
 - a. Tnemec: EpoxoBlock at 80-100 SF/Gallon
 - b. Sherwin-Williams: Cement-Plex 875 at 100
 - c. PPG: PermaCrete 4-100
 - 3. Two Finish Coats:
 - a. Tnemec: Series N69 Tneme-Epoxoline at 3 to 5 mils
 - b. Sherwin-Williams: Pro Industrial High Performance Epoxy at 4 to 6 mils
 - c. PPG: Amerlock 2/400 at 3 to 5 mils
- C. Other Masonry Surfaces: 2 finish coats over a primer.
 - 1. Surface Preparation: Clean and Dry
 - 2. Primer:
 - a. Tnemec: EpoxoBlock at 80-100 SF/Gallon
 - b. Sherwin-Williams: Heavy Duty Block Filler at 8 to 10.5 mils
 - c. PPG: PermaCrete 4-100
 - 3. Two Finish Coats:
 - a. Tnemec: Series 1028/1029 Enduratone at 2 to 3 mils
 - b. Sherwin-Williams: Pro Industrial Acrylic Coating at 3 to 4 mils
 - c. PPG: Pitt-Tech Plus at 3 to 4 mils
- D. Concrete Vertical and Ceiling Surfaces to Receive Epoxy: 2 finish coats over a primer.

1. Surface Preparation: Brush-off Blast to achieve uniform anchor profile
 2. Primer:
 - a. Tnemec: Series N69 Tneme-Epoxoline at 3 to 5 mils
 - b. Sherwin-Williams: Pro Industrial High Performance Epoxy at 4 to 6 mils
 - c. PPG: Amerlock 2/400 at 3 to 5 mils
 3. Finish Coats:
 - a. Tnemec: Series N69 Tneme-Epoxoline at 3 to 5 mils
 - b. Sherwin-Williams: Pro Industrial High Performance Epoxy at 4 to 6 mils
 - c. PPG: Amerlock 2/400 at 3 to 5 mils
- E. Other Concrete Vertical and Ceiling Surfaces: 2 finish coats over a primer.
1. Surface Preparation: Clean, Dry and Surface Grind
 2. Primer:
 - a. Tnemec: 151-1051 Elasto Grip FC at 2 to 3 mils
 - b. Sherwin-Williams: Loxon Conditioner Primer at proper DTF
 - c. PPG: Pitt-Tech Primer at 1.0 to 2.5 mils
 3. Two Finish Coats:
 - a. Tnemec: Series 1028/1029 Enduratone at 2 to 3 mils
 - b. Sherwin-Williams: Pro Industrial Acrylic Coating at 3 to 4 mils
 - c. PPG: Pitt-Tech Plus at 3 to 4 mils
- F. Other Concrete Floors: 2 finish coats over a primer.
1. Surface Preparation: Clean, Dry and Surface Grind
 2. Primer:
 - a. Tnemec: 201 Epoxoprime at 3 to 4 mils
 - b. Sherwin-Williams: ArmorSeal 33 Epoxy Primer/Sealer at 8 mils
 - c. PPG: Amerlock Sealer
 3. Two Finish Coats:
 - a. Tnemec: 281 Tnemec-Glaze at 8 to 10 mils
 - b. Sherwin-Williams: ArmorSeal 1000 HS at 3 to 5 mils
 - c. PPG: Amerlock 2/400 at 3 to 5 mils
- G. Metals: Metal items including but not limited to hollow metal doors and frames, steel bollards, etc., 2 finish coats over a primer.
1. Surface Preparation: Per Manufacturer's Specifications
 2. Primer:
 - a. Tnemec: Series 1 Omnithane Gray at 2.5 to 3 mils
 - b. Sherwin-Williams: Kem-Bond HS Universal Primer at 3 mils
 - c. PPG: Pitt-Tech Primer
 3. Two Finish Coats:
 - a. Tnemec: Series 1028/1029 Enduratone at 2 to 3 mils
 - b. Sherwin-Williams: Pro Industrial Acrylic Coating at 3 to 4 mils
 - c. PPG: Pitt-Tech Plus
- H. Electrical Conduit:
1. Conduit Painting Schedule:
 - a. Electrical Room: Not painted.
 - b. Above Finish Ceiling: Not painted.
 - c. All Other Rooms and Areas: Painted.
 2. Same color and finish as surface conduit is mounted to.

- I. Ferrous Metals concealed within wood or metal stud framing and not exposed to view: Items including but not limited to steel beams, plates, etc., 1 primer coat.
 - 1. Surface Preparation: SSPC-SP3
 - 2. Primer:
 - a. Tnemec: Series 1 Omnithane Gray at 2.5 to 3 mils
 - b. Sherwin-Williams: Kem-Bond HS Universal Primer at 3 mils
 - c. PPG: Amerlcok 2/400 at 4-6 mils
- J. Galvanized metal fabrications built into concrete and masonry: Items including but not limited to steel beams, plates, etc., 1 primer coat.
 - 1. Surface Preparation: ASTM D6386 Solvent Cleaning Followed by SSPC-SP16
 - 2. Primer:
 - a. Tnemec: Series 1 Omnithane Gray at 2.5 to 3 mils
 - b. Sherwin-Williams: SW Recoatable Epoxy Primer at 4 to 6 mils
 - c. PPG: Sigmafast 278
- a. PVC Trim: Provide primer and two finish coats of a product as recommended by the manufacturer.

3.10 PAINTING SCHEDULE, INDUSTRIAL COATINGS

- A. General: This section covers painting of the piping and equipment systems including but not limited to, valves, levers, valve handles, fittings, stands, supports, hangers, pumps, motors and appurtenances.
- B. Submerged Ferrous Metals in contact with potable water: Two finish coats over a primer.
 - 1. Surface Preparation: SSPC-SP10 Near White Metal Blast Cleaning
 - 2. Primer:
 - a. Tnemec: 94 H20 Hydro-Zinc at 2.5-3.5 mils
 - b. Sherwin-Williams: Corothane I Galvapac Zinc Primer at 3.0 – 4.0 mils
 - c. PPG: Amercoat 68HS
 - 3. Two Finish Coats:
 - a. Tnemec: N140F at 6 to 8 mils
 - b. Sherwin-Williams: Macropoxy 646 PW Epoxy at 6.0 – 10.0 mils
 - c. PPG: Amerlock 2
- C. Submerged Ferrous Metals in contact with sewer water with high hydrogen sulfide exposures: Process piping and equipment systems located in the preliminary treatment channels, the headworks structure, wetwells, sludge holding tanks, sludge wetwells, and dewatering, filtrate and centrate tanks, 1 primer coat, 1 intermediate coat and 1 finish coat.
 - 1. Surface Preparation: SSPC-SP10 Near White Metal Blast Cleaning
 - 2. Primer:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: SW Sher-Glass FF Epoxy at 8 to 10 mils
 - c. PPG: Sigmashield 880 at 12-16 mils
 - 3. Intermediate Coat:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: N/A
 - c. PPG: N/A

4. Finish Coat:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: SW Sher-Glass FF Epoxy at 8 to 10 mils
 - c. PPG: Sigmashield 880 at 12-16 mils
- D. All other Submerged Ferrous Metals: Two finish coats over a primer.
 1. Surface Preparation: SSPC-SP10 Near White Metal Blast Cleaning
 2. Primer:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
 - c. PPG: N/A
 3. Two Finish Coats:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: Macropoxy 646 PW Epoxy at 5.0 –6.0 mils
 - c. PPG: Amercoat 240 at 6-8
- E. All portions of submerged metals subjected to UV Exposure: Provide 1 additional finish coat as indicated in this section in addition to the primer coat and 2 finish coats specified for submerged ferrous metals.
 1. Finish Coat:
 - a. Tnemec: Series 73 Endura-shield at 3 to 4 mils
 - b. Sherwin-Williams: Acrolon 218 HS Acrylic Polyurethane at 3 to 4 mils
 - c. PPG: Amershield VOC
- F. Weather Exposed Ferrous Metal Piping and Equipment: Two finish coats over a primer.
 1. Surface Preparation: Per Manufacturer's Specifications
 2. Primer:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
 - c. PPG: Amerlock 2/400
 3. Two Finish Coats:
 - a. Tnemec: Series 73 Endura-shield at 3 to 4 mils
 - b. Sherwin-Williams: Acrolon 218 HS Acrylic Polyurethane at 3 to 4 mils
 - c. PPG: Amershield VOC
- G. Enclosed Ferrous Metal Piping and Equipment: Two finish coats over a primer.
 1. Surface Preparation: Per Manufacturer's Specifications
 2. Primer:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
 - c. PPG: Amerlock 2/400
 3. Two Finish Coats:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: Macropoxy 646 Epoxy at 5.0 –6.0 mils
 - c. PPG: Amerlock 2/400
- H. Plastic Clad Insulated Pipe: One finish coat over a primer.
 1. Surface Preparation: Clean & Dry
 2. Primer:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils

- b. Sherwin-Williams: Extreme Bond Bonding Primer at 2 to 5 mils
- c. PPG: Amerlock 2/400
- 3. Finish Coat:
 - a. Tnemec: Series 1028/1029 Enduratone at 2 to 3 mils
 - b. Sherwin-Williams: Pro Industrial Acrylic Coating at 3 to 4 mils
 - c. PPG: Durethane topcoat
- I. PVC Pipe and PVC Conduit: One finish coat over a primer.
 - 1. Surface Preparation: Clean & Dry - Scuffed Up with Medium Grit Sandpaper
 - 2. Primer:
 - a. Tnemec: Series N69 Tneme-Epoxoline 11 at 3 to 5 mils
 - b. Sherwin-Williams: Extreme Bond Bonding Primer at 2 to 5 mils
 - c. PPG: Amerlock 2/400
 - 3. Finish Coat:
 - a. Tnemec: Series 1028/1029 Enduratone at 2 to 3 mils
 - b. Sherwin-Williams: Pro Industrial Acrylic Coating at 3 to 4 mils
 - c. PPG: Durethane topcoat

3.11 PIPING IDENTIFICATION SCHEDULE

A. Pipe Coating

- 1. All pipes, whether concealed or exposed to view shall be painted a separate color as directed by the Engineer. For insulated pipes, only the insulation shall be painted.
- 2. Pipe supports consisting of pipe rings, clamps, clevises, U bolts, pipe rollers, saddles, etc., shall be painted with the same color as that of the pipe.
- 3. Wall supported pipe hangers consisting of brackets, standoffs, etc., shall be painted with the same color as that of the wall.
- 4. Ceiling/roof supported pipe hangers consisting of thread rods, beam clamps, etc., shall be painted with the same color as that of the ceiling.
- 5. Floor supported pipes consisting of stanchions shall be painted with same color as that of the pipe.

B. Pipe Markers

- 1. Markers shall be corrosion resistant laminated plastic bound to the pipes with nylon fasteners or shall be "coil-fit." Stickers are not acceptable. Markers and flow direction indicators shall be manufactured by Seton, Brimar Industries, or equivalent.
- 2. Pipes with diameters less than 1-1/4 inch shall have marker hung from pipe with nylon fasteners.
- 3. Lettering size shall be in accordance with the following:

SIZE OF LEGEND LETTERS

Outside Diameter of Pipe or Covering	Minimum Length of Marker	Size of Letters
In	In	In
Up to 1-1/4	8	1/2
1-1/2 to 2	8	3/4
2-1/2 to 6	12	1-1/4
8 to 10	24	2-1/2
Over 10	32	3-1/2

4. Adjacent to each marker there shall be an arrow indicating flow direction.
 5. Marker location shall be in accordance with the American National Standard Institute Scheme for Identification of Piping Systems (ANSI A13.1). Markers shall be placed adjacent to all valves and/or flanges; adjacent to all changes in direction on all pipe branches; and where all pipes pass through walls or floors on each side of wall/floor. On straight runs of piping, markers shall be placed at no less than 10 foot intervals. Where pipes are located above or below the normal line of vision, the lettering shall be placed below or above (as appropriate) the horizontal centerline of the pipe.
- C. Valve Status Indication Arrows
1. Valve status indicator alignment arrows shall be provided on the indicator and scale sides of all interior hand wheel, chain and lever operated valves. Arrow heads shall appear aligned when the valve is in the full-open position. Arrow heads shall be painted on with stencils, or a color contrasting with the color of the valve. Arrow heads shall be minimum of 3/4-inch in smallest dimension. Valve position indicators shall be aligned to be visible from normal working levels.

END OF SECTION

SECTION 09905SHOP COATINGSPART 1 - GENERAL1.1 SECTION INCLUDES

- A. Surface preparation and application of shop coatings on materials, equipment, and piping indicated in the various specification sections relating thereto, and as specified herein, including primers and topcoats for materials, equipment and piping that are finished at the point of manufacturer or fabrication.
- B. Examine the various Sections of the Specifications and be thoroughly familiar with all provisions regarding shop coatings.

1.2 PREFINISHED ITEMS NOT REQUIRING PAINT OR FINISH

- A. Copper, bronze, brass, chromium plate, nickel, stainless steel, aluminum or monel metals, except surfaces in contact with or embedded within concrete or masonry, unless otherwise specified elsewhere.

1.3 REFERENCES

- A. ASTM D2247 - Practice for Testing Water Resistance of Coatings in 100 Percent Relative Humidity.
- B. ASTM D 2794 - Test Method for Resistance of Organic Coatings to the Effects of Rapid Deformation (Impact).
- C. ASTM E84 - Test Method for Surface Burning Characteristics of Building Materials.
- D. Federal Test Method No. 141 - Method 6141, Stain Removal.
- E. SSPC - Steel Structures Painting Council.
- F. SSPC-PA1, "Standard for Shop, Field, and Maintenance Painting".
- G. SSPC-PA2, "Measurement of Dry Paint Thickness with Magnetic Gauges".
- H. SSPC-SP1, "Solvent Cleaning".
- I. SSPC-SP6, "Commercial Blast Cleaning".
- J. SSPC-SP10, "Near-White Blast Cleaning".
- K. SSPC-SP16, "Brush Blast Cleaning of Non Ferrous Metals"
- L. SSPC-PA Guide 3, Standard "A Guide to Safety in Paint Application", latest revision.

1.4 SUBMITTALS

- A. Submit product data under provisions of Section 01340.
- B. As a minimum, the following shall be included in the submittal package for all items, products, material or equipment, as specified.
 - 1. Submit data on the proposed shop coatings, details on surface preparation methods, application procedures and dry mil thickness.
 - 2. Submit a minimum of three (3) color charts for all factory top coats for color selection by Engineer.
 - 3. Submit coating manufacturer's certification that the proposed shop coatings are applicable for the applications indicated.
 - 4. Submit coating manufacturer's certification that proposed shop coatings are

- compatible with field coatings, as specified in Section 09900.
5. For potable water applications, submit coating manufacturer's certification that the proposed shop coatings comply with ANSI/NSF Standard 61.

1.5 QUALITY ASSURANCE

- A. All Shop Coatings shall meet the requirements of the materials section and shall be guaranteed by the manufacturer to be compatible with the field coatings, as specified in Section 09900. The Contractor shall coordinate this requirement during the Shop Drawing Phase.
- B. All Shop Coatings shall meet all Federal and State regulations pertaining to Volatile Organic Compounds (VOC) compliance.PRODUCTS

2.1 MATERIALS

- A. Refer to Part 3 - EXECUTION for specific products and applications.

PART 3 - EXECUTION

3.1 SURFACE PREPARATION

A. Definitions

1. Submerged surfaces are defined as:
 - a. Those surfaces which are below the maximum water surface level as indicated on the drawings, and/or extend 3'-0" above the maximum water surface for uncovered tanks.
 - b. All surfaces contained within covered tanks.
 - c. The full height of all partially submerged items such as sluice gates, slide gates, weir gates, piping, etc.
 - d. All surfaces contained within underground structures, vaults and manholes such as valve pits, drywells, etc.
2. Enclosed surfaces are those non-submerged surfaces enclosed and/or protected within a building in such a manner that it cannot be exposed to UV light or weather conditions.
3. Weather exposed surfaces are all other conditions including buried items which do not fall into the definition of submerged or enclosed surfaces, as noted above.

B. Ferrous Metal

1. All submerged ferrous metals shall be sandblast cleaned in accordance to SSPC-SP10, near white, immediately prior to priming.
2. All other ferrous metals, Enclosed and Weather exposed surfaces, shall be sandblast cleaned in accordance to SSPC-SP6, commercial grade, immediately prior to priming.
3. Remove dirt, oil and grease by washing surfaces with mineral spirits.
4. Surfaces shall be dry and free of dust, oil, grease and other foreign material before priming.

C. Galvanized Metal (nonferrous metals indicated to be painted):

1. Solvent clean in accordance with ASTM D6386.
2. Surfaces shall receive SSPC-SP-16 and shall be surfaced prepared in accordance with ASTM D6386.
3. Surfaces shall be dry and free of dust, oil, grease and other foreign material

- before priming.
4. Restore shop coats of paint with identical materials if removed for welding and fabrication.

3.2 APPLICATION

A. Equipment

1. Motors, speed reducers and similar parts shall have a surface preparation in accordance with the manufacturer standard coating requirements and suitable for weather exposed use. The minimum coating system shall be 3 coats of polyamide epoxy at a minimum of 3 mils per coat. Other coatings must be approved by the Engineer.
2. Items finished at the point of manufacture (shop primed and painted), such as submersible pumps and other similar surfaces, shall receive manufacturer's standard coating of baked, powder epoxy enamel, suitable for the intended service.
3. All equipment casing openings requiring protection shall have a water repellent tape and vapor phase inhibitor treated paper.
4. All other ferrous surfaces shall be factory primed except ferrous surfaces obviously not to be painted such as gears, exposed machined or bearing surfaces, enclosed machined or bearing surfaces, lubricated contact surfaces moving under load, thread connections to be field connected and other similar items. Surfaces not to be painted shall be given a heavy shop coat of grease or other suitable rust resistant coating per manufacturer's recommendations. The minimum priming system shall be a coat of a single component metal primer with good corrosion and rust protection, rated for exterior exposure and with ability to be topcoated with acrylics, epoxies and urethanes.
5. These coatings shall be maintained as necessary to prevent corrosion during all periods of storage and erection, until final acceptance by the Owner.

B. Pipe, Fittings and Valves

1. The exterior surfaces of all ductile iron pipe and fittings buried shall receive the standard factory applied asphaltic coating (in accordance with AWWA C151).
2. The exterior surfaces of buried valves and miscellaneous piping appurtenances shall be prepared in accordance with the manufacturer's recommendations and at a minimum shall receive a shop coat of fusion bonded epoxy coating.
3. The exterior surfaces of ductile iron pipe, fittings and valves submerged, enclosed or weather exposed shall receive a factory applied shop primer. The minimum priming system shall be a coat of a single component metal primer with good corrosion and rust protection, rated for exterior exposure and with ability to be topcoated with acrylics, epoxies and urethanes.
4. Machined surfaces shall be cleaned and coated immediately after being machined, with a suitable rust resistant coating per manufacturer's recommendations.
5. All other ferrous surfaces shall be factory primed except ferrous surfaces obviously not to be painted. Ferrous surfaces not to be painted shall receive a heavy shop coat of grease or other suitable rust resistant coating per manufacturer's recommendations. The minimum priming system shall be a coat of a single component metal primer with good corrosion and rust protection,

rated for exterior exposure and with ability to be topcoated with acrylics, epoxies and urethanes.

6. These coatings shall be maintained as necessary to prevent corrosion during all periods of storage and erection until final acceptance by the owner.

END OF SECTION

SECTION 11000EQUIPMENT - GENERALPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included: Furnish, install and test all equipment specified in this Contract and as shown on the Drawings.
- B. Related Work Specified Elsewhere (When Applicable):
 - 1. Submittals are specified in Section 01340.
 - 2. Delivery, Storage and Handling is specified in Section 01600.
 - 3. Equipment Startup, Certification and Operator Training are specified in Section 01800.
 - 4. Field painting is specified in Section 09900.
 - 5. Surface Preparation and Shop Coatings are specified in Section 09905
 - 6. Controls and Instrumentation are specified in Division 13.
 - 7. Electrical work and components, and variable frequency drives, are specified in Division 16.

1.2 QUALITY ASSURANCE

- A. Provide only equipment of proven reliability manufactured by reputable manufacturers.
- B. Acceptable manufacturers are listed in each equipment item section in this Division and are intended to indicate the type and quality of materials expected.
- C. Certificates, patents, licenses or other required legalities, when applicable, are specified in each Section of this Division.
- D. Submit complete shop drawings, cuts, specifications, etc. to the Engineer to review for compliance with the Contract Documents prior to ordering any equipment. If the equipment differs materially from the dimensions given on the Drawings, submit complete drawings showing elevations, dimensions etc. for the installation. If Engineer's acceptance is obtained for alternate equipment, make any needed changes in the structures, piping or electrical systems necessary to accommodate the equipment at no additional cost to the Owner.
- E. Workmanship shall be first class in all respects.

1.3 SUBMITTALS

- A. Provide shop drawings and samples as specified in the General Conditions and Section 01340 of the Construction Contract. Equipment Systems Manufacturers shall integrate all required shop drawings into a common package.
- B. Catalog Data: Submit manufacturer's literature and illustrations for all equipment to be installed, including dimensions, construction details, shop painting details, and materials by generic name.
- C. Installation Instructions: Submit complete sets of manufacturer's instructions for each equipment item, including equipment storage requirements.
- D. Complete Operation and Maintenance Manuals in compliance with Specification

Section 01340.

- E. Certificates: Submit manufacturer's certification that equipment, accessories and shop painting meet or exceed the Specification requirements. Submit equipment performance testing results as required by these specifications. Should the proposed equipment not comply with all the specification requirements, all deviations from the specification requirements shall be listed.
- F. Submit all requirements for interface with controls and/or equipment furnished in Divisions 13 and 16. Submit wiring diagrams as required to accurately depict all such interface requirements to ensure proper operations of each system or item of equipment.
- G. Provide certified bearing life calculations on all equipment bearings.
- H. Submittals are further specified in this Division.
- I. Guarantees/Warranties as specified below.
- J. Attention is directed to the fact that the Drawings are based upon a particular piece of equipment.
- K. If the equipment to be provided requires an arrangement differing from that indicated on the Drawings, the Contractor shall prepare and submit for review, detailed mechanical drawings showing all necessary changes. Such changes shall be at no additional cost to the Owner.
- L. Contractor shall provide a Submittal Certification from each individual Equipment Manufacturer certifying that the Equipment Manufacturer has:
 - 1. Reviewed the Construction Documents, the intended installation by the Contractor, and the intended functional and operational conditions;
 - 2. Determined all conditions to be acceptable; and
 - 3. Found no conditions which would cause the warranty to be void; or the equipment to function improperly, or not meet the performance requirements.The submittals will not be reviewed without the inclusion of these noted certifications. Process Equipment Manufacturer Submittal Certification Form is provided in Section 01340.
- M. Proposed equipment/valve identification tag information.

1.4 GUARANTEE/WARRANTIES

- A. The Contractor shall provide the Owner with a Guarantee/ Warranty for the entire project.
- B. Any specified extended warranties (i.e. those which run longer than the Contract Correction/ Warranty Period) shall be prepared in the name of the Owner and shall become effective after the completion of the Correction/ Warranty Period. The Contractor will be required to handle warranty problems during the Correction/ Warranty Period. Extended warranties shall meet the requirements specified in the relevant Section. Proposed extended warranty language shall be submitted to the Engineer for review as a part of the Shop Drawing process.
- C. Equipment that is supplied by a system supplier and is intended to function as a complete and integrated system shall be warranted accordingly.
- D. Any part of a mechanical equipment system that shows undue or excessive wear, or that fails due to normal operational conditions during the Correction/ Warranty Period, shall be considered as evidence of defective material or defective workmanship, and it shall be replaced with equipment or parts to meet the specified

requirements at no cost to the Owner.

1.5 DELIVERY, STORAGE AND HANDLING

- A. Refer to Section 01600 for additional requirements.

PART 2 - PRODUCTS

2.1 GENERAL DESIGN OF EQUIPMENT

- A. All parts and components of mechanical equipment shall be designed for satisfactory service under continuous duty without undue wear under the specified operating conditions.
- B. All parts of mechanical equipment shall be amply proportioned for all stresses which may occur during operations, and for any additional stresses which may occur during fabrication and erection. Iron castings shall be tough, close-grained gray iron casting, Class 30, in accordance with ASTM A48, latest revision. Structural steel shall conform to ASTM A36.
- C. Mechanical equipment, including drives and electrical motors, unless otherwise noted, shall be supplied and installed in accordance with Occupational Safety and Health Act (OSHA) requirements. The Contractor's attention is drawn to the requirements for equipment guards. The noise level of equipment, drives and motors, unless otherwise noted, shall not exceed 90 dBA measured 3 feet from the unit under free field conditions.
- D. All equipment and machinery furnished under this Contract shall be the latest improved design suitable for the service specified. All equipment and machinery shall be designed and constructed to operate efficiently, continuously and quietly under the specified requirements with a minimum of maintenance, renewals and repairs. The design and construction of all equipment and machinery shall be such as to permit operation with minimum wear, vibration and noise when properly installed.
- E. Ample room for erecting, repairing, inspecting and adjusting of all equipment and machinery shall be provided. The design, construction and installation of all equipment and machinery shall conform to and comply with the latest safety codes and regulations.
- F. All equipment of identical size, type and service shall be the product of the same manufacturer.
- G. All equipment selected shall suit the general arrangement of the space in which it is to be installed.
- H. Unless otherwise specified, electrical SCR controller units shall be furnished with the driven equipment, mounted and factory aligned, where applicable. Wiring of motors and controls shall be in accordance with the requirements of Division 16 and other applicable portions of the Specifications. Electrical variable frequency drives shall be furnished and installed by the electrical contractor, unless otherwise noted as specified in Division 16.
- I. Suitable provisions shall be made for easy access for service and replacement parts.

2.2 BOLTS, ANCHOR BOLTS AND NUTS

- A. Furnish all necessary bolts, anchor bolts, nuts, washers, lock washers or locking nuts, plates and bolt sleeves in accordance herewith. Anchor bolts shall have suitable

- washers, lock washers and, where so required, their nuts shall be hexagonal.
- B. All bolts, anchor bolts, nuts, washers, lock washers, plates, and bolt sleeves shall be galvanized unless otherwise indicated below or specified elsewhere.
1. Galvanized steel in accordance with Division 5 unless otherwise indicated below or specified elsewhere.
 2. Stainless steel hardware (minimum of Type 304, unless otherwise indicated) is required in all corrosive atmospheres, exterior areas, and/or areas with NEMA 4X or NEMA 7 rating.
 3. Stainless steel hardware (minimum of Type 316, unless otherwise indicated) is required in all submerged applications, including but not limited to the wetwells, headworks, dewatering rooms, chemical rooms, clarifiers, aeration basins, splitter structures, equalization or storage tanks, etc. For additional description and definition of submerged surfaces refer to Specification Section 09900.
- C. Expansion bolts shall have malleable iron and lead composition elements of the required number of units and size.
- D. Unless otherwise specified, stud, tap, and machine bolts shall be of the best-quality refined bar iron. Hexagonal nuts of the same quality of metal as the bolts shall be used. All threads shall be clean cut and shall conform to AN Standard B 1.1-1974 for Unified Inch Screw Threads (UN and UNR Thread Form).
- E. Anchor bolts and expansion bolts shall be set accurately. If anchor bolts are set before the concrete has been placed, they shall be carefully held in suitable templates of acceptable design. Where indicated on the Drawings, specified, or required, anchor bolts shall be provided with square plates at least 4 in. by 4 in. by 3/8 in. or shall have square heads and washers and be set in the concrete forms with suitable pipe sleeves, or both. If anchor or expansion bolts are set after the concrete has been placed, all necessary drilling and grouting or caulking shall be done by the Contractor and care shall be taken not to damage the structure or finish by cracking, chipping, spalling, or otherwise during the drilling and caulking.
- F. All anchors shall be designed and supplied by the equipment manufacturer. Anchors include, but are not limited to, anchor rods, epoxy anchors and expansion anchors. All anchor designs shall include the following:
1. Anchors shall be designed for all applicable loads and load combinations in accordance with the Building Code applicable to the Project as by the equipment manufacturer. Equipment dynamic loads shall also be included with the other loads.
 2. Anchor design shall include the quantity, material, finish, diameter, type, spacing and concrete embedment depth of anchors. Design of epoxy and expansion anchors shall be based on cracked concrete.
 3. Expansion anchors are not permitted for exterior applications, wet service conditions, or dynamic loads. Cast-in anchor rods or epoxy anchors shall be used in these applications.
 4. All anchors shall be installed with the required embedment depth. If anchors are fully developed in the concrete equipment pad and are not embedded in the slab, the anchorage capacity of the pad to the slab shall be verified by the Engineer prior to placement of the pad.

5. Anchors shall be no less than 3/8" diameter.
6. Concrete strengths are as follows:
 - a. New concrete: $f'c = 4,000$ psi
 - b. Existing concrete: $f'c = 3,000$ psi
7. Epoxy and Expansion Anchors shall conform to Specification Section 03300. Anchor rods shall conform to Specification Section 05500 [05120] [Note to Specifier: Coordinate with Structural Engineer].
8. Anchors shall be shown on the equipment shop drawings, with all the required information indicated.

2.3 FOUNDATIONS, INSTALLATION AND GROUTING

- A. The Contractor shall furnish the necessary materials and construct suitable concrete foundations for all equipment installed by the Contractor, even though such foundations may not be indicated on the Drawings. The tops of foundations shall be at such elevations as will permit grouting as specified below.
- B. All such equipment shall be installed by skilled mechanics and in accordance with the instructions of the manufacturer.
- C. In setting pumps, motors, and other items of equipment customarily grouted, the Contractor shall make an allowance of at least 1 in. for grout under the equipment bases. Shims used to level and adjust the bases shall be steel. Shims may be left embedded in the grout, in which case they shall be installed neatly and so as to be as inconspicuous as possible in the completed work. Unless otherwise permitted, all grout shall be a suitable non-shrink grout.
- D. Grout shall be mixed and placed in accordance with the recommendations of the manufacturer. Where practicable, the grout shall be placed through the grout holes in the base and worked outward and under the edges of the base and across the rough top of the concrete foundation to a peripheral form so constructed as to provide a suitable chamfer around the top edge of the finished foundation.
- E. Where such procedure is impracticable, the method of placing grout shall be as permitted by the Engineer. After the grout has hardened sufficiently, all forms, hoppers, and excess grout shall be removed, and all exposed grout surfaces shall be patched in an approved manner, if necessary. All foundation and grout exposed surfaces shall be given a burlap-rubbed finish and painted with at least two coats of the epoxy-based paint specified for concrete.
- F. If threaded rod with lower support nuts are used to secure the equipment in place temporarily during concrete equipment pad placement, the support nuts shall be removed prior to grouting so that the threaded rod anchor bolts are not supporting the equipment and the top nuts can be tightened to secure the equipment directly to the large bedding surface provided by the non-shrink grout and concrete equipment pad. Equipment foundations shall be designed to absorb equipment vibration and transmit forces to building structure or ground. Contractor shall demonstrate that this has been completed to the RPR prior to grouting.

2.4 ELECTRIC MOTORS

- A. Unless otherwise specified or permitted by the Engineer, all electric motors furnished and installed by the Contractor shall conform to the requirements hereinafter set forth.
- B. All equipment motors and appurtenances (e.g., switches, instruments, etc.) shall meet

the area classification and NEMA requirements as listed on Drawing E-1.

- C. All motors shall be specifically designed for the installation orientation required by the equipment submitted (i.e., horizontal motor design for horizontal installation, vertical motor design for vertical installation). Universal motors shall not be allowed.
- D. Ratings of Motors
 - 1. Every motor shall be of sufficient capacity to operate the driven equipment under all load and operating conditions without exceeding its rated nameplate current or power or its specified temperature limit.
 - 2. When the horsepower rating is specified for a motor, the motor furnished shall meet the requirements of the output specified. When the horsepower rating is not specified, the motor shall have sufficient capacity to operate the driven equipment as given in the Detailed Specifications.
 - 3. All electric motors shall be UL recognized.
 - 4. Motor shall have a service factor of 1.15, unless otherwise specified.
- E. Type of Motors
 - 1. All motors shall be NEMA Design B, and shall have starting characteristics and ruggedness as may be necessary under the actual conditions of operation and, unless otherwise specified, shall be suitable for full-voltage starting.
 - 2. Motors shall be manufactured by General Electric Co., Reliance, Toshiba, Siemens, or be an equivalent product, that meets all the requirements herein.
 - 3. All motors shall have Class F insulation with temperature rise in accordance with NEMA Standards for Motors and Generators and based on a maximum ambient temperature of 40 deg. C.
 - 4. Motors Installed in Class I/ Division 1 Hazardous Locations:
 - a. Motors shall be explosion-proof (XP) rated for Class I/ Division 1/ Group C and D rated for hazardous locations and shall meet the requirements of the National Electric Code and other safety codes pertaining thereto.
 - b. Motors shall include integral high temperature thermostats or similar device with a high temperature interlock to shut down the motor and auxiliary contact to activate an alarm condition.
 - c. Thermostats shall be normally closed, hermetically sealed and rated a minimum of 0.5A at 120 VAC. The thermostats shall be set so that the temperature of the motor will not exceed the auto-ignition temperature for a Class I/ Division 1/ Group C and D location.
 - 5. Motors Installed in Class I/ Division 2 Hazardous Locations:
 - a. Motors shall be either explosion-proof (XP) rated for Class I/ Division 1/ Group C and D or Class I/ Division 2 Group C and D locations. Motors may be TEFC rated; however, TEFC motors used in hazardous areas shall be non-sparking type (brushless) and shall have non-sparking cooling fans. All motors shall meet the requirements of the National Electric Code and other safety codes pertaining thereto.
 - b. Motors shall include integral high temperature thermostats or similar device with a high temperature interlock to shut down the motor and auxiliary contact to activate an alarm condition.
 - c. Thermostats shall be normally closed, hermetically sealed and rated a minimum of 0.5A at 120 VAC. The thermostats shall be set so that the

temperature of the motor will not exceed the auto-ignition temperature for a Class I/ Division 2/ Group C and D location.

6. All motors shall be NEMA Premium Efficiency type. The nominal and/or minimum guaranteed efficiency shall be printed on the motor nameplate. The efficiency values shall conform to Energy Policy Act of 1992, unless exempted, and shall be as indicated in the following table:

Nominal Full Load Motor Efficiencies						
HP	Open Motors			Enclosed Motors		
	3600 rpm	1800 rpm	1200 rpm	3600 rpm	1800 rpm	1200 rpm
1	77.0*	85.5	82.5	77.0	85.5	82.5
1.5	84.0	86.5	86.5	84.0	86.5	87.5
2	85.5	86.5	87.5	85.5	86.5	88.5
3	85.5	89.5	88.5	86.5	89.5	89.5
5	86.5	89.5	89.5	88.5	89.5	89.5
7.5	88.5	91.0	90.2	89.5	91.7	91.0
10	89.5	91.7	91.7	90.2	91.7	91.0
15	90.2	93.0	91.7	91.0	92.4	91.7
20	91.0	93.0	92.4	91.0	93.0	91.7
25	91.7	93.6	93.0	91.7	93.6	93.0
30	91.7	94.1	93.6	91.7	93.6	93.0
40	92.4	94.1	94.1	92.4	94.1	94.1
50	93.0	94.5	94.1	93.0	94.5	94.1
60	93.6	95.0	94.5	93.6	95.0	94.5
75	93.6	95.0	94.5	93.6	95.4	94.5
100	93.6	95.4	95.0	94.1	95.4	95.0
125	94.1	95.4	95.0	95.0	95.4	95.0
150	94.1	95.8	95.4	95.0	95.8	95.8
200	95.0	95.8	95.4	95.4	96.2	95.8
250	95.0	95.8	95.4	95.8	96.2	95.8
300	95.4	95.8	95.4	95.8	96.2	95.8
350	95.4	95.8	95.4	95.8	96.2	95.8
400	95.8	95.8	95.8	95.8	96.2	95.8
450	95.8	96.2	96.2	95.8	96.2	95.8
500	95.8	96.2	96.2	95.8	96.2	95.8

F. General Design of Motors

1. Motors shall comply with the latest NEMA Standards for Motors and Generators, unless otherwise specified. Motors shall not run beyond nominal full speed rpm.
2. Motor windings shall be braced to withstand successfully the stresses resulting from the method of starting. The windings shall be treated thoroughly with acceptable insulating compound suitable for protection against moisture and slightly acid or alkaline conditions.
3. Bearings shall be of the self-lubricating type, designed to ensure proper alignment of rotor and shaft and to prevent leakage of lubricant.

4. Bearings for open motors shall be of the sleeve or ball type, as specified under the respective items of mechanical equipment. Bearings for totally enclosed and explosion-proof motors shall be of the ball type. The exception to this shall be belt-drive applications in which case the motor manufacturer shall determine if roller bearings are required in lieu of ball bearings due to higher radial loads.
5. Vertical motors shall be provided with thrust bearings adequate for all thrusts to which they can be subjected in operation.
6. Vertical motors of the open type shall be provided with drip hoods of acceptable shape and construction. When the drip hood is too heavy to be easily removed, provision shall be made for access for testing.
7. All motors installed above or within potable water storage tanks shall use food grade lubrication that is NSF approved.

G. Wound-Rotor Induction Motors

1. Wound-rotor motors shall be designed for operation of the motor-driven equipment under the conditions specified in the Detailed Specifications.
2. Motors shall be of the wound-rotor, induction type suitable for speed control by rotor resistance.
3. The collector rings shall be constructed of hard composition metal of sufficient conductivity and ample contact surface. The rings shall be mounted accurately and securely on the shaft by means of acceptable insulating construction. The leads to the collector rings shall be fastened to and insulated from the shaft in a suitable manner.
4. The collector rings and brushes for the wound-rotor induction motors shall be suitable for operation in an atmosphere containing moisture.
5. The brushes shall be of the electrographite type, or other suitable type, of sufficient hardness and conductivity and shall have ample contact surfaces. Brush holders shall be provided with adjustable, spring-tension devices. Brushes shall be connected to the holders with tinned, flexible, copper-wire pigtailed so arranged that no appreciable current shall be carried through the sliding contacts or springs. Brushes shall operate without noise or chattering. Rings and brushes shall be located on top of the motor, and shall be easily accessible for inspection and maintenance.

H. Synchronous Motors

1. Synchronous motors shall comply in all respects with the latest NEMA Standards for Motors and Generators, and AN Standard C50 for Rotating Electrical Machinery.
2. Synchronous motors shall be designed for operation of the motor-driven equipment under the conditions specified in the Detail Specifications.
3. The temperature rise (based on a cooling temperature not exceeding 40 deg. C. and an altitude not exceeding 3,300 ft.) in the various parts of the motors, when operating continuously at rated voltage, frequency, and power factor, shall conform to the applicable requirements of the above- mentioned NEMA Standards.
4. Synchronous motors shall be manufactured by General Electric Co., or be an equivalent product.

I. Single-Phase Motors with Auxiliary Devices

1. Single-phase motors requiring switching devices and auxiliary starting resistors, capacitors, or reactors shall be furnished as combination units with such auxiliaries either incorporated within the motor housings or housed in suitable enclosures mounted upon the motor frames. Each combination unit shall be mounted upon a single base and shall be provided with a single conduit box.
- J. Motor Terminal Boxes and Leads
1. Motors shall be furnished with oversize conduit terminal boxes to provide for making and housing the connections and with flexible leads of sufficient length to extend for a distance of not less than 4 inches beyond the face of the box. The size of cable terminals and conduit terminal box holes shall be as permitted by the Engineer. An acceptable type of solderless lug shall be furnished. Totally enclosed and explosion-proof motors shall have cast-iron terminal boxes.
- K. Special Motors
1. Hoists and other devices complying with special safety codes shall be furnished complete with their control equipment and with all accessories and safety devices for code-approved, safe, and efficient operation.
- L. Premium Efficiency Motors – “For Use with Variable Frequency Drives”
1. Motors other than inverter duty rated type which are used on variable frequency drive equipment shall have an insulation system that is inverter grade to meet NEMA MG1-2016, Class F insulation system with a Class B temperature rise at a 1.15 service factor. Motors shall be wound with inverter duty wire and shall be multi-dipped and baked in a polyester, Class H varnish.
 2. Nameplate on motor shall be stamped indicating motor is “Certified for Use with VFDs”.
 3. Motors of the sizes indicated below and operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge electrical shaft currents within the motor and/or its bearings to ground.
 - a. Motors between 25 HP and up to 100 HP shall be provided with a minimum of one shaft grounding ring installed either on the drive end or non-drive end.
 - b. Motors over 100 HP shall be provided with an insulated or hybrid bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or Contractor and shall be installed in accordance with the manufacturer’s recommendations.
 - c. Grounding rings may be external or internal to the motor for open drip proof motors (ODP), totally enclosed fan cooled (TEFC) and totally enclosed non-ventilated (TENV). Grounding rings shall be internal to the motor for all Class 1/ Division 1 and Class 1/ Division 2 motors. Grounding rings shall not interrupt or alter the motor design flame path.
 - d. Grounding rings shall be AEGIS or equal.
- M. Premium Efficiency Motors – “Inverter Duty Rated”

1. Inverter Duty Rated motors which are used on variable frequency drive equipment shall meet the following requirements:
 - a. Motor shall be suitable for operation over entire speed range indicated without causing motor overheating at any condition.
 - b. Forced ventilation type inverter duty rated motors with a separate external continuously operating fan shall not be acceptable.
 - c. Motors installed in Division 1 hazardous (classified) location shall be identified as acceptable for variable speed when used in Division 1 locations.
 - d. Motor shall have Class F insulation with a Class B temperature rise at a 1.0 service factor (non-sinewave power) and 40°C ambient conditions per NEMA MG1-2016.
 - e. Motor shall be wound with inverter duty wire and phase paper and shall be multi-dipped and baked in polyester, Class H varnish.
 - f. Nameplate on motor shall be stamped indicating motor is "Inverter Duty Rated".
 2. Motors of the sizes indicated below and operated on variable frequency drives shall be equipped with a maintenance free, conductive micro fiber, shaft grounding ring with a minimum of two rows of circumferential micro fibers to discharge electrical shaft currents within the motor and/or its bearings to ground.
 - a. Motors between 25 HP and up to 100 HP shall be provided with a minimum of one shaft grounding ring installed either on the drive end or non-drive end.
 - b. Motors over 100 HP shall be provided with an insulated or hybrid bearing on the non-drive end and a shaft grounding ring on the drive end of the motor. Grounding rings shall be provided and installed by the motor manufacturer or Contractor and shall be installed in accordance with the manufacturer's recommendations.
 - c. Grounding rings may be external or internal to the motor for open drip proof motors (ODP), totally enclosed fan cooled (TEFC) and totally enclosed non-ventilated (TENV). Grounding rings shall be internal to the motor for all Class 1/ Division 1 and Class 1/ Division 2 motors. Grounding rings shall not interrupt or alter the motor design flame path.
 - d. Grounding rings shall be AEGIS or equal.
- N. Submersible Motors
1. Motors which are rated for submersible use shall be of the highest efficiency in the industry for this type of motor and horsepower rating.
 2. When used in conjunction with variable frequency drive equipment, the submersible motor shall be rated for inverter duty with Class H insulation.

2.5 DRIVE COUPLINGS

- A. Couplings shall be all metal, flexible, designed for both angular and parallel misalignment, provided with a guard, and provided with a means for lubrication.
- B. Close-coupled connections shall have machined shouldered joints for motor and pump motor support.
- C. High torque couplings shall be all metal gear couplings with external grease fittings.

A service factor of 1.50 shall be used based on the motor nameplate rating.

- D. Drive couplings for mixers which differ from the above referenced all metal type, which are standard integral parts of a mixer manufacturer's assembly may be permitted, with review and approval of the Engineer.

2.6 BELT DRIVES

- A. V-belt drives shall be provided with front removable guards (refer to Section 2.12), not requiring disturbing of the sheaves.
- B. Capable of upsize and downsize sheaving.
- C. Design shall be based upon minimum 1.5 service factor, unless specified elsewhere.

2.7 MECHANICAL-TYPE VARIABLE-SPEED DRIVE UNITS: (WHEN APPLICABLE)

- A. Type as specified in equipment specification sections and as shown on the Drawings.
- B. The variable-speed transmission shall be a self-contained drive which shall consist of a totally enclosed constant-speed motor, a housing on which the motor is mounted and which encloses an adjustable, heavy duty V-belt drive between two variable-pitch pulleys and the output shaft.

2.8 GEAR REDUCTION UNITS

- A. Gears of gear reduction units shall be made of highest quality alloys treated for hardness and severe service. All gear reduction units on equipment shall be selected for Class II or more severe service as classified by the American Gear Manufacturers Association.
- B. Unless otherwise specified, the complete reduction unit shall be fully enclosed in a heavy cast-iron or fabricated steel housing with gears running in oil. All bearings shall be of the anti-friction type.
- C. The actual and rated horsepower, torque, overhang capacity, or bearing capacity of each reduction unit shall be not less than the horsepower rating of the drive motor, nor less than that which will be encountered under full load or under the most severe loading conditions of the equipment. The Engineer may reject any gear reduction unit that does not meet the above requirements. The manufacturer of gear reduction units shall be long established with a good reputation.
- D. Unless otherwise specified, all gear reduction units shall be helical or spiral bevel helical combinations. The planetary gear units and worm gear type units may be used only where specified. Class of service shall be Class II or heavier, as determined by the manufacturer or as directed by the Engineer.
- E. The equipment manufacturer shall furnish the Engineer with complete engineering information, catalog data, design features, loading capacities, and mechanical efficiency ratings for every gear reduction unit incorporated in the work.

2.9 LUBRICATION FITTINGS

- A. All lubrication fittings shall be brought to locations that are readily accessible to operators from normal operating walkways or platforms. Equipment lubrication fittings shall be extended to outside of all equipment so that they are readily accessible from the outside without the necessity of removing covers, plates, housings, or guards, floor plating or other obstruction, and to eliminate creating falling hazards by unusual elevations. Fittings shall be buttonhead type. Lubrication fittings shall be

- mounted together wherever possible.
- B. Pressure grease-lubricated fittings shall be the "Zerk Hydraulic" type or the "Alemite" type.
 - C. Housings of grease-lubricated bearings shall be automatically exhausted to the atmosphere to prevent excessive greasing.
 - D. Oil drains shall be piped to a location outside the equipment frame for ease of draining. Provide ball valve for positive shutoff. Pipe shall be type-L copper or galvanized steel.

2.10 SPARE PARTS AND SPECIAL TOOLS

- A. For each type of equipment furnished, the Contractor shall provide spare parts, as specified on the respective sections of the Division, and a complete set of all special tools (including grease guns or other lubricating devices) which may be necessary for the adjustment, operation, maintenance, and disassembly of such equipment.
- B. Tools shall be high-grade, smooth, forged, alloy, tool steel. Grease guns shall be lever type.
- C. Special tools are considered to be those tools which because of their limited use are not normally available, but which are necessary for the particular equipment.
- D. All spare parts and special tools shall be delivered at the same time as the equipment to which they pertain. The Contractor shall properly store and safeguard such spare parts and special tools until completion of the work, at which time they shall be delivered to the Owner.
- E. Spare parts shall be appropriately labeled and containerized, and shall be properly packaged for long-term storage.
- F. If the Contractor utilizes a spare part to remedy an issue during the Contract work (through Final Completion) they shall replace the spare part at no additional cost to the Owner.

2.11 EQUIPMENT DRIVE GUARDS

- A. All equipment driven by open shafts, belts, chains, or gears shall be provided with all-metal or rigid fiberglass OSHA approved guards enclosing the drive mechanism. Guards shall be securely installed but shall be removable with quick open latches.
- B. Guards shall be constructed of galvanized sheet steel or galvanized woven wire or expanded metal set in a frame of galvanized steel members, unless otherwise specified.
- C. Guards shall be secured in position by steel braces or straps which will permit easy removal for servicing the equipment.
- D. The guards shall conform in all respects to all applicable safety codes and regulations.

2.12 PROTECTION AGAINST ELECTROLYSIS

- A. Where dissimilar metals are used in conjunction with each other, suitable insulation shall be provided between adjoining surfaces so as to eliminate direct contact and any resultant electrolysis.
- B. The insulation shall be bituminous impregnated felt, heavy bituminous coatings, nonmetallic separators or washers, or other acceptable materials.

2.13 NAMEPLATES

- A. Each piece of equipment shall be provided with a substantial nameplate of noncorrodible metal, securely fastened in place and clearly and permanently inscribed with the manufacturer's name, model or type designation, serial number, principal rated capacities, electrical or other power characteristics, and similar information as appropriate.
- B. An enlarged paper copy of all the nameplate data on equipment and motors shall be provided in the Shop Drawings and Operation and Maintenance Manuals.

2.14 SURFACE PREPARATION AND SHOP COATINGS

- A. Provide surface preparation and shop coatings in accordance with Specification Section 09905.

2.15 ELECTRICAL CONTROLS

- A. Additional controls for various items of equipment are specified under Division 13 and/or Division 16, as indicated on the Drawings, and as specified. Due to potential differences in electrical requirements for equipment of various manufacturers, the Contractor shall coordinate the electrical requirements of the equipment supplied with the work specified in Division 13 and/or Division 16.
- B. Provide auxiliary contacts as required for remote status and alarm conditions. Contractor shall coordinate each piece of equipment. Refer to the Electrical and Instrumentation Drawings.
- C. Electrical controls for all equipment shall comply with the requirements of Division 16 and the National Electric Code, including provisions to allow each piece of equipment to be locked out/tagged out for maintenance or repairs.
- D. Control panels shall be constructed in conformance with UL 508A and bear the UL 508A seal confirming the construction. UL inspection and seal application can be accomplished at the panel fabrication facility or by field inspection by UL inspectors. Obtaining the UL seal and any inspections shall be provided at no additional cost to the Owner.

2.16 EQUIPMENT AND VALVE IDENTIFICATION TAGS

- A. All new process equipment and valves shall be identified by a color-coded identification valve tag provided and installed by the Contractor. The tags shall be provided with identifying numbers and letters to match those as shown on the Drawings. Contractor shall submit a complete list of proposed Identification Tag information and it shall be reviewed/confirmed with the Engineer and Owner through the submittal process prior to ordering any tags. In general, tag information shall match the information provided on the Drawings.
- B. All identification tags shall be provided with sufficient lengths of chain for attachment to the respective equipment and/or valve.
- C. Tags shall conform to the following specifications:
 - 1. The tags shall be 2.5-inch diameter, 1/16" thick, rigid, multi-layered sandwich laminate with contrasting inner and outer colored acrylic plastic layers. Top hole size is 5/32" for hanging tags.

2. Tags shall be available in 7 different outside colors. Owner and Engineer shall select up to 4 different colors for the project.
3. Tags shall have up to three lines engraved on a side and eight characters per line of identification information. Tags shall be engraved one side.
4. Tags shall be secured to valves with nylon cable ties or adjustable metal bead chain. Securing method shall be selected by the Owner and Engineer.
5. Tags secured to equipment shall be fastened to a flat visible surface by a minimum of two SS screws or SS pop rivets.
6. Tags shall have a service temperature of -40°F to 175°F
7. Manufactured by Seton Name Plate Corporation, New Haven, CT, Brimar Industries, Garfield, NJ or equal.

PART 3 - EXECUTION

3.1 EXAMINATION

- A. Contractor shall carefully inspect receiving structures and anchor supports for defects in workmanship prior to equipment arrival.
- B. Contractor shall carefully inspect all equipment for:
 1. Damage in shipping.
 2. Defects in workmanship and materials.
 3. Tightness of all nuts and bolts.
- C. Inspection shall include, but not be limited to, the following as applicable:
 1. Soundness (without cracked or damaged parts).
 2. Correctness of setting, alignment, and relative arrangement of various parts.
 3. Adequacy and correctness of packing, sealing and lubricants.
 4. Completeness in all details, as specified.
- D. Field Quality Control
 1. As part of the equipment cost, the Contractor shall provide the services of a duly authorized Manufacturer's representative to assist the Contractor with equipment adjustment, start-up, and necessary testing to prove that the equipment is in proper and satisfactory operating condition.
 2. On completion of the work, the Manufacturer's representative shall provide written certification that the equipment conforms to the requirements of the Contract and is ready for permanent operation and that nothing in the installation will render the manufacturer's warranty null and void, as outlined in the attached equipment certification form.
 3. As part of the startup services, the Manufacturer's representative shall provide the Owner's personnel with training in the proper operation and maintenance of all associated equipment. The equipment training certification form shall be used for this purpose.
 4. When the work is substantially complete the Contractor will be required to demonstrate, to the satisfaction of the Engineer, the ability of all equipment to operate as intended without defect including binding, vibration, jamming, overheating, etc.
 5. All equipment shall meet the Commissioning and/or Acceptance Testing Specifications and Tolerances for Rotating Equipment.

6. All equipment found defective by the Engineer shall be replaced by the Contractor at no expense to the Owner.
7. The cost of any retesting by Owner's independent inspector, required because of defective equipment, shall be borne by the Contractor.

3.2 PREPARATION

- A. Provide all required adhesives, sealants, insulation, lubricants, waterproofing, fireproofing or other protection specified in each Section of this Division.

3.3 INSTALLATION

- A. Contractor shall install equipment in accordance with Manufacturer's requirement. Manufacturer(s) shall work with the Contractor to ensure that the equipment has been properly installed.
- B. Do not install equipment until all defects or inadequacies in receiving structure have been corrected to meet Specifications.
- C. Erect and lubricate equipment in strict accordance with the manufacturer's instruction. Installation shall include all oil and grease required for proper operation.
- D. All equipment mechanisms shall withstand all stresses that may occur during fabrication, erection, and intermittent or continuous operation.
- E. Contractor to furnish and install supports as indicated on the Drawings, and as required by the equipment manufacturer.
- F. Thoroughly clean all equipment and appurtenant piping to remove all dirt, grease, mill scale, and other foreign matter and touch up factory finish to the satisfaction of the Engineer.

3.4 STARTUP AND TESTING

- A. Test and adjust all equipment in accordance with the general requirements of Specification Section 01800, and the specific requirements of the various Division 11 Specification Sections.
- B. Demonstrate the equipment's ability to operate without overloading jamming, excessive vibration, etc. during normal operation conditions.
- C. Demonstrate the equipment's ability to meet all the performance requirements specified for the equipment system to make a complete operational system, suited for its intended use.

3.5 EXISTING EQUIPMENT RELOCATION

- A. All relocated equipment shall be reconditioned and serviced prior to operation in the new locations. Equipment shall be cleaned, rust removed, re-primed and painted in accordance with Section 09900, balanced, lubricated, oiled, calibrated and properly wired and plumbed to provide the intended service. Start-up of relocated equipment shall be done in accordance with the manufacturer's instructions.

END OF SECTION

SECTION 11361BPOWER SCUM SKIMMER SYSTEMPART 1 - GENERAL1.1 DESCRIPTION

- A. Work Included: Furnish, install and field test a complete power scum skimmer collection system in Primary Sedimentation Basin 1 (3-bays) at the Mattabassett District located in Cromwell Connecticut including the following for each bay:
1. Drive and Collector Chains,
 2. Flights with wearing shoes, filler block and flight floor squeegee
 3. Sprockets,
 4. Head shafts and stub shafts,
 5. Mounting and retainer plates
 6. Drive Units
 7. Stainless steel scum trough and beach plate
 8. Mounting brackets as shown on drawings
 9. And all other appurtenances necessary to make the system complete and operable as specified herein and as shown on the Drawings.

The system shall be controlled as indicated on the Electrical and Instrumentation Drawings, and in Specification Section 13 and Division 16.

- B. Related Work Specified Elsewhere:
1. Additional requirements are specified in Sections 01800 and 11000.
 2. Surface preparation and shop coatings are specified in Section 09905.
 3. Field painting is specified in Section 09900.
 4. Instrumentation and Control is specified in Division 13.
 5. Electrical is specified in Division 16.

1.2 QUALITY ASSURANCE

- A. In accordance with the requirements of Section 11000.
- B. All equipment specified in this section shall be furnished by the manufacturer of the power scum skimmer system, except when otherwise specified. This does not require that all equipment be manufactured by a single manufacturer, but does require that the manufacturer of the power scum skimming system be responsible for the manufacture and satisfactory operation of the power scum skimming system specified herein. Refer to Specification Section 01800 regarding manufacturer's certification of the installation.
- C. The power scum skimmer system shall be designed, fabricated and assembled in accordance with the best engineering and shop practices. Individual parts shall be manufactured to standard sizes and gauges. Components of the power scum skimmer system shall be designed for the stresses that may occur during fabrication, shipping, erection or maintenance. Materials shall be suitable for service conditions and as described herein.

- D. Coordination: The power scum skimmer equipment vendor shall review the existing structures and provide the Contractor with any additional modifications required for the installation of the equipment. This coordination shall include location of any bond outs or insets in walls and slabs to facilitate installation of the equipment. Equipment vendor shall also provide anchor bolts and anchor bolt location templates for clarifier equipment to the Contractor for correct installation of cast-in-place concrete.
- E. Acceptable Manufacturers:
 - 1. Brentwood Industries, Inc., Polychem Brand Reading, PA
 - 2. No Equal

1.3 SUBMITTALS

- A. In accordance with the requirements specified in Section 01340 and 11000. Submit such shop drawings, manufacturer's literature, short-term and long-term storage requirements, and operations and maintenance manuals.
- B. Additional specific information required for submittal is listed below.
 - 1. Certified shop and erection drawings showing all important details of construction, dimensions and anchor bolt locations.
 - 2. Descriptive literature, bulletins and catalogs of the equipment.
 - 3. A complete total bill of materials.
 - 4. The total weight of the equipment including the weight of the single largest component.
 - 5. Documentation of the AGMA rating of the drive assembly, including gear tooth quality.
 - 6. Selection of gear driver, including criteria.
 - 7. Certified design chain pull of the drive and collector chains, including determination of working loads.
 - 8. A complete description of surface preparation and shop prime painting for any metal components.
 - 9. Certification that the equipment conforms to the design criteria specified herein.
 - 10. Submit certified copies of proof load, accelerated wear and flight strength tests performed by the manufacturer of the collector chain, as specified herein.
 - 11. List of the manufacturer's recommended spare parts, include gaskets, seals, etc. on the list. Submit the manufacturers recommended summer and winter grades of lubricants along with alternative references to equal products of other manufacturers.
 - 12. Factory test reports
 - 13. Field start-up test plan
 - 14. Field start-up and test reports

1.4 DELIVERY, STORAGE, AND HANDLING

- A. In accordance with the requirements of Section 11000. Manufacturer shall deliver equipment to the project site where and when directed by the Contractor.

1.5 WARRANTY

- A. In accordance with the requirements of Section 11000.
- B. Submit written warranty as required in Section 11000. Submit copies of the

warranties during shop drawing submittals for review and comment. All extended warranties shall go into effect when the equipment has passed the on-site installed tests. Approval of the Contractors one year warranty and the manufacturers warranties are required prior to issuing Substantial Completion. All warranties shall include the costs of the materials shipping both ways and installation labor. All standard and extended warranties longer than the one-year standard warranty period shall be issued to, and in the name of, the Owner.

- C. The Manufacturer shall warranty for one-year from the date of Substantial Completion, the equipment from all manufacturing defects, and/or structural failures. Any defects occurring within the first year period shall be repaired or replaced at no additional cost to the Owner within 14 working days after notification. Motor and gearbox warranty will be limited to the original manufacturer's warranty beyond the one year contract warranty.

PART 2 - PRODUCTS

2.1 GENERAL

- A. Sedimentation Basin No. 1 consists of three bays and each bay shall consist of a power scum skimming system driven by a dedicated motor.
- B. The scum collection equipment shall move the floating material from the water surface in each bay along the scum beach plate and onto the 16-inch diameter scum trough as shown on the Drawings.
- C. The dimensions of the sedimentation basins are as shown on the Drawings. The Contractor shall field verify all final dimensions and elevations including side tolerances and shall certify in writing prior as part of the shop drawing submittal.
- D. The equipment to be supplied, installed, and tested include Drive and Collector Chains, Flights with wearing shoes, filler block and flight floor squeegee; Sprockets, Head shafts and stub shafts; Mounting and retainer plates; Drive Units; Stainless steel scum trough and beach plate; Mounting brackets all other appurtenances, attachment bolts and anchor bolts, spare parts and special tools necessary to make the system complete and operable as specified herein and as shown on the Drawings.
- E. The power scum skimming system supplied shall, in part, include nonmetallic parts as specified.
- F. The chain and flight driving mechanism shall be driven by constant speed rated motors rated for Class 1, Division 1 environment and rated for hazardous duty.
- G. The speed of the flights shall be no greater that from 1 to 3 feet per minute.
- H. The power scum skimming system shall also allow operation of the chain and flight system on an On-Off mode of operation (5 minutes On, 15 minutes Off) as determined through the PLC/SCADA system.
- I. The power scum skimming system supplied shall be of the design that allows operation under dry tank conditions.
- J. Flight spacing shall be 5-foot maximum.
- K. All parts of the equipment shall be amply proportioned for long, continuous, and uninterrupted service. Wherever strengths of materials are indicated, these are to be considered minimums. Supplier shall provide strength of materials as required for the service intended, but never less than the minimum indicated.
- L. Provision shall be made for easy access for service or replacement of parts.

- M. Corresponding parts of multiple units shall be interchangeable.
- N. Workmanship shall be first class in all respects.
- O. Gears shall have endurance and strength ratings of 1,000,000 cycles.
- P. All antifriction bearings shall have a L-10 life rating of not less than 17,000 hour, except for the lower bearing of the pinion shaft and the bearing on the drive end of the worm shaft, if required, which shall have a life of 100,000 hour.
- Q. All components of the equipment shall be fully compatible with expected wet corrosive environmental (H₂S concentrations up to 100 ppm) and be designed for extended service.
- R. The collector components shall be based upon the following design criteria:
 - 1. Operation under wet and dry tank conditions.
 - 2. Friction factor: Nonmetallic on Nonmetallic: 0.08 to 0.30
Nonmetallic on Dry Steel: 0.25
 - 3. Bearing friction - 0.05 to 0.20 per shaft assembly.
 - 4. Shaft deflection - not to exceed 0.033 inch per foot of shaft length.
 - 5. Flight deflection - not to exceed 5/8-in, measured at mid-span.
 - 6. Where not specified, design criteria shall be in conformance with accepted industry standards and shall be subject to approval by Engineer.
- S. All components shall be able to operate uninterrupted under all temperature conditions. Cold weather provisions, such as chain guard, shall be provided to prevent icing of the drive chains and/or gears which may cause the drive clutch slip alarm to trip. Guard cover shall be constructed of corrosive resistant materials such as 316 Stainless Steel or Fiberglass.

2.2 CHAINS

- A. Collector chain shall be NCS720S non-metallic type having 6-inch pitch links with an average weight of 1.3 lbs/ft. The chain shall have a minimum catalog working load of 2,600 lbs. based on strength, fatigue, and wear considerations, and a minimum ultimate strength of 6,500 lbs. The chain strands shall have an elongation of not more than 6 percent at ultimate strength. Chain links shall be manufactured from unfilled acetyl resin or glass reinforced thermoplastic and shall be integrally molded with the barrel and both side bars formed in one piece to assure squareness and strength of the links. Chain links formed by welding two halves together shall not be acceptable. Chain links shall have a minimum ultimate strength of 6,500 pounds. Provide certified ultimate strength test results, based upon a minimum of 3 chain lengths. All chains shall be completely resistant to ultraviolet degradation.
- B. Connecting pins shall be non-metallic a minimum of 0.86 inch diameter, molded in one piece, from reinforced nylon resin or acetal resin. Pins shall have a molded T-head which seats and locks inside molded chain links to prevent rotation. The pins shall positively lock when chain is assembled.
- C. Except as otherwise specified, steel plates and shapes shall have a minimum thickness of 1/4 inch and bolts a minimum diameter of 1/2 inch.
- D. The power scum skimming system manufacturer, as part of the shop drawing submittal process, shall include certified documentation that the chain they propose to furnish is proof load tested to 5000 pounds as quality assurance procedure during manufacture.

2.3 FIBERGLASS FLIGHTS

- A. The longitudinal flights shall be fiberglass reinforced isophthalic polyester resin, 3-in by 8-inch size, especially designed for scum collector service. The flights shall be constructed by the pultrusion method to ensure complete encapsulation of the glass fiber strands in the resin. The glass filaments and mat shall run the full length of the flight. The full member shall have 45 percent minimum glass by weight in compliance with ASTM D638. The resin shall contain protection against degradation by ultraviolet light. The use of extenders in the resin is prohibited. At the attachment to the collector chain links, the flights shall have a plastic filler block. Flights shall be attached to the filler block by four 3/8-in diameter stainless steel bolts. Flights shall not be buoyant and shall not incorporate weights.
- B. FRP flights shall be a composite construction. The flights shall have a maximum water absorption not exceeding 0.5 percent. The finished composite shall have a minimum tensile strength as follows: Longitudinal 38,000 PSI, Transverse 7,000 PSI, as measured in accordance with ASTM D638.
- C. The structural characteristics of the flights shall exhibit a Moment of Inertia (I) of not less than 3.57 in⁴ about its minor axis and 19.15 in⁴ about its major axis. Submit certified test results that the flights do not deflect more than 1/125 with a 3 pound per foot loading on the flight.
- D. All bolts, nuts, washers and related hardware used to attach flights and wear shoes shall be a minimum of 3/8-in Type 316 stainless steel.
- E. Flight spacing shall be 5-ft for scum collectors shall cover the full width of the tanks (Refer Contractor Drawings for layout). For areas not covered by the flights a baffle plate shall be provided to push the scum towards the flight path.
- F. All attachment hardware shall be 316 Stainless Steel.
- G. All flights shall be equipped with neoprene squeegee assemblies. Each floor squeegee assembly shall consist of 3/16 inch thick x 4 inch wide Neoprene material slotted at a maximum of 12 inch centers, 1/4 inch x 3 inch wide FRP backing plate, and 316 SS hardware. Slotted neoprene shall allow for depth adjustment of the squeegee assembly. The neoprene squeegees shall extend below the lowest elevation of the beach plate for complete scum capture.

2.4 COLLECTOR CHAIN SPROCKETS

- A. Sprockets for the collector chain shall be molded totally of polyurethane, or Polychem Cast Nylon 6, having a water absorption rate not to exceed 1.3 percent at saturation in accordance with ASTM D570. The sprockets shall be of split construction and shall have the double life tooth profile compatible with non-metallic chain. The sprocket halves shall be assembled on the shafting by Type 316 stainless steel bolts and hardware designed to draw the sprocket halves tight to the shaft and maintain lateral alignment. All sprockets shall be designed to operate with the specified chain. Collector sprockets shall be of the extended life type.
- B. Headshaft sprockets shall not be less than 22.23 inch pitch diameter and have 23 teeth. Cornershaft sprockets shall not be less than 16.61 inch pitch diameter and have 17 teeth. The driven and headshaft sprockets shall be keyed firmly to the end of the headshaft. The cornershaft sprockets shall rotate freely on bearing sleeves clamped to the stub shafts.

2.5 DRIVEN SPROCKET

- A. Non-metallic NH-78 driven (bull) sprockets manufactured of Cast Nylon are acceptable.

2.6 DRIVER SPROCKET

- A. Non-metallic drive sprockets manufactured by Polychem Celeron are acceptable.

2.7 DRIVE CHAIN

- A. Non-metallic NH-78 drive chain, 2.609" pitch links manufactured of glass-reinforced nylon utilizing a 304 stainless steel pin, with a minimum working load of 1,740 lbs shall be acceptable.

2.8 ALARM TRIP

- A. A clutch ball detent type, 316 SS torque limiter will be provided to protect the drives in case of a failure and in turn, shall shut off the motor and energize the alarm circuit.
- B. Designation of clutch ball detent switch is show on Instrumentation Drawings The alarm condition shall be monitored by the SCADA System via input to PLC-GBCP and as detailed in Section 13440.

2.9 SHAFTING

- A. All shafting shall be bi-axially wrapped fiberglass head shaft assemblies and idler sprocket stub shafts assemblies manufactured of Cast Nylon.
- B. The mounting plate for the head shaft and idler stub shaft shall be 304SS.
- C. The retainer plate for stub shaft shall be made of polycarbonate.
- D. Wall mounted support system fabricated from stainless steel to allow for proper location of the head shaft and idler shafts shall be provided by the manufacturer and installed by the Contractor as shown in the drawings.
- E. Alum braces at locations shown on the Drawings shall be provided and installed by the Contractor under each shaft locations for Bay A of Sedimentation Basin 1.

2.10 BEARINGS

- A. All bushings shall be manufactured from UHMW material. The bushing length shall be a minimum of 3 ¾ inch for rotating head shafts.

2.11 CHAIN AND FLIGHT DRIVES

- A. The scum skimmer system shall be driven by electric motor drives as indicated on the Drawings and as specified herein and in Section 11000. Each scum collector skimmer system in a bay shall be driven by one motor/drive(total 3 drives). The chain and flight driving mechanism on the scum skimmer system shall be constant speed rated and will allow flight speeds of no more than from 1 to 3 feet per minute.
- B. The main drive unit with motor shall be rated at a minimum of ½ HP, Class I, Div. I, Group D rated, constant speed motor, and of ample power for starting and continuously operating the mechanism under normal operating conditions (over the entire operating speed range) without overloading. The motor shall comply with NEMA standards and shall be nameplated for operation at 230/460 volts, 3 phase,

- 60 Hertz.
- C. The motor shall be directly connected to the speed reducer and mounted as a common unit. V-belt drives will not be acceptable.
 - D. The drive speed reducer shall be of the helical gear right angle type or in-line type conforming to all applicable requirements of the AGMA Standards, and shall be designed with a service factor of 1.5 based upon calculated motor horsepower. Gears shall run in an oil bath with anti-friction bearings throughout. The drive units shall be assembled by the manufacturer and shipped as a complete assembly to ensure proper assembly of all components. The unit shall be mounted directly on the concrete. Required recesses, corbels, and cornerfills shall be as determined by the manufacturer.
 - E. The drive chain shall be tensioned by a sliding base plate.
 - F. The drive chain and sprockets located above the operating platform shall be covered with a removable metal guard of No. 16 gauge type 304 stainless steel, with mounting gasket and seals to minimize leakage of odorous air.
 - G. A 304 Stainless Steel base plate shall be provided for drive unit mounting.
 - H. Contractor to orient drive to facilitate plant staff maintenance of the drive from outside the tank.

2.12 SCUM TROUGH AND BEACH PLATE:

- A. Contractor to field survey elevation of the existing scum tube and existing pipe sleeve prior to demolition work. Contractor shall immediately notify engineer if field survey elevations differ from elevations shown on the contract drawings. Contractor shall match the invert elevation of the new scum trough with the invert elevation of the new sleeves. The existing invert elevations are shown on the drawings.
- B. Contractor shall coordinate with the manufacturer and locate the scum trough such that it will not allow wastewater to enter the scum trough at peak wet weather events (as shown in Contract drawings – Condition No.1).
- C. A beach plate, spanning the width of the tank in each bay shall be furnished and connected to new 16-diameter trough, as shown on the contract drawings.
- D. The beach plate and trough shall be supplied by the manufacturer and shall be made of 316 SS.
- E. The beach plate and trough shall be ¼” thick.
- F. Beach plates and troughs shall be furnished with supports and gaskets as required by design and shall be supplied by the manufacturer.
- G. Beach plate shall be angled and designed so that flights can positively push the scum up the plate and into a trough for removal as shown on the contract drawings.
- H. The beach plate will also incorporate an angled side to account for offset of the driven sprocket.
- I. Provide neoprene gasket between basin bay walls and beach plate to minimize leakage.

2.13 SURFACE PREPARATION AND SHOP COATINGS

- A. In accordance with the requirements of Section 09905 and 11000.

2.14 SPARE PARTS AND SPECIAL TOOLS

- A. In accordance with the requirements of Section 11000.
- B. Provide the following spare parts:
 - 1. 20 feet of drive chain
 - 2. 10% of all collector chain furnished
 - 3. 10% of all chain-to-flight attachment links furnished
 - 4. 5 longitudinal flights complete with wear shoes, filler blocks and hardware
 - 5. 1 replacement 11 T drive sprocket (sprocket plate only)
- C. In addition to the spare parts listed above, provide a list of all available spare and replacement parts, including a price for each. These prices shall hold firm for the Owner for the period of at least one year after installation.

PART 3 - EXECUTION

3.1 EXAMINATION, PREPARATION AND INSTALLATION

- A. In accordance with the requirements of Section 11000 and the manufacturer's written instructions.

3.2 START-UP AND TESTING

- A. In accordance with Specification Sections 01800 and 11000.
- B. After installation of the equipment, after adjustments by Manufacturer's representative, and prior to running the equipment, the Contractor shall torque test each unit to demonstrate that the overload shutdowns occur as specified.
- C. Dry-Run Testing and Inspection
 - 1. Operate equipment in an empty tank ("dry-run test") for a minimum of 4 hours to demonstrate proper installation, alignment, and flight travel speed.
 - 2. Immediately following the dry-run test, a dry-run inspection will be completed by the Engineer and Manufacturer's Representative.
 - 3. Upon satisfactory completion of each dry-run test and dry-run inspection, as determined by the Engineer and Owner, Contractor may request permission to fill the primary basin and proceed to wet-run testing.
- D. Wet-Run Testing
 - 1. Once authorized by Engineer and Owner, the Contractor shall fill the primary basin (with plant water) and operate the equipment for at least 2 continuous days during normal working hours to demonstrate its ability to operate without vibration, jamming or overheating and to perform as specified. Record drive motor amperages during this operation.
- E. After completion of both wet and dry tests, Contractor shall fill the tank with wastewater and demonstrate the power skimmer's ability to effectively remove scum for liquid level elevations EL 30.37 (Condition III) as shown in the contract drawings.

3.3 CLEANING AND FIELD COATINGS

- A. In accordance with the requirements of Section 09900 and 11000.

3.4 TRAINING AND WARRANTY PERIOD SUPPORT

- A. In accordance with the requirements of Section 01800.
- B. Provide a minimum of one 8-hour days, separate from start-up time, to instruct Owner's personnel on operation and maintenance of the equipment, including all mechanical and controls aspects, and review of the provided Operation and Maintenance Manual.

END OF SECTION

SECTION 13410

INSTRUMENTATION AND PROCESS CONTROL GENERAL

PART 1 - GENERAL

1.1 DESCRIPTION

A. General Requirements and Definitions:

1. A single System Integrator (SI) shall furnish all services and equipment as specified herein and in the following Specification sections:

<u>Section</u>	<u>Title</u>
13441	Control Narratives
13442	Programmable Logic Controllers
13444	Control Panels
13445	Communications Network
13460	Fiber Optic Cabling

2. The System Integrator (SI) provide all labor, materials, equipment, operations, methods and procedures as indicated in the Contract Documents to achieve a fully integrated and operational system.
3. The System Integrator Shall also act as the Application Engineering System Supplier(AESS)
4. All systems indicated in the Contract Documents shall mean all necessary supervision, labor, equipment and materials required to provide complete, properly integrated systems.
5. All systems shall be adjusted, tested, inspected and optimized to the satisfaction of the Engineer and Owner prior to being turned over to the Owner.
6. The words "provide", "supply", "supply and install", "install", "furnish" or "furnish and install" shall mean a complete and properly functioning hardware installation performed by the System Integrator unless otherwise noted. The System Integrator shall design and coordinate the Instrumentation & Process Control system for proper operation with related equipment, materials, and labor furnished by others under other sections of these Specifications and with related existing equipment.
7. Refer to Process, Instrumentation, and Electrical Drawings to coordinate material and equipment locations. Refer to the Process Drawings for locations and connection to primary instrumentation, and process equipment. Refer to the Electrical Drawings for the location of transmitters, control stations, motor drives and centers, control panels, wiring diagrams, network, and computer equipment.

B. Work Included:

1. Refer to Paragraph 1.1.A.1 for list of specifications.
2. Equipment Control:
 - a. Provide PLC programming, SCADA programming, and network configuration for equipment control or connection to control, status indication and alarm annunciation of equipment as shown in the

- Instrumentation Drawings, and described in Section 13441 – Control Loop Descriptions.
3. Application Development: Refer to Section 13441
 4. Meetings:
 - a. The SI shall attend a Pre-Instrumentation meeting with the Contractor, Engineer, and others prior to the submission of any specifications.
 - b. The SI shall attend construction meetings as necessary to coordinate construction sequencing.
 - c. The Contractor, SI, and Engineer shall attend a separate construction meeting shall be dedicated specifically for SCADA Testing to include types of test, responsibility and requirements, scheduling, coordination, verification of test results prior to witness testing by the Engineer/Owner, and testing notification requirements.
 5. Miscellaneous:
 - a. Furnish and install all transducers, media converters, protocol converters, terminals, transformers, interposing or pilot relays (for both new and existing equipment), signal transmitters, signal splitters/boosters, intrinsic safety barriers, power supplies, power supply connections and other miscellaneous instrumentation required to make a complete system for new and existing equipment.
 - b. Furnish and install all vendor or manufacturer cables and appurtenances between primary instruments and the transmitters, receiving instruments or destination terminals. All methods, materials and supplies will meet the requirements of Division 16.
 - c. Furnish mounting hardware for each instrument. The System Integrator will provide information on the proper installation in accordance with the Manufacturer's requirements for each instrument and shall supervise the installation. Tubing, process taps and an isolation valve will be provided under Mechanical in Division 11 and 15. Coordinate the size and type of connection required. Refer to the Instrument Installation Detail Drawing in the Contract.
 6. O&M Documentation:
 - a. Provide complete O&M documentation as listed under paragraph 1.4 and other related Division 13 specifications.
 7. Demolition:
 - a. Remove and/or relocate existing equipment as indicated on the Drawings.
 - b. Deliver PLC, OIT, and communications equipment not reused to Owner.
 8. Coordination:
 - a. Process Instrumentation and Process Control Systems will be provided under Division 11, where specified. The System Integrator shall coordinate with the instrumentation and control systems provided under these sections.
 - c. Conduit and wiring (excluding integral or vendor furnished cables and fiber optics) shall be provided and tested under Division 16 and as shown on the Electrical Drawings.

- d. The SI shall provide the drawings as specified in Section 13444 to be used by the Electrical Contractor as a wiring aid.
 - e. The SI shall coordinate with the Electrical Contractor to update all ISA S5.4 or equivalent loop diagrams with actual terminal and wire label information as required.
 - f. Provide manufacturer recommended installation and mounting requirements for each instrument to be connected to process equipment, piping or fittings requiring a process connection such as NPT taps, sample piping and process line insertion. The System Integrator will supervise and provide guidance on proper installation of instrumentation equipment. This shall include manufacturer's recommended mounting installation heights and locations for gas detection sensors, clearances for level sensors per manufacturer's blanking distance, etc.
 - g. The System Integrator shall coordinate with Division 11 control panel manufacturers in establishing network communications as required on the Drawings, and the signals required in Section 13441.
 - h. If the Division 11 provided PLC's communication protocol does not match that of the PLC being provided by the Division 13 System Integrator, the System Integrator shall provide a protocol converter as specified in Section 13445. The System Integrator shall provide communication parameters and network addresses to the Division 11 control panel manufacturer. The Division 11 control panel manufacturer shall coordinate communication and programming requirements with the Division 13 System Integrator prior to programming effort. Any programming and network configuration changes shall be done to provide network communication shall be provided at no cost to the Engineer and Owner.
- C. Related Work Specified Elsewhere:
- 1. Coordination is specified in Division 1.
 - 2. Manufacturer's control systems for process equipment are specified in Division 11.
 - 3. Electrical Systems are specified in Division 16.
- D. Related Work by Others under this Contract:
- 1. Local control stations (including E-stops, local hand switches, speed pots, and local indicating lights) and equipment control panels (i.e. MCCs,), indicated on Electrical Drawings.
- E. Demonstration of Complete Instrumentation and Process Control System:
- 1. The Owner will assume no liability or responsibility for any portions of the installation under this Contract until they are demonstrated by the Contractor and accepted by the Engineer in writing. Final demonstrations shall be made only after the Engineer is satisfied that the work has been completed in accordance with the intent of the Contract Documents.
 - 2. After the Instrumentation and Process Control System is completed, and when directed by the Engineer, demonstrate the total system operation and make final adjustments to the system. If any system or piece of equipment within a system

- fails to function properly, rectify such defects or inadequacies and make a final demonstration as directed by the Engineer.
3. Provide the services of authorized manufacturers' representatives to instruct the Owner's representatives in the proper operation of each partial or complete system installed under this Contract where noted.
 4. Pay all charges or fees, including the cost of any special test equipment, factory engineers, etc., necessary for the proper performance of the specified tests, demonstrations and instructions.
 5. All demonstrations and instructions referred to shall be scheduled at the convenience of the Engineer and the Owner and in no case shall be scheduled without at least 72 hours written notice to the Engineer. Scheduling of testing and certification of equipment by the Engineer until all instrumentation and electrical equipment have been installed, calibrated including testing/transmitting of alarms, status, etc have been performed in the field in accordance with the Specifications. Once the systems have been tested in the field, the Contractor shall notify the Engineer a minimum of 72 hours before a formal startup and testing of each location. All testing of the equipment or system(s) shall be performed in a single contiguous block of testing dates or as agreed upon by the Engineer.
- F. Removals, Relocations and Rearrangements:
1. Examine the existing site for the work of all trades, which will influence the cost of the work under Division 13. This work shall include removals, relocations and rearrangements relating to the work of all trades which may interfere with, disturb or complicate the performance of the work under Division 13; and relating to the work involving systems, equipment and related service lines which shall continue to be utilized as part of the finished project.
 2. Provide in the bid a sufficient amount effort to include all removals, relocations, rearrangements and reconnections herein specified, necessary or required to provide approved operation and coordination of the combined new and existing systems and equipment.

1.2 QUALITY ASSURANCE

- A. All materials provided under this Contract shall be equal in quality, appearance and performance to that specified herein and shall be subject to the approval of the Engineer. Verify the availability of all materials proposed to be used in the execution of the work prior to submitting same for the Engineer's approval. Supply chain issues or the discontinuance of production of any material or product after approval has been granted shall not relieve the Contractor from furnishing an Engineer approved alternate of comparable quality, function, and design without additional cost.
- B. Materials and equipment furnished under this Contract shall be standard products of manufacturers regularly engaged in manufacture of such products and shall be manufacturer's latest standard design that complies with Specification requirements. Products shall essentially duplicate material and equipment that have been in satisfactory local use at least three years.
- C. Materials and equipment furnished under this Contract shall purchased and supported by the manufacturer or by an authorized manufacturers representative.
- D. Material and equipment furnished under this Contract shall disallowed for use by any

applicable government agency (E.g. EPA, DHS, etc) for use with critical infrastructure (E.g. the National Defense Authorization Act of 2018 banned the use of Hikvision).

- E. The Contractor shall have supplied comparable systems to those specified herein and shall maintain engineering and service departments capable of designing and maintaining these systems. Provide, for a period of 12 months from the date of final acceptance of the work, all necessary supervision, labor, materials, and equipment, in order to correct any defects in any system due to faulty materials, equipment, installation methods, or workmanship and consequent damage resulting from such defects. This work shall be scheduled during normal working hours and at the convenience of the Owner.
- F. System Integrator:
 - 1. The Contractor's attention is directed to the fact that the instrumentation is an integrated system and as such, shall be furnished by one supplier, who shall provide all of the equipment and appurtenances regardless of manufacturer, and be responsible to the Contractor for satisfactory operation of the entire system provided. Substitutions on functions specified will not be acceptable.
 - 2. The exception shall be where instrumentation and control packages are furnished by respective equipment manufacturers as required in Division 11, 14, 15, and 16. All necessary provisions will be made to ensure a proper signal and communication interface as indicated on the P&IDs and associated equipment specifications between the main process instrumentation and control packages specified within this section and those provided. The Contractor shall provide startup reports which demonstrate proper operation of Division 11, 14, 15, and 16 equipment and associated Division 11 control systems.
- G. Acceptable System Integrators:
 - 1. NIC Systems Corp., Cromwell, CT
 - 2. No or Equal

1.3 SUBMITTALS TO THE ENGINEER

- A. Shop Drawings and Samples:
 - 1. Submit Shop Drawings and O&Ms in accordance with General Conditions Section 01340 and as indicated herein.
 - 2. Shop Drawings shall consist of:
 - a. Project name and location
 - b. Contractor's name
 - c. Index Sheet - Listing the equipment being submitted utilizing equipment designations, or symbols, indicated on the Contract Documents together with the proposed manufacturer, style/type and catalog number. The .pdf shall also have integral bookmarks.
 - d. Manufacturer's scale or dimensioned drawings along with standard catalog number.
 - e. Equipment ratings, service clearances and configuration.
 - f. Listing of accessories to be furnished
 - g. Panel wiring diagrams showing the location of each mounted component, front panel elevation(s), internal wiring diagram of each component including terminal numbers.

- h. Bill-of-Material Table showing a complete listing of the components in each control panel. Table shall include separate columns for the following: Item Number, Quantity, Manufacturer, Part number, Description, Designator Tag, Supplier name and phone number.
- i. Initial and record ISA S5.4 loop diagrams or equivalent showing point to point wiring for all instrumentation equipment including terminal numbers. Prior to final completion, update the above drawings with wire labels and terminals provided by the Electrical Subcontractor. Refer to Section 13444 for additional information.
- j. SAT Report:
 - i. The SI shall furnish an I/O checkout sheet identifying and acknowledging that field wiring is properly terminated to the SI furnished hardware.
 - ii. The SI shall furnish a checklist of all the instruments that have been configured and ready for additional testing.
- k. SCADA screens, OIT screens, and database tags.
- l. Refer to the other Division 13 Sections for additional shop requirements.
- 3. All material shall be contained in one submission; partial submissions will not be accepted.
- 4. Submissions shall be in the form and quantity indicated in the General Conditions. Each equipment type shall be separated by index tabs with typewritten titles.
- 5. Provide samples of programs, graphics, etc., within 10 days upon receipt of request from the Engineer.
- B. Maintain properly documented and witnessed test and checkout reports and submit these to the Engineer. No form of energy shall be applied to any part of the instrumentation system prior to receipt by the Engineer, from the Contractor, of the supplier's certified statement of approval of the installation and containing his authorization to energize the system, except that the supplier's serviceman may do so for the purpose of check-out as described herein.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Coordinate material and equipment delivery with the project schedule. Notify the Engineer immediately, in writing, if material or equipment delivery will adversely affect the project schedule, include documentation from equipment suppliers indicating the revised delivery dates and the reason for the delay.
- B. Coordinate delivery of equipment directly to other vendors where instrumentation supplied under this section has to be installed in panels supplied under other specification sections.
- C. Exercise care during loading, transporting, unloading and handling of materials to prevent damage.
- D. Check for defective or damaged materials, and for incomplete equipment shipments within seven days after equipment delivery to the project site.
- E. Store materials and equipment on the construction site in enclosures or under protective covering in order to assure that materials and equipment are kept undamaged, clean and dry. The Contractor shall maintain an inventory of instruments and control panels received on site and store in a safe, secure, dry and temperature

controlled location. This inventory shall be made available to the Engineer upon request.

- F. Replace or repair, to the satisfaction of the Engineer, all materials and equipment that are defective or that have been damaged during installation, at no additional cost to the Owner.

1.5 O&M REQUIREMENTS:

- A. Provide the Owner with a list of local service departments of duly authorized distributors of materials and equipment of the type installed, which will stock the manufacturer's standard parts, etc. The list may be included on the bill-of-materials.
- B. At the completion of the installation, provide Record Drawings on sheets no less than 11" x 17", indicating the final configuration of all systems as they were installed. Symbols, equipment designations, instrument ISA designations, etc., shall be consistent with the Contract Documents. Provide exact locations of all work which has been concealed in concrete, masonry or underground. The following diagrams shall be included:
 - 1. Control Panel diagrams on 11" by 17" sheet showing the front face and panel mounted equipment with full listing of components including names, descriptions and model numbers for each component. One copy of the panel diagrams will be laminated for insertion into the pocket inside each control panel.
 - 2. Point to Point terminal wiring diagrams for all field instruments, motor starters, equipment drives, valve actuators and other field equipment connected to the control system. When called out provide diagrams meeting ISA S5.4 standards requirements for loop diagrams on 8½" by 11" sheets, showing one loop per sheet. Drawings shall reflect as built conditions.
 - 3. Panel wiring diagrams showing the location of each mounted component; front panel elevation(s) and name plates; internal wiring diagram of each component including field instruments and terminal numbers; and network communications including all provided equipment, on 11" by 17" sheets.
 - 4. Network diagrams on 11" x 17" format. Refer to Section 13444 for additional requirements.
 - 5. Provide a hardcopy set of applicable drawings in each control panel and one binder with a hardcopy of all record drawings.
 - 6. Provide a copy of all record drawings to the Owner and Engineer in AutoCAD DWG format or Adobe PDF format on a USB drive. .pdfs shall have integral bookmarks denoting all sections and subsections.
- C. Refer to the other Division 13 Sections for additional O&M requirements.
- D. O&M Manual Organization:
 - 1. O&M's shall be organized to be easily navigable. Devices shall be arranged by group and type. Example, all flow meters will be grouped together and arranged so that mag meters are together, than thermal mass meters, etc.
 - 2. The hardcopy operations and maintenance manuals shall be organized in three ring binders with a maximum size of 4". The following is a proposed outline for the O&M Manual(s), provide applicable Sections:

TITLETable of Contents

Section 1 - Reserved for description of system by Owner

Section 2 - Field Instruments (arranged by device group and type, ex. Flow meters, submersible level, floats, etc.)

2.1 ISA instrument calibration data sheets and instrumentation listing with part numbers

2.2 O&M literature for each type of instrument with labeled dividers

2.3 Instrument configuration data

Section 3 - Panel Equipment (arranged device type)

3.1 Bill-of-Material Table

3.2 O&M and Manufacturer's literature

Section 4 - Miscellaneous devices (arranged alphabetically by manufacturer)

4.1 Bill-of-Material Table

4.2 O&M and Manufacturer's literature

Section 5 - Drawings

5.1 Network drawings

5.2 Panel fabrication and assembly drawings

5.3 Panel wiring diagrams

5.4 Interconnection wiring diagrams

5.5 ISA S5.4 loop diagrams

Section 6 - PLC

6.1 CPU, memory capacity, communication ports

6.2 Rack Layout and module configuration

6.3 I/O List

6.4 PLC Program (in native format)

6.5 OIT Program (in native format)

6.6 PLC communication parameters/ port configuration

Section 7 - Miscellaneous Data

7.1 Data Networking Equipment List

7.2 Data Networking Equipment Configuration, IP Addresses, Layout, and Security Access.

7.3 Fiber Optic Cable installation pull-test, and signal test reports.

7.4 Radio telemetry study or startup testing results, license details, signal strength report, path profile, communication parameters, ERP, addresses, polling parameters, etc.

Section 8 - Software programs and PDF Literature

8.1 PLC Programming Software

8.2 OIT Programming Software

8.3 SCADA Software and Licenses

Section 9 - Program

9.1 PLC Program in native format with data tag registers, cross reference list, and comments.

9.2 PID parameter printouts (per loop)

9.3 OIT programs in native format with screen color Printouts, communication configuration, and data tag printout.

- 9.4 SCADA programs with screen color printouts, communication configuration, and data tag printout.
- 9.5 Custom Report Printouts
- 9.6 Alarm Configuration and alarm tag printouts.

E. The cover and edge of each volume shall contain the following information:

Scum Pipe Automation
Mattabasset District

Instrumentation and Control System
Operations and Maintenance Manual
Specification Section 13###
Volume X of Y

(where X is the volume number and Y is the number of volumes)

Subcontractor Name, Date

F. Electronic O&M Information:

1. Supply all electronic files on USB storage media.
 - a. .PDFs shall be bookmarked by order of O&M.
 - b. Scanned .PDFs shall not be accepted.
 - c. Control Panel Drawings shall be provided in both PDF and DWG format.
 - d. USB Storage media shall be set to Read only on project completion (substantial completion)
2. Refer to other Division 13 specifications for additional information.

G. Warranty Documentation: The Contractor and System Integrator shall investigate, diagnose, repair, update and distribute all pertaining documentation of deficiencies which become evident during the warranty period. All such documentation shall be submitted to the Engineer within 30 days of solving the problem.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General:

1. All of the equipment shall be the manufacturer's latest proven design. If a piece of equipment was sole sourced, but is no longer the current version, the SI shall propose and carry the latest version of the product migration path. Specifications and Drawings call attention to certain features, but do not purport to cover all details entering into the design of the instrumentation and process control system. The completed system and the equipment furnished by the Contractor shall be compatible with the functions required.
2. Components shall be finished to the manufacturer's standard for the service intended unless otherwise indicated in the Specifications or on the Drawings.
3. All electrical components of the system shall operate on 120-volt, single-phase, 60-Hertz current, except as otherwise noted in the specifications and drawings. Power shall be supplied from either local electrical distribution panels, or an

- associated control panel UPS with breakers for each circuit as indicated on the Instrumentation and Electrical drawings.
4. All controls for electrically operated or motor-driven equipment (including electrically actuated valves, small pumps and chemical feed equipment, etc.) shall be complete, including all necessary auxiliary relays, so as to require only wiring and connections to the equipment control circuit. All contacts for control of motor-operated or electrically operated equipment shall be rated not less than 10 amperes on 120 volts unless otherwise specified herein.
 5. Panel components including switches, relays, instrumentation, etc. supplied by the various process equipment manufacturers, but indicated to be installed within panels furnished by the System Integrator, shall be furnished to the System Integrator for incorporation into his panels. Equipment shall be installed to the manufacturers requirements and recommendations. System Integrator shall install these items within his panel and shall produce a complete, functional, pre-wired system for installation requiring only external power and instrumentation connections. The Contractor shall coordinate this requirement and shall ensure that equipment manufacturers provide all necessary installation instructions and requirements to the System Integrator.
 6. Identification:
 - a. All panels, and control devices shall have identifying nameplates. Equal quality nameplates shall be attached to all field-installed units.
 - b. Each field transmitter shall have an attached manufacturer's tag with the Manufacturer's name, model number, serial number, power requirements, and scaled range of the instrument.
 - c. Provide suitable lamoid labels for each process measurement element and transmitter. Label will identify each medium being measured, range and units of measurement and indicating transmitter/element ID No., for example:

PST 1 and 2 Solenoid
SV-2650A

PART 3 - EXECUTION

3.1 INSTALLATION

A. General:

1. The Specifications and Drawings do not attempt to fully indicate the degree of assembly, subassembly, shipped condition, extent of field work, or degree of accuracy required to install the equipment or materials. The Contractor shall be required to rely on his prior experience or to otherwise inform himself of the amount of field work required to assemble, erect, and install the equipment or material, as received, to produce a finished installation ready for use or operation.
2. All equipment installed as part of the work shall be positioned, assembled, aligned, doweled, and otherwise set to the tolerances required by the equipment

manufacturer. Where tolerances and methods are not specifically indicated, they shall be in accordance with best millwright practice.

3. All materials incorporated in the work shall be installed in accordance with the Drawings and Specifications. Where detailed drawings or technical specifications are not provided, the materials shall be installed in accordance with the manufacturer's preferred recommendations and conforming to the best practice of the trade involved. Installation shall include all accessories required to produce a completed installation ready for use.
 4. The Owner will assume no liability or responsibility for any portions of the installation under this Contract until they are demonstrated and accepted in writing. Final demonstrations shall be made only after the Owner and Engineer are satisfied that the work has been completed in accordance with the intent of the Contract Documents.
 5. Sensors or instrumentation to be installed shall be provided with sufficient cable length and mounting configuration for easy removal, service, and replacement. The service of the instrument shall not require its wiring removed or disconnected. Any instrument found deficient in this area shall be reconfigured by the Contractor as approved by the Engineer at no additional cost to the Owner or Engineer. Refer to instrumentation details or submit an RFI prior to procurement, submittal, and/or installation.
- B. Electrical Work:
1. All electrical work shall conform to the requirements indicated in Division 16.
- C. Procedures Prior to Startup:
1. The Contractor and System Integrator shall:
 - a. Coordinate and schedule the work through Engineer as necessary. The SI shall notify the contractor of the individuals required to be onsite during and MCC startup and configuration to verify proper connection and scaling to the control panel using PLC program.
 - b. All wiring will be installed, terminated, and tested by the Contractor in each control panel. Wire labeling shall be coordinated between the SI and the Electrical Contractor during construction to assign terminal numbers in loop drawings of all field terminations, including intermediate junction boxes. Refer to Section 16010.
 - c. Calibrate and configure all Division 13 supplied instrumentation as specified in Section 13440.
 - i. Verify that each instrument is properly installed, configured, and is properly measuring values for the application.
 - ii. Coordinate with the AESS that the control system is scaling matches the instrument scaling.
 - iii. Provide digital averaging/filtering or any other advanced configuration where required for proper equipment control. This "filtered" engineering process signal used for process control shall accurately track and represent the original engineering process signal without "turbulence", "signal delay" or "signal droop".
 - iv. Configure all instruments to fail in the safest condition for the specific application. Example, a wastewater pump station with

backup floats should have the analog level measurement fail low and a water plant finish water chlorine instrument should fail to a value to shut the facility down.

- d. Coordinate with Division 11 control panel manufacturers in establishing network communications as required on the Drawings. If the Division 11 provided PLC's communication protocol does not match that of the PLC being provided by the Division 13 System Integrator, the System Integrator shall provide a protocol converter as specified in Section 13445.
 - e. Verify the facility installation.
 - f. Be onsite during Equipment Startup to verify equipment wiring and basic functionality of Division 13 furnished equipment.
 - g. Coordinate and verify interface with electrical equipment, including field wiring terminations.
 - h. Document hardware configuration and wiring information.
 - i. Configure all furnished network equipment unless otherwise specified.
 - j. Demonstrate network functionality.
2. The Contractor and SI shall:
- a. Coordinate with Division 11 control panel manufacturers in establishing network communications as required on the Drawings, and the signals required in Section 13441. The Division 11 control panel manufacturer shall coordinate communication and programming requirements with the SI prior to programming effort. Any programming and network configuration changes shall be done to provide network communication shall be provided at no cost to the Engineer and Owner.
 - b. Prior to the witnessed site acceptance testing, the SI shall perform a preliminary test to verify operation prior to witnessed testing. The Contractor shall assist as necessary.
 - c. Perform and IO checkout from field device to PLC prior to any automated and PLC testing.
 - i. The SI shall monitor and manipulate the PLC inputs and outputs through the PLC program.
 - ii. The Contractor, Electrical Contractor, and SI will assist with testing IO from devices. The individual(s) assisting with checkout shall be qualified to do the required testing.
- D. Site Acceptance Testing
1. A Site Acceptance Test shall be performed on each Division 13 control system after the installation at each site to verify that each instrument and equipment drive is connected properly to the control panel and that all functions of the control panel are operating as specified.
 - a. The Contractor shall schedule Startup and SAT activities with the Engineer at least 5 business day in advance.
 - b. The Contractor shall not schedule more than 3 days of site acceptance testing, or training during any week without agreement from the Engineer and Owner. No site acceptance testing shall occur on Fridays without agreement from the Engineer and Owner.

- c. Additional SAT activities restrictions may be determined by the Owner.
 2. The Contractor and SI shall:
 - a. Verify the facility installation.
 - b. Provide final instrument field calibration sheet/documentation after SAT has been completed.
 - c. Verify accuracy of documentation, operator's manuals, software documentation, and site operating instructions, etc. after SAT has been completed. Documentation shall include all field modifications.
 - d. Troubleshoot and correct any hardware deficiencies, including, but not exclusive to communications issues identified by the AESS that are not due to the configuration of the device.
 - e. Be available during the Site Acceptance Test to correct any hardware deficiencies and/or adjust instrument configurations as necessary.
 3. The Contractor and AESS shall:
 - a. The AESS will be responsible for all PLC, OIT, and SCADA programming. The Contractor will be responsible for all hardware and equipment unless otherwise specifically stated.
 - b. Demonstrate each functional requirement identified by the Specification.
 - c. Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices and operation of equipment shall be closely coordinated with Engineer and Owner's staff.
 - d. Demonstrate all networking functionality.
 - e. Verify system performance parameters and system responses under field operational conditions.
 - f. Demonstrate all equipment control functions, including the operation of automatic control strategies. Actuation of field devices and operation of equipment shall be closely coordinated with Engineer and Owner's staff.
 - g. Demonstrate that the parameters for each PID operation in the PLC provide a smooth responsive transition without over oscillation with a sudden change in the process value or set point. PID parameters will be determined, verified, and demonstrated with PID tuning software that displays trending of the process variable, controlled variable, and set point over time.
 - h. Verify system performance parameters and system responses under field operational conditions.
 - i. Verify accuracy of documentation, especially operator's manuals, software documentation, and site operating instructions. Documentation shall include all field modifications.
 - j. Provide completed site acceptance testing (SAT) test documentation. Including:
 - i. Startup reports
 - ii. Initial startup values
 4. The SAT will be observed by the Engineer and/or Owner's representative.
- E. Refer to Section 01800 for additional startup, testing, training requirements for the instrumentation equipment.

END OF SECTION

SECTION 13441CONTROL LOOP DESCRIPTIONPART 1 - GENERAL1.1 SUMMARY

- A. Section includes control descriptions for loop diagrams shown on the Instrumentation Drawings.
- B. Control Loops Descriptions shall be used by the System Integrator (SI) for developing PLC code and SCADA development under this contract. The AESS or SI executing this specification shall be referred to as the “programmer” herein.
- C. The General Contractor shall coordinate with the System Integrator to maintain project schedule.
 - 1. Equipment startup shall be completed at least two weeks before substantial completion.
 - 2. Site Acceptance Testing shall be started no later than 4 weeks prior to substantial completion.
- D. The Programmer shall be responsible for all of the scope within this specification unless specifically stated otherwise.
- E. At a minimum, all status, alarm, and control signals shown on the drawings shall be provided as such and in accordance with the CONTROL DESCRIPTIONS - GENERAL unless specifically stated otherwise.
- F. The specific requirements of the custom software will be defined during the Shop Drawing submittal process, with the input of the Owner and Engineer. A meeting(s) will be held at the project site, with a representative of the System Integrator, PLC Programmer/Supplier, Client, Contractor, and Engineer, to finalize the custom programming specifications.
- G. The Programmer shall provide 10 hours of additional programming time and 3 round trips to be used for scope not listed. Unused programming time in the first year will be given to the Owner as a credit.
 - 1. The Programmer shall update and create the SCADA Screens and alarms for the new functionality as described herein. The AESS shall update SCADA computers at the WWTP.
 - 2. The Programmer shall assign IP addresses and establish communication to all network Division 11 panels, VFD’s and other networked equipment outside of Division 11 manufacturers
 - 3. The specific requirements of the custom software shall be defined during the Shop Drawing submittal process, with the input of the Owner and Engineer. A meeting shall be held at the project site, with a representative of the Programmer, Client, Contractor, and Engineer, to finalize the custom programming specifications.

1.2 SYSTEM DESCRIPTION

- A. Provide instrumentation hardware, software and programming as necessary to

perform control functions specified herein and as shown on drawings. Ensure coordination with other work to ensure that necessary wiring, conduits, contacts, relays, converters, and incidentals are provided in order to transmit, receive, and control necessary signals to other control elements, to control panels, and to receiving stations.

- B. The specifications direct attention to certain required features of the system, but do not purport to cover all details entering into its design and construction. Nevertheless, the Contractor shall furnish the CONTROL LOOPS complete in all details and ready for operation.

1.3 SUBMITTALS

A. Shops

- 1. Provide annotated versions of the PLC, operator interface terminal and SCADA programming files in .pdf format for review by the Engineer. Provide the PLC and OIT files 15 days prior to FAT.

B. Operation and Maintenance Manuals:

- 1. Provide annotated final versions of the modified PLC, operator interface terminal and SCADA programming files on DVD or USB drive. The PLC and OIT programming files shall be stored on individual USB drives located in each of the respective control panels as well as a USB drive with the SCADA programming files.
- 2. Refer to Section 13410 for additional O&M sections.

PART 2 - PRODUCTS

Not Used.

PART 3 - EXECUTION

3.1 CONTROL DESCRIPTIONS – GENERAL

- A. Operator Interface Terminal (OIT) and SCADA software will be used for process monitoring and control as noted in the specific control loop descriptions. OIT and SCADA screens shall be constructed in accordance with the following general requirements:

- 1. Process Overview Screen showing status and location of each process related field instrument and process equipment in relation to the Process Flow Diagrams (PFD) and Process and Instrumentation Diagrams (P&ID). Operators shall be able to access more detailed screens for equipment control, process control setpoints and time delays, mode control, alarm history, and alarm setpoints and time delays.
- 2. Process Equipment Control Screens: Screens and pop-up displays shall be provided for process equipment monitoring, equipment control, and operating parameters/setpoints and delay timer adjustment.
- 3. Alarm Summary and Alarm Set-up Screens: Screens shall be provided to display active alarms, entry of alarm setpoint values and delay timer settings, and enable/disable alarms. The screens shall also include capability to acknowledge and reset alarms.

4. Graphical symbols shall be used to represent each piece of process equipment and field instrument. Equipment symbols that are used shall be representative of each piece of equipment displayed. Instrument symbols shall be in accordance with ISA S5.1 standards and Instrument Drawing I-1.
 - a. Refer to Instrumentation Drawing I-1 “Indicator Light Color Legend” for light color convention.
 - b. Display the status and process values for all equipment in the system.
 - c. Refer to the Instrument Schedule in Section 13440 for all process value scaling and ranges.
5. Skeuomorphism shall be used as a design theme as required for quickly familiarizing the operator with the functionality.
6. Alarm History Screen: A screen shall be provided to display all active and past alarms. The operator shall also be able to acknowledge and reset alarms from this screen.
7. Provide an alarm banner on each OIT/SCADA screen that displays at a minimum the last three alarm conditions. Active alarms shall flash in red. Acknowledged alarms shall be “solid” red.
8. Process Variable Historical Trends shall include the following:
 - a. Screens shall be provided to display historical trends of all process variables with adjustable scale and units.
 - b. The operator shall be able to add and delete pens as necessary and load and save pen groups to form analytical groups of data.
 - c. Trends shall be configured to minimize space on hard drive by updating on change only.
- B. All process, operational and alarm setpoints and associated delay-timer setpoints will be adjustable through the OIT/SCADA screens and will be generated and controlled at each respective PLC.
- C. All Control Loop programming shall be done in the PLC where the inputs/outputs terminate unless otherwise stated. All PLC tags shall be descriptive in nature.
- D. Equipment Fail Alarms:
 1. Equipment Fail alarms are defined as a condition where a command is given and the status confirmation of that command is not received within an acceptable time-frame. Fail Alarms shall not be triggered in the event of Loss of Power, or any other alarms related to the equipment (ie. High Temp, O/L. Fault, Low Pressure, etc.). Examples are as follows:
 - a. Fail to start-stop: A piece of equipment is given the command to start and the running status is not confirmed within an appropriate time delay. Conversely a piece of equipment is commanded to stop and the run status does not drop out within an appropriate time delay.
 - b. Fail to open-close: A duty valve is given the command to open and the opened status is not received within an appropriate time delay. Conversely, a duty valve is given the command to close and the closed status is not received within an appropriate time delay.
 - c. Fail to make position: A modulating control valve is commanded to go to a specific position and it does not reach that position (within a bandwidth) within an appropriate time delay.

2. Provide the applicable Equipment Fail alarms for all equipment based on type and I/O available.
- E. PID Controllers:
1. The words “PID”, “PID Control” “PID Controller” shall mean a control loop feedback mechanism that is a complete function for the described process control and which includes operator adjustable inputs for fine tuning. These terms do not purport to require a prescribed method but to describe a universal function for feedback control. Nevertheless, the Contractor shall furnish a means to control the process smoothly and accurately, complete in all details, using standard good practices, and ready for operation.
 2. The PID controller algorithm parameters DEADBAND, GAIN (Proportional), DELAY, RESET (Integral), REPEATS (Derivative), Loop Update Time, and MINIMUM/MAXIMUM Controller Output shall be adjustable through a password protected screen (accessible at the OIT/SCADA).
 3. Each PID controller shall have a faceplate configured with numeric and graphic indication of setpoint, process variable and controller output, AUTO/MAN mode selection (as applicable), means of setpoint entry, and navigation button to access a historical display screen with the setpoint, process variable, and controller output.
 4. Process Values and Setpoints shall be scaled from the true engineering range to the required PID range as necessary to provide the full resolution in the calculation of error.
 5. The setpoint shall be limited to prevent hazardous process conditions. Range shall be hardcoded in the OIT/SCADA during startup and commissioning.
 6. Loop update time of the feedback control shall be coordinated with the analog input module and the requirements of the process.
 7. Unless otherwise noted, PID controller outputs are 0 to 100%, linearly scaled to a 4 to 20 mA DC output signal by the PLC.
 8. Each PID controller shall be configured for bumpless transfer with anti-windup and anti-reset when switching between manual (or hand) and automatic modes.
 9. Each PID controller shall be configured for Bumpless Restart when the controller changes from Program to Run mode or when the controller powers up.
 10. Control Value (CV) Clip and Clamp: The PID controller output shall be compared with an adjustable low limit (0% unless otherwise noted) and an adjustable high limit (100% unless otherwise noted). The PID controller output signal will not be lower than the low limit (clamp) or greater than the high limit (clip). If the PID algorithm calculates an output that is out of range, then the PID algorithm shall cease accumulating error for the integral term until the calculated output is back in range.
 11. If an alternative algorithm to PID is used, the method that is provided shall include equivalent requirements.
 12. Where PID or equal is required, additional provisions shall be made for the control loop to function as described.
- F. Where specifically noted in the loop descriptions software Hand/Off/Auto and On/Off selector switches shall be forced to the OFF position under certain interlock logic

conditions so that an energized run output from the PLC is de-energized. This will require an operator to manually restart the equipment or to place the equipment in AUTO to allow for automatic operation. The L/O/A selector shall not be enabled in the LOCAL or AUTO positions until the condition causing the forced placement to the OFF position has returned to normal.

- G. In the event of an instrument or process analyzer failing or loss of signal, the PLC shall utilize last know value as not to upset the process condition/control. An alarm shall be generated as “loss of signal” for that particular instrument/analyzer. If associated with a PID loop, the PID loop shall be automatically place in manual mode with bumpless transfer and anti-windup/anti-reset.
- H. Reports: See Section 13443 for requirements.
- I. All SCADA Servers, View Nodes, and PLC’s shall time sync once a day. A single SCADA Server shall time sync with the NIST server. A Firewall exception policy shall be created to allow for the specific address and protocol.
- J. Control Loops
 - 1. Local LOA/HOA – all local hardware selector switches shall:
 - a. In Local or Hand position run the associated equipment to be used in conjunction with Open-Stop-Close pushbuttons or a potentiometer for valve position or VFD speed.
 - b. In Off position, Stop the associated equipment
 - c. In Remote or Auto position, the control of the associated equipment shall be transferred to the PLC. At the OIT/SCADA the operator shall control the equipment with either a software HOA or both a software HOA and an OSC. The OIT/SCADA system will display the “In Remote” and “Not in Remote” status based on an auxiliary contact in the Remote position. This status shall be displayed near the software selector switch. The same shall apply for “Auto” and “E-stop”.
 - 2. Software HOA – all OIT/SCADA software selector switches shall:
 - a. In Hand position Run the associated equipment in manual mode whereby an operator can make adjustments with setpoint speed or position entry.
 - b. In Off position, Stop the associated equipment from running remotely.
 - c. In Remote or Auto, the control of the associated equipment shall be transferred to PLC control as described in the control loop.
 - d. Related alarms such as Motor High Temperature, E-Stop, etc. shall be displayed as statuses at the LOR/HOA controls or with the equipment status.
 - 3. Local OSC – all valving local hardware selector switches shall:
 - a. In Open position change the valve position towards Open
 - b. In Stop position remains in position
 - c. In Close position change the valve position towards Close
 - 4. Software OSC – all valving software selector switches shall:
 - a. Pressing Open will latch the Open command until a Full Open or 100% Open is received
 - b. Pressing Stop will interrupt and unlatch any current Open/Close commands

- c. Pressing Close will latch the Close command until a Full Close or 0% Open is received.
 5. Runtime Hours Totalizing –
 - a. All equipment with a Run Status signal shall be configured in the PLC for run hour totalizing with display at OIT/SCADA.
 - b. Runtime Hour totals shall be configured as both running totals with a password protected (or higher user privilege) reset and with a separate pushbutton resettable total.
 6. Alarms: All alarms shall be displayed and identified as an alarm priority. Alarm priorities shall be indicated as 1 through 4.
 - a. 1 – Critical priority
 - b. 2 – High priority
 - c. 3 – Low priority alarm
 - d. 4 – Warning, notice, or informational event
 - e. Only Level 1 & 2 alarms shall dial out.
 - f. The specification assigns initial alarm prioritization. Owner and engineer reserve the right to change alarm priority at no cost.
 - g. All alarms will be able to be enabled or disabled by SCADA users. Refer to the Security Section below.
 - h. All alarms shall be latched upon activation and reset with the Alarm Acknowledge pushbutton unless otherwise specified.
 - i. All alarms, unlatching and latching shall be logged in the alarm history.
 - j. All alarms shall be able to be enabled or disabled with a button.
 - k. Delays – Alarms shall activate if TRUE setpoint exceed for this adjustable time period (0-60 seconds, initially 5s).
 7. Analog Alarms: shall be configured at the OIT/SCADA with the following (operator adjustable):
 - a. Low and High Setpoints as specified in specific loops below
 - b. Low Low and High High Setpoints as specified in specific loops below.
 8. Digital Alarms: all alarms noted as such or as other (fault, overload, fail, E-Stop, etc.) on drawings as shall be configured at the OIT/SCADA with the following (operator adjustable):
 9. Alarm Dialing: Refer to Alarms above.
 10. Security: Level 1 alarms will only be able to have the setpoints changed, enabled or disabled by Supervisor account levels or higher.
 11. Timer modes: Any control that requires a duration setpoint shall include a countdown displayed value to indicate to the operator the length of time until the mode expires or starts.
 12. Totalizer modes: Any control that requires a totalized setpoint shall include a current total displayed value to indicate to the operator the current progress towards the setpoint.
 13. PLC Failure Mode: Upon PLC failure, all discrete outputs shall de-energize to an off condition.

K. Logging & Auditing: Provide the necessary programming and configuration to perform the logging specified in Specification 13443.

L. Integration of Division 11 Control Panels

1. Standard Functionality - Control Panels provided by others shall be integrated to provide controls equivalent to the OIT control provided by the Division 11 manufacturer.
 2. Enhanced Functionality – Communications, calculations, and any other additional provisions shall be made as necessary to meet the requirements listed in the CONTROL DESCRIPTIONS.
- M. Reading/Writing across the Network– Provisions shall be made such that multiple points of access have the ability to change setpoints and modes. This functionality shall be furnished such the setpoint or command will automatically reset and the operator does not have to intervene. The setpoint or command shall change to a value that does not have control in the system once the required change is made.

3.2 CONTROL PANEL DESCRIPTIONS – GENERAL MOTOR STARTER DRIVEN EQUIPMENT AND VALVE ACTUATORS

- A. The following is a general description of VFD and motor driven equipment as well as modulating actuators. Refer to individual loop numbers for specifics.
 - a.
- B. General Motor Starter driven equipment.
 1. PLC Control:
 - a. Monitoring:
 - i. The status of the drive shall be displayed at SCADA as RUN/STOP based on the run status contact. The PLC shall totalize the run time hours.
 - ii. The PLC shall activate a Motor High Temp Alarm when the contact activates (fixed delay of 5s).
 - iii. The PLC shall activate a Pump Seal Leak Warning when the contact activates (fixed delay of 5s).
 - iv. The PLC shall activate an O/L Alarm when the O/L contact activates (fixed delay of 5s).
 - v. The PLC shall activate an E-Stop Alarm when the contact activates (fixed delay of 1s).
 - vi. The PLC will monitor and display the status of the Remote position of the LCS LOR.
 - b. Activation:
 - i. A Fail Alarm shall be activated if the equipment is available and PLC attempts to start the equipment and the return run contact does not indicate that the motor is running (fixed delay of 60s).
 - ii. The equipment shall have a virtual Manual/Off/Auto switch. In Off, the pump shall not run.
 - iii. Refer to specific control narratives for additional functions.
 2. Alarms at OIT/SCADA:
 - a. Refer to specific control narratives
 3. Monitoring at OIT/SCADA:
 - a. Refer to specific control narratives

3.3 GREASE BUILDING CONTROL PANEL

- A. Loop 2611,2612,2613 (FUTURE: 2621,2622,2623): Scum Tube Collector Drives
1. General: Three new (SCD-2611,2612,2613) and three future Scum Tube Collector Drives (SCD-2621,2622,2623) will be installed, one in each tank of PST-1 and PST-2. Each collector is driven by a motor starter and will run continuously. The drive mechanisms are monitored with a current monitor and clutch slip switch.
 2. Field Instruments:
 - a. IE/IIT-2611,2612,2613 (FUTURE: 2621,2622,2623): Scum Tube Collector Drives Current Monitor.
 - b. TSH-2611,2612,2613,2621,2622,2623: Scum Tube Collector Drive Motor High Temp Switch
 - c. ZS-2611,2612,2613,2621,2622,2623: Scum Tube Collector Drives Clutch Slip Switch
 3. PLC Control:
 - a. SCD Monitoring
 - i. The status of the drive will be displayed at SCADA as RUN/STOP based on the run status contact. The PLC will totalize the run time hours.
 - ii. The PLC will activate a SCD High Temp Alarm when the motor high temperature switch activates (fixed delay of 1s).
 - iii. The PLC will activate a SCD O/L Alarm when the O/L contact activates (fixed delay of 1s).
 - iv. The PLC will activate a SCD E-Stop Alarm when the contact activates (fixed delay of 1s).
 - v. The PLC will activate a SCD High Torque Alarm when the ISHH contact activates, this limit shall be programmed into the IIT (fixed delay of 1s).
 - vi. The PLC will activate a SCD Torque Warning when the ISH contact activates, this limit shall be programmed into the IIT (fixed delay of 1s).
 - vii. The PLC will activate a SCD Clutch Slip Alarm when the contact activates (fixed delay of 1s).
 - b. SCD Activation
 - i. The PLC shall control the drive when the Local-Off-Remote selector switch is in the Remote position. In Off, the drive will not run.
 - ii. The SCD will be displayed as In Remote/Not In Remote based on the remote contact from the pump.
 - iii. A SCD Fail Alarm will be activated if the motor is in Remote and the PLC attempts to start in Remote and the return run contact does not indicate that the motor is running (delay 0-60s, initially 15s).
 - iv. In Remote, the PLC will provide virtual Manual/Off/Auto control for each collector at the OIT and SCADA. In the Manual position, the collector will run. In Off, the collector will not run except in Local.

- (1) When the Collector is in Remote and SCADA Auto the PLC shall start the collector on a timed interval (Initially 15 minutes settable 5-600 minutes) and shall run the collector for an adjustable time (Initially 5 minutes settable 1-60 minutes). When the time delay expires the PLC shall energize a momentary completion signal to loop 2650 to initiate the flushing sequence. The interval timer shall then reset.
- c. Alarms at OIT and SCADA:
 - i. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) High Temp Alarm
 - ii. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) O/L Alarm
 - iii. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) E-Stop Alarm
 - iv. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) Fail Alarm
 - v. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) High Torque Alarm
 - vi. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) Clutch Slip Alarm
- d. Monitoring and Control at OIT and SCADA:
 - i. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) Run Status and Totalizer
 - ii. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) In Remote / Not in Remote
 - iii. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) Virtual Manual/Off/Auto
 - iv. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) Torque Warning
 - v. Scum Tube Collector Drive No.1A,1B,1C (FUTURE: 2A,2B,2C) Amps
 - vi. Collector Interval Setpoint and Timer
 - vii. Collector Runtime Setpoint and Timer
 - viii. Adjustable Enable / Delay / Setpoints for each warning and alarm
- B. Loop 2650 – Scum Tube Flushing Solenoids
 1. General: Four Existing Flushing Valve Solenoid valves will be controlled from the new control panel (GBCP). The valves will be activated in a timed manner to clean the scum tubes after a collection cycle or by manual request.
 2. Field Instrument:
 - a. SV-2650A, SV-2650B, SV-2650C and SV-2650D
 3. PLC Control:
 - a. Flushing Water Monitoring:
 - i. The status of the valves will be displayed at SCADA as OPEN/CLOSED based on the PLC coil energized status The PLC will totalize the open hours.

- ii. The PLC will activate a Flushing Water Extended Open Time (settable delay of 0-600s).
- b. Valve Activation:
 - i. The PLC shall control the valves when the Local/Off/Auto selector HS-2650A switch is in the Auto Position.
 - ii. When the selector is in the Off position the solenoids will not open
 - iii. When the Selector Switch is in the Local position the valves will be activated by two separate start push buttons HS-2650B will activate a manual flushing cycle for Primary basins 1 and 2, and HS-2650C will activate a manual flushing cycle for Primary Basins 3 and 4. The manual flushing cycle time shall be controlled by 3 adjustable solid state timers. The first timer shall be set to 10 seconds and shall energize the supply water solenoid and the drain solenoid. When the timer expires the selected basin flush solenoid will be activated by the remaining 2 timers (initially set to 60 seconds).
 - iv. Basins 1 / 2 Automatic control
 - (1) When the selector switch is in Auto the PLC shall monitor both the Start push button HS-2650B and the Completion signal (software based) from the collector drives (Loops 2611-2623). On either the completion signal or the input from the start button the PLC shall energize the Basin 1 / 2 Flush contact to commence flushing and shall maintain the contact for a settable time delay (initially 1-minute, settable 30sec-15 minutes)
 - v. Basins 3 / 4 Automatic control
 - (1) When the selector switch is in Auto the PLC shall monitor a settable interval timer and the Start push button HS-2650C. On expiration of the interval timer or the start button input the PLC shall energize the Basin 3 / 4 Flush contact to commence flushing and shall maintain the contact for a settable time delay (initially 1-minute, settable 30sec-15 minutes). When the flushing time delay expires the interval timer shall reset.
- c. Alarms at OIT and SCADA:
 - i. Extended Valve open (>15 minutes) (Any Basin)
- d. Monitoring and Control at OIT and SCADA:
 - i. Flushing Time Basin 1/2 and Setpoint.
 - ii. Flushing Time Basin 3/4 and Setpoint.
 - iii. Flushing interval time Basin 3/4 and Setpoint.
 - iv. Totalized On Time Basin 1/2 Flushing.
 - v. Totalized On Time Basin 3/4 Flushing.

END OF SECTION

SECTION 13442

PROGRAMMABLE LOGIC CONTROLLERS

PART 1 - GENERAL

1.1 DESCRIPTION

A. Work Included:

1. Furnish, install, program and test the programmable logic controllers (PLCs) and all graphical interfaces as shown in the Instrumentation Drawings and described in Specification Sections 13440 and 13442 herein.
2. Furnish, install, configure, wire, and test the uninterruptable power supply (UPS) and maintenance bypass switch (MBS) as shown in the Instrumentation Drawings and described in Specification Sections 13440 and 13442 herein.
3. Provide a perpetual licensed copy licensed to and in the Owner's name, of all required PLC programming software, communication drivers, hardware interface, and cables used to program the PLC(s). The programming software shall be capable of all functions described in 13441 and required by the PLC.
 - a. Programming software to be provided on a dongle.
4. Provide a perpetual licensed copy licensed to and in the Owner's name, of all required OIT programming software, communication drivers, hardware interface, and cables used to program the OIT. The programming software shall be capable of all functions described in 13441.

B. Related Work Specified Elsewhere.

Section	Title
13410	Instrumentation General
13441	Control Loop Descriptions
13444	Control Panels
13445	Communications Network
13460	Fiber Optic Cabling
Division 16	Electrical Requirements
	Electrical and Instrumentation Drawings

1.2 QUALITY ASSURANCE

- A. The PLCs and OITs form an integral part of the overall control system for the facility and as such all PLCs shall be the product of one manufacturer. The Contractor shall provide all coordination as necessary to ensure that all PLCs, whether provided by the System Integrator, individual equipment manufacturers or others, are by the same manufacturer.
 1. All PLC's provided (E.g. micro, modular, automation modular) shall be part of the same series unless otherwise specified.
- B. The OITs form an integral part of the overall control system for the facility and as such all OITs shall be the product of one manufacturer. The Contractor shall provide all coordination as necessary to ensure that all OITs, whether provided by the System Integrator, individual equipment manufacturers or others, are by the same manufacturer.

- C. The manufacturer or its authorized representative shall provide complete technical support for all their products.

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with the General Conditions of the Construction Contract, Section 01340 (Submittals) and Section 13410.
- B. PLC programming logic (ladder logic, function blocks, structured text, etc.). Ladder will be fully documented including a listing of each task/function. Annotations shall clarify the intent of each task/function with a description of the process so that the engineer or a future programmer will be able to clearly understand. Include the following:
 - 1. PLC I/O configurations
 - 2. PLC communication configurations
 - 3. PLC cross reference list
 - 4. PLC tag data base and memory usage
- C. OIT Program. Submit the following:
 - 1. OIT communication configurations
 - 2. OIT Screen List
 - 3. OIT Screen printouts

1.4 DELIVERY, STORAGE AND HANDLING

- A. In accordance with Section 13410.

PART 2 - PRODUCTS

2.1 GENERAL

- A. The PLC shall consist of rugged components designed specifically for industrial environments. The PLC shall consist of a power supply and one or more racks containing a central processing unit (CPU) module, I/O modules, PLC memory, and PLC network interface module(s). All components shall be housed in structurally secure enclosures.
- B. The central processing unit CPU shall be modular and fully enclosed within a durable plastic shroud. When mounted on the system base, the modular CPU shall not occupy more than one available slot.
- C. The I/O system shall be modular. Each module shall be fully enclosed within a durable plastic shroud. When mounted on the system base, each I/O module shall not occupy more than one available slot.
- D. All components within the controller family shall be manufactured with a high degree of durability. All switches and other operator controlled devices shall be of the size and durability for their intended use as is normally offered for industrial applications. All signal and/or rack expansion cables furnished by the manufacturer shall be constructed so as to withstand, without damage, all normal use and handling.
- E. All components within the controller family shall be part of the same series unless otherwise specified, or noted on the drawings, or approval by the engineer.
- F. In order to minimize spare parts stocking requirements, the controller family shall have a high degree of interchange ability. The system shall incorporate a modular design using plug in assemblies with pin and socket connectors. Wherever possible,

all assemblies and sub-assemblies performing similar functions shall be interchangeable. The system design shall accommodate the replacement of assemblies/modules without having to disconnect field wiring. Wherever possible, removable connectors shall be used to connect field wiring to the individual circuit board assemblies. All major assemblies and sub-assemblies, circuit boards, and devices shall be identified using permanent labels or markings each of which indicates the manufacturer's catalog number and a product manufacturing date code.

G. Refer to the control panel descriptions in Specification Section 13444.

2.3 MODULAR PROGRAMMABLE LOGIC CONTROLLERS (PLCS)

- A. General: Provide Programmable Logic Controllers (PLC) in the control panels as identified on the Instrumentation Drawings, capable of performing the functions and handling the network communications as described in Section 13441.
- B. The following Control Panels provided by Division 13 shall have a PLC:
 - 1. GBCP
- C. PLC Min. Memory: 1 MB of programmable memory with battery backed-up static RAM.
- D. Max. Scan Time: 1 ms/K
- E. Max. Bit Execution Time: 0.4 microseconds
- F. Power: 24 VDC power supply. Each PLC and Remote I/O Module shall be powered by an uninterruptible power supply (UPS)
- G. Required agency approvals:
 - 1. UL Listed (UL 508)
 - 2. CSA Certified (CSA 142)
- H. PLC External Communications: The PLC shall contain 2 Ethernet ports.
- I. Programming and diagnostic software shall be Windows based via Relay Ladder Logic (RLL) custom programming tools for the PLCs.
- J. Provide an unlocked copy of the PLC program, the program nor functions or add-on instructions within the program shall be password protected.
- K. Provide memory module and battery backup.
- L. PLC and Remote I/O Requirements:
 - 1. Provide all PLCs and I/O modules shall be from a single manufacturer.
 - 2. Discrete Inputs: 120 VAC and 24 VDC as required, maximum of 16 points per module.
 - 3. Discrete Outputs: 120 VAC Relay outputs. Maximum of 16 points per module.
 - 4. Analog Inputs: 4-20 mA DC, minimum 15-bit resolution. Maximum 8 channels per module. Provide differential Inputs.
 - 5. Analog Outputs: 4-20 mA DC, minimum 12-bit resolution. Maximum 8 channels per module. Provide differential Outputs.
- M. Future Connections: Provide a minimum of the following for future connections:
 - 1. 20% additional discrete inputs per PLC (rounded up) wired to terminal blocks
 - 2. 20% additional discrete outputs per PLC (rounded up) wired to interposing relays and terminal blocks
 - 3. 10% with a minimum of four (4) additional analog inputs per PLC wired to terminal blocks
 - 4. 10% with a minimum of two (2) additional analog outputs per PLC wired to terminal blocks

5. two (2) module spaces for future input, output, or special modules
- N. Spare Parts: Provide a minimum of the following spare parts for Division 13 panels only:
1. one (1) PLC Processor (of each type)
 2. one (1) PLC Power Supply (of each type)
 3. one (1) Analog Input Module (of each type)
 4. one (1) Analog Output Module (of each type)
 5. one (1) Digital Input Module (of each type)
 6. one (1) Digital Output Module (of each type)
- O. Communications Modules:
1. Provide adapters to extend PLC communication from the CPU to separate PLC module racks as necessary for internal or external IO modules. Refer to network drawings.
 2. Provide protocol converters for communication between the PLC native protocol to other networked devices as required.
 3. Adapters shall be fully supported or compatible with the PLC manufacturer or a Manufacturer Technology Partner.
- P. Acceptable Programmable Logic Controller (PLC):
1. Allen Bradley CompactLogix 1769 Series
 2. No or equal

2.4 OPERATOR INTERFACE TERMINALS

- A. General: Provide an Operator Interface Terminal (OIT) at the control panels as identified on the Instrumentation Drawings, capable of performing the functions and handling the network communications as described in Section 13441.
- B. General: Provide an Operator Interface Terminal (OIT) at each control panel to continuously indicate status of equipment, change operational parameters and indicate alarm status as described in Sections 13440 and 13441. The OIT shall be fully compatible with the PLC provided. The following Control Panels provided by Division 13 shall have an OIT:
1. GBCP
- C. Screen Size: 10.4 inch color active matrix screen with a minimum resolution of 640 by 480 pixels with field replaceable backlight.
- D. Interface: Touchscreen rated at 1 million cycles (minimum).
- E. Memory: 64 MB minimum application and graphic memory. The OIT shall also include a compact flash port. Provide a compatible SD card.
- F. Clock: Provide integral real time clock with battery backup.
- G. Communication: Ethernet and USB ports.
- H. Power: 120 VAC or 24 VDC
- I. Operating Temperature: 32-130°F
- J. Enclosure: NEMA 12 with NEMA 4X front-face and touchpad
- K. Provide a licensed copy licensed to the name of the Owner, of all programming software, drivers, hardware interface and cable used to configure the OIT.
- L. Provide programming time required to configure OIT interface as described in Sections 13440, 13441 and finalized in the instrumentation meetings.
- M. Provide all cables required to connect the OIT to the network or PLC.
- N. The integrated OIT software shall have the following features:

1. Trending
 2. Data Logging
 3. Alarms
 4. Graphic Symbols
 5. Animation
- O. Acceptable Operator Interface Terminal (OIT):
1. Allen Bradley PanelView Plus 7
 2. No Or Equal

2.5 UNINTERRUPTIBLE POWER SUPPLIES (UPS)

- A. Provide an uninterruptible 120-volt backup power supply for each PLC, OIT, Ethernet switch or other device as shown on the Drawings to maintain continuous operation of PLCs, operator interface terminals, Ethernet switches, monitoring instrumentation and control and process circuits during a power outage.
- B. UPS type shall be provided as a continuous-duty, on-line, solid state, double conversion, single-phase 120 VAC input, single-phase 120VAC true sinewave output uninterruptible power system with auto-bypass. The UPS shall be provided with surge arresting capabilities to prevent sudden surges to the attached electrical control systems.
- C. The UPS will be inside the control panel, located in the bottom section of floor stand type control panels or provided an independent wall mounted enclosure. The UPS shall be installed per UL 508 requirements and be powered by a simplex outlet.
- D. UPS shall be installed in a manner to not impede access to terminals or field wiring.
- E. Provide appropriate maintenance bypass switch as specified herein to easily remove and bypass the UPS.
- F. The UPS shall have “hot-swappable” batteries and be capable of being replaced with the UPS in operation. The run time operation of the UPS shall be accomplished using batteries mounted within the UPS enclosure and supplemented as necessary with batteries in an enclosure to provide the battery runtime specified herein. The battery enclosure shall match the main UPS enclosure as closely as possible.
- G. The UPS shall come equipped or provided with an added interface card with the means to signal the following alarms using dry contacts input to the control panel PLC:
 1. UPS Fault
 2. UPS on Battery Power
- H. The UPS shall be type rated for industrial use and capable of supplying standby power to all connected control panel equipment and circuits at peak load for a minimum of fifteen (15) minutes at full load, thirty (30) minutes half load. UPS minimum rating shall be 750 VA.
- I. Acceptable manufacturers:
 1. Schneider Electric APC Smart-UPS
 2. Liebert GXT3 Series
 3. Tripp-Lite SU Series
 4. Eaton Powerware
 5. or equal.

2.6 MAINTENANCE BYPASS (MBS)

- A. Each UPS shall be provided with a two-position external maintenance bypass switch and outlet system to permits the UPS to be removed for repair or maintenance without causing power disruption to the connected power loads. The external bypass switch shall be a snap-action type with switching speed 10ms or less independent of operator action. External bypass switch positions shall be labeled UPS and UTILITY. The bypass switch shall be capable of switching the required amps for the UPS system.
- B. For UPS units up to and including 3 KVA, furnish Liebert MicroPOD, Tripp-Lite PDUB15, or equal
 - 1. Substitution of standalone switches along with custom plugs, receptacles, and appropriate wiring to achieve the specified functionality is acceptable.
 - 2. For UPS units above 3 KVA, substitute standard manufacturers Maintenance Bypass switch offering or standalone switches as indicated above.

PART 3 - EXECUTION - In accordance with Sections 13410 and 13444

END OF SECTION

SECTION 13444CONTROL PANELSPART 1 - GENERAL1.1 DESCRIPTION

A. Work Includes:

1. Furnish, install, test, and commission the following panels listed in the control panel schedule.
2. Coordinate with the manufacturers of supplied equipment for specific instrumentation and control requirements. Any deviation in instrumentation or electrical requirements for the supplied equipment shall be provided at no additional cost to the Owner.

B. Related Work Specified Elsewhere:

Section	Title
13410	Instrumentation and Process Control General
13441	Control Loop Descriptions
13442	Programmable Logic Controllers
13445	Communications Network
13460	Fiber Optic Cabling
Division 16	Electrical Requirements
	Electrical and Instrumentation Drawings

1.2 QUALITY ASSURANCE

- A. The specifications direct attention to certain required features of the equipment but do not purport to cover all details entering into its design and construction. Nevertheless, the Contractor shall furnish the control panels complete in all details and ready for operation.
- B. The control panels are an essential component of an integrated system with all plant controls and as such shall be supplied by the System Integrator in accordance with Sections 13410 and 13441.

1.3 SUBMITTALS

- A. Submit shop drawings in accordance with the General Conditions of the Construction Contract, Section 01340, Submittals, and Section 13410.
 1. Control Panel Layouts, Wiring Diagrams:
 - a. Control panel wiring diagrams shall also include ISA S5.4 loop diagrams or equivalent showing point to point wiring for all instrumentation equipment including terminal numbers. Examples of drawings with type of information required are attached to the end of this section. Control panel drawings shall be provided on 11" x 17" format. Loop drawings shall include at a minimum:
 - i. Area delineation
 - ii. Instrument tagging
 - iii. Signal converters, isolators, etc.

- iv. Cable / wire numbers
 - v. Terminal numbers
 - vi. Junction boxes, terminal boxes, etc.
 - vii. Control panel, remote IO panels etc.
 - viii. PLC / IO terminations
2. Network Diagrams:
- a. Provide a network diagram showing all networked connections. Information on the network drawings shall include the following at a minimum:
 - i. Networked devices and all of the panels or enclosures they are within
 - ii. Cable type and specific termination interfaces/ports (including jumpers) of all cables (fiber and copper)
 - iii. Cable labels
 - iv. VLANs (if used)
 - v. IP address with CIDR notation
 - b. Network drawings of the different layers shall on separate drawings. Telemetry, SCADA, PLC, and DMZ layers may be combined on a single drawing.
 - c. Information on all drawings shall be displayed in traditional drawing format. Information on tables will not be accepted.
 - d. This submittal shall be provided as part of the initial submittals for approval by the Engineer. After installation, testing, and acceptance of the Network by the Engineer, the Network Supplier shall resubmit as part of closeout O&M documentation per as-built field conditions.
 - e. System Integrator shall investigate and document the network as needed to confirm the required capacity and to ensure the integration of new equipment is successful.
3. Bills of Materials (with separate columns for the following: Item Number, Quantity, Manufacturer, Part number, Description, Designator Tag)
4. FAT Report Results
5. SAT Report Results
6. Refer to Section 13410 for additional requirements

1.4 DELIVERY, STORAGE AND HANDLING

- A. In accordance with Section 13410

1.5 CONTROL SYSTEM TESTING:

- A. Tests Procedures Prior to Start-up:
- 1. Refer to Section 13410.
 - 2. Factory Acceptance Test (FAT): A unwitnessed Factory Acceptance Test and verification for all deliverable equipment, software, and associated documentation shall be performed prior to shipment of control systems. The factory tests shall be performed to verify that the control systems are manufactured and assembled correctly, are operating as designed, and are in compliance with the contractual requirements for the deliverables. Communication and integration with Division 11 equipment shall be

demonstrated by indication of network addresses and required data tags with forced status/value changes to be witnessed on SCADA.

- a. The FAT shall include verification and integrated testing of all components. These tests shall include the following.
- b. Visual Inspections: The following inspection checks shall be performed on all deliverable hardware items, as a minimum:
 - i. I/O Subsystem physical layout
 - ii. Power supply mounting
 - iii. Power cable routing
 - iv. Data cable routing and mounting
 - v. Wiring runs properly separated and installed
 - vi. Fans, blowers, and heaters are unobstructed
 - vii. Power supply and power conditioning equipment correctly installed
 - viii. Wire numbering and color coding
 - ix. Device labeling
 - x. Enclosure integrity
 - xi. Paint work
 - xii. Control panel lighting
 - xiii. Panel and enclosure ground connections
 - xiv. Provide photos:
 - (1) Panel Exterior
 - (2) Panel Interior – Door
 - (3) Panel Interior – Enclosure
 - (4) Incoming power distribution
 - (5) PLC
 - (6) Communications devices
 - (7) Rear view of enclosure OIT/HMI
- c. Relay Logic Checkout:
 - i. The System Integrator shall perform a complete checkout for all ladder logic circuits to ensure designed functionality.
- d. I/O Point Checkout:
 - i. The System Integrator shall perform a complete checkout for every I/O point from the field wiring terminal strip to the operator interface terminal functions. The System Integrator shall test every input and output point including spares for proper operation. Test signals shall be generated to verify the operation of each Analog Input (AI) and Discrete Input (DI) including connected interposing relays, intrinsically safe circuits and relay circuits. Each Analog Output (AO) and Discrete Output (DO) shall be also tested for proper operation including control circuits, isolation relays, signal conditioner/isolators and other required control circuits.
 - ii. The System Integrator shall demonstrate that signals are alarmed when reporting under 4 mA and over 20 mA and do not report negative or out of range values.
 - iii. The System Integrator shall develop a point checkout form for each I/O point. The point checkout form shall include the point ID,

description, all checks performed for the point, configured PLC hardware alarms, date and time of the check, and a signoff block for the System Integrator. For each item checked, the form shall include both the expected value/result and the actual value/result witnessed.

- iv. The following items shall be checked for each I/O point:
 - (1) For each analog input point, the following values shall be checked:
 - (a) Value at -2% of full scale (ramped in both directions)
 - (b) Value at 0% of full scale (ramped in both directions)
 - (c) Value at 25% of full scale (ramped in both directions)
 - (d) Value at 50% of full scale (ramped in both directions)
 - (e) Value at 75% of full scale (ramped in both directions)
 - (f) Value at 100% of full scale (ramped in both directions)
 - (g) Value at 102% of full scale (ramped in both directions)
 - (h) Each High and Low Alarm condition
 - (i) Alarm Delay
 - (j) Alarm Enable/Disable
 - (2) For each analog output point, the following values shall be checked:
 - (a) Milliamp reading at 0% of full scale (ramped in both directions)
 - (b) Milliamp reading at 25% of full scale (ramped in both directions)
 - (c) Milliamp reading at 50% of full scale (ramped in both directions)
 - (d) Milliamp reading at 75% of full scale (ramped in both directions)
 - (e) Milliamp reading at 100% of full scale (ramped in both directions)
 - (3) For each discrete input point, the following items shall be checked:
 - (a) For status points, proper indication
 - (b) For alarm points, proper alarm notification
 - (4) For each discrete output point, the following items shall be checked:
 - (a) Proper operation
- e. PLC Programming and OIT/SCADA Operation Checkout:
 - i. Submit the proposed PLC program and OIT/SCADA Configuration (screen printouts) as a shop drawing 15 days prior to the performance of the Factory Acceptance Testing. PLC code shall be a formal submittal.

- ii. Verify to the extent possible that the PLC program and OIT/SCADA Operation, as submitted, performs all control and monitoring requirements as described in section 13441 - Control Loop Descriptions. A list of all modifications to the submitted PLC program shall be maintained and submitted after the FAT.
 - f. 48-Hour Continuous Burn-in Test:
 - i. After the successful completion of the functional testing specified above, a 48-hour continuous run of each control panel provided shall be performed. The test shall be passed if no function is lost, no hardware or software failure occurs, and no module automatic failover occurs. Hardware failure is defined for this test as the loss of a major piece of hardware, such as a PLC processor, I/O board, power supply, UPS, other panel equipment, or improper operation by the controller.
 - ii. During this test, the PLC shall be occasionally (a minimum of 3 times per 24-hour period) exercised with simulated inputs, events, and conditions in a manner that approximates an operational environment in order to verify proper operation.
 - iii. No programming changes will be allowed to bypass failed modules during this test. Any major software and/or hardware correction made to the control panel shall result in the mandatory rerun of the entire 48-hour test for that control panel.
 - iv. FAT Report
 - (1) After FAT, provide and submit a checkout sheet of the FAT. The FAT Report shall include a list of all IO checkout, IO checkout procedure used, Analog IO checkout procedure used, relay logic checkout, visual, and other QAQC observations.
 - g. If any control panels are shipped to the site without having undergone the specified Factory Acceptance Test; and without the prior authorization by the Engineer, shall be removed from the site and shipped back to the control panel manufacturer's factory for testing at no cost to the Engineer or Owner.
- B. Procedures Prior to Start-up:
 - 1. Refer to Section 13410.
 - C. Onsite Control System Startup:
 - 1. Refer to Section 13410.

PART 2 - - PRODUCTS

2.1 MATERIALS

- A. General: Refer to the General Conditions of Section 13440.
- B. Field Instrumentation Enclosures:
- C. Control Panels
 - 1. PLC Control Panels (CP):
 - a. PLC control panels, furnished by Division 13, shall house all of the required PLC and communications equipment.

- b. For PLC and OIT hardware in the panel, see Programmable Logic Controllers - Section 13442.
 - c. For other components in the panels, see Control Panel Components section herein.
 - d. A lamicoid label on the door of the enclosure shall identify the PLC Control Panel. Label shall include the panel tag number and the panel name as indicated on the Instrumentation Drawings and in the list below.
 - e. The enclosure ratings shall be NEMA 12 or NEMA 4X, refer to Electrical drawing E-1 for NEMA ratings required by area.
 - f. Refer to Electrical power plans and control panel schedule for maximum panel sizes (use scaled drawings).
2. PLC & RIO Control Panel Requirements
- a. Each control panel enclosure shall be a NEMA 12 or NEMA 4X enclosure. The panel shall be sized by the System Integrator house all equipment and room for 20% I/O expansion and meet UL 508A requirements.
 - b. All control components shall be mounted using a 35 mm DIN rail.
 - c. The center of the Operator Interface Terminal (OIT), Human Machine Interface (HMI), or panel mounted transmitter shall be mounted no higher than 67" and no lower than 63" above the finished elevation where an operator will stand.
 - d. Provide a folding shelf and keyboard for panel as indicated in the control panel schedule. Shelf should be mounted at least 36-in and no more than 40-in above the floor. Shelf shall hold keyboard when in folded position. Provide an industrial keyboard with integral mouse/touchpad on the enclosure, iKey, Advantech, or equal.
 - e. Provide a PLC control panel shall be provided with a marshaling shelf for top conduit entry cable management as indicated in the panel schedule.
 - f. Floor mount Panels will be located on a 4" high housekeeping pad. Provide a window-kit for outdoor installation.
 - g. Thermal gain calculations shall be provided for all panels provided for or modified in this contract. These calculations shall include all thermal gain sources internal to the panel as well as external factors such as elevated ambient air temperatures, solar gain and any other factors identified by the engineer during the submittal process. Design ambient temperature shall be that of the nearest (to the installation location) ASHREA Climatic monitoring station Annual Mean Maximum and Minimum Dry Bulb Temperature.
 - i. Thermal calculations may use available commercial calculation algorithms or manual calculations using industry standard methods and the below solar gain calculations.
 - ii. Solar Gain shall be calculated by the following table of values using the area of the enclosures Front Face, Top and one side. Sides protected by a sun shield with air gap may be omitted:

Panel Color/Finish	Watts/SqFt
Black	9
Stainless/Grey	7
White	1

- h. Insulation requirements for heated or cooled panels:
 - i. 1” Rigid Fiberglass Insulation installed. The insulation shall:
 - (1) Be of a type that conforms with ASTM C612 Type 1VB, C795
 - (2) Be installed using mechanical fastening or an adhesive that is listed with a MAGW2 rating.
 - ii. Panels that rely on the on the panel thermal transfer for cooling only or indoor panels may not use insulation.
- i. Outdoor installations:
 - i. Provide a dead-front enclosure with front panel components mounted to the interior swing-door kit.
 - ii. Provide enclosure with provisions for mounting in a NEMA 4X enclosure.
 - iii. If a dead-front enclosure is not provided as noted on drawings, a window kit and sunshield shall be provided for OIT/HMI installation.
 - iv. Conduit penetrations on top of enclosure shall not be permitted.
 - v. Provide a door stop kit to prevent doors from opening further than 120°.
- j. Unheated spaces or general outdoors:
 - i. Shall be equipped with a factory installed built-in heater and adjustable thermostat to heat enclosure to the minimum operating temperature of the installed devices.
 - ii. The heater shall include a fan to circulate the air within the enclosure to prevent hot spots. Thermostat shall measure air temperature, not surface temperature.
 - iii. Heater shall be Hoffman Enclosures DAH, Saginaw SCE series, or approved equal.
 - iv. For smaller panels where an enclosure heater would exceed the requirements (temperature, spacing), provide a strip heater with thermostat for condensation control.
 - v. Panel heaters shall be installed in the bottom 1/3 of the control enclosure to assist in thermal efficiency.
 - vi. Refer to above for insulation requirements.
- k. Special Cooling Requirements
 - i. Enclosures installed in high ambient heat areas or which contain Variable Frequency Drives (VFDs) or other heat-producing equipment shall be provided with modifications and/or accessories designed to dissipate excess heat and allow for proper equipment cooling, while maintaining the enclosures NEMA rating. Following are several accessories which may be used, depending upon the

ambient temperature and NEMA rating of the area installed.

- (1) Heat exchangers with circulating fans and filters, for NEMA 12 enclosures.
 - (2) Air conditioners, for NEMA 12 or NEMA 4X enclosures in areas with high ambient temperatures. NEMA 4X air conditions shall be close-looped.
 - (3) Cooling fans shall be wired such that they only operate when the VFD or heat producing equipment is running.
 - (4) Air conditioners where used in enclosures shall operate constantly.
- ii. Refer to above for insulation requirements.
 - l. The enclosure shall open with a padlock-able three-point latch.
 - m. All equipment shall be DIN rail mounted to a subpanel in the enclosure.
 - n. Provide an LED enclosure light fixture for each panel door at the top of the enclosure with an accessible On/Off switch. Provide a duplex GFI receptacle in the panel with a label showing "For Test Instruments only/Computer use only". The receptacle and panel light shall be provided with a separate overcurrent protective device and connected in such a manner so as to not disconnect control, instrumentation, or PLC power in the event that the GFI outlet should trip.
 - o. Each PLC control panel shall have a UPS. See section 13442 for specific UPS requirements. The UPS shall be mounted inside of the enclosure on a specific UPS shelf which keeps it off of the floor of the enclosure. Provide a UPS maintenance bypass switch (MBS) that allows the panel to be powered through the UPS or from line power, refer to schematics for additional details.
 - i. Unless stated otherwise each field instrument whether powered by 120 VAC or 24 VDC shall be powered from the associated Control Panel's UPS. Field instruments that measure processes that are not disrupted during a power outage, require a significant amount of time to reset after power is restored from a power outage, or will cause disruptions to process control if the process value is not immediately available once power is restored shall be backed up by the UPS from the associated Control Panel.
 - ii. The following shall NOT be powered from the UPS:
 - (1) Control panel lighting.
 - (2) Control panel heating.
 - (3) Control panel cooling.
 - (4) Instrumentation powered from control panel, but not indicated by UPS power as indicated on the Instrumentation and/or Electrical Drawings.
- D. Components and Requirements:
1. Enclosures
 - a. Shall be either UL508A or UL698 Listed as an assembly, as required by location of intrinsically safe relays or barriers.

- b. Enclosures shall be sized as required to contain the necessary apparatus for the particular installation. Final panel/enclosure dimensions shall provide for easy access to all internal components with ease of maintenance and future modifications considered. Enclosure size shall accommodate UL requirements. Conflicts with panel sizing and available spacing shall immediately be brought to the attention of the Engineer prior to proceeding to procurement. Panels purchased without submittal/Engineer approval that present installation/egress/clearance issues shall be replaced by the Contractor at no additional cost to the Owner/Engineer.
- c. Panels larger than 36-inches in width or 48-inches in height shall not be wall mounted. Provide two doors if panel is larger than 36-inches wide.
- d. Enclosures larger than 16" in any dimension shall utilize a three-point latching system.
- e. Provide door and body stiffeners where necessary for a rigid enclosure. Floor mounted enclosures shall be provided with lifting eyes and, where floor-mounted, with 12-inch floor stands. No floor stands are to be provided for free-standing models.
- f. Doors shall have side mounted, stainless steel, continuous length, piano-type hinges and pins.
- g. Panels/enclosures shall be equipped with print pockets located on the inside of the door.
- h. A complete "As-Built" panel wiring diagram including exterior devices and motors to be connected shall be encased in clear re-sealable plastic pouch(es) and placed in the print pocket.
- i. NEMA 12 enclosures shall be sheet steel, 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 60" by 36", and 12 gauge for box sizes greater than 60" by 36". Free-standing enclosures shall be 12-gauge minimum. Enclosures shall have continuously welded seams, ground smooth, supplied with no holes or knockouts and a rolled lip around door and enclosure opening. Enclosures to be installed in areas with the potential for dripping liquids shall be provided with drip shields. Provide Oil resistant door gaskets. NEMA 12 enclosures shall be coated inside and out with ANSI 61 gray over phosphatized surfaces. Interior sub-panels for mounting of components shall be painted white.
- j. NEMA 4X stainless steel enclosures shall be Type 304 stainless steel enclosures shall be 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 36" width, and 12 gauge for box widths greater than 36 inches. Free-standing enclosures shall be 12-gauge minimum. Enclosures shall have continuously welded seams, ground smooth, supplied with no holes or knockouts and a rolled lip around door and enclosure opening. Enclosures to be installed outdoors shall be provided with drip shields. Provide oil-resistant door gaskets all around door openings. All enclosure hinges, clamps, etc. shall

- be stainless steel. Enclosures/panels shall be provided unpainted, with metal enclosures having a smooth brushed finish.
- k. Provide enclosures equivalent to:
 - i. Saginaw Control and Engineering
 - ii. Hoffman
 - iii. Or equal
2. Control Panel Wiring Requirements:
- a. All control panel wiring shall conform to the latest requirements of NEC and all state and local code requirements.
 - b. Bundles of wires not in raceways must be secured to the panel structure every 8 inches minimum. All interior wiring will be point to point with no splices.
 - c. Wires to the front of panel devices shall be looped, extra flexible, bundled and located in a manner to prevent damage due to opening and closing the door.
 - d. All control wires internal to panels shall be minimum No. 14 AWG. Wires carrying line voltage shall be minimum No. 12 AWG. All conductors shall be copper. Wiring in close proximity to heating devices shall be Type AVA UL approved. All wiring shall be run in PVC wiring channels and bundled with nylon cable ties. Line voltage wiring must be run separately from control, signal and intrinsically safe wiring. PVC wiring channels shall be properly sized for the capacity of wires being installed based on the overall project needs and shall not be over filled.
 - e. Discrete and analog wiring shall be separated to the greatest extent possible. It shall be assumed that discrete and analog conduits shall be installed into the panel on opposing sides. PLC I/O modules slots and field terminal blocks shall be grouped by type. I/O entry shall be indicated on the drawings as required by UL508.
 - f. Wiring to equipment shall be distributed to the greatest extent possible amongst the PLC IO modules to minimize the amount of common failure points across common equipment. Example: If there are four DI modules and four raw water pumps, each DI module shall have IO for one of the raw water pumps.
 - g. All network switches and routers shall be powered with redundant power supplies.
 - h. Analog wire shields shall be continued until the PLC I/O modules.
 - i. All main, feeder, and branch circuits shall be provided overcurrent protection. PLCs, OITs, HMIs, instruments, power supplies (if not supplied with a field resettable fuse), spare circuits, and networking equipment shall have a dedicated fuse. Overcurrent protection shall be sized appropriately and account for inrush currents.
 - i. Main panel circuit protection shall be a fused disconnect.
 - ii. Feeder 120 VAC circuits shall use breakers for circuit protection. 24VDC branch circuits may use breakers or fuses.
 - iii. All outgoing power (120 V and 24 V) to field devices shall be fused.
 - iv. All loop powered devices shall be fused.

- v. Each PLC module shall have a dedicated fuse.
- vi. Fuse and circuit breaker sizing is the responsibility of the System integrator.
- j. All wires shall be marked at both ends with numbers by self-sticking wire markers or with slip-on style plastic markers. Wire markers shall match the terminal block labels, unless otherwise specified.
- k. Wire color coding shall include the following:
 - i. Red wires - Interior control circuits
 - ii. Yellow wires - Power from external sources
 - iii. Blue wires - DC voltages
 - iv. Blue/White wires – DC return (i.e.-24VDC)
 - v. Green wires - Ground
- l. Terminals shall be arranged in alphabetic and numeric order in columns on removable sub-plates. A maximum of two connections shall be made to each side of a terminal, including jumpers. Provide an additional 20 percent spare terminals for each control panel with the following minimum requirements:
 - i. Power terminals
 - (1) 1 spare 120VAC
 - (2) 1 spare 24VDC
 - ii. Control terminals
 - (1) 10 spare
 - iii. Signal terminals
 - (1) 2 spare non-loop powered
 - (2) 2 spare loop powered
- m. Provide ground terminal for each panel.
- n. All control panels shall be provided with spare mountings for additional relays. Number of spare mountings will correspond to 5% of the total number of relays within each panel, with a minimum of one (1) spare mounting.
- o. All wiring entering and leaving control panels shall be terminated on field terminal blocks and labeled.
- p. Provide individual surge protection for all for all field instruments mounted outside of the building or facility housing the control panel and/or as indicated on the drawings. Instruments mounted within the same structure as the associated control panel do not require surge protection.
- q. Provide protection on all signal and data circuits that leave a building or are routed external to a building. Data circuit protection shall be provided at both ends of the signal or data highway lines within the control panel at one end and as close to the instruments or termination device as possible. Refer to drawings for additional requirements.
- r. Provide equipment labels for all devices on the subpanel to easily identify panel components (relays, network switches, power supplies, etc.) Labels on equipment is not acceptable.
- s. Provide a label indicating the power source on the front of each panel. As-built Panel drawings shall also indicate power source.

- t. Wiring shall be in compliant with the National Electric Code and with the applicable UL requirements. All wiring shall be done with best practices and follow equipment manufacturer guidelines.
 - u. Provide complete "As Built" wiring diagrams to be provided with the O&M manuals and in the enclosures for all control panels.
3. Programmable Logic Controllers (PLC):
 - a. Refer to Specification 13442 - Programmable Logic Controllers for PLC requirements.
 4. Operator Interface Terminal (OIT):
 - a. Refer to Specification 13442 - Programmable Logic Controllers for OIT requirements.
 5. Uninterruptible Power Supply (UPS):
 - a. Refer to Specification 13442 - Programmable Logic Controllers for UPS requirements in Control Panels.
 6. Ethernet Switches (Managed MES, Unmanaged ES):
 - a. Refer to Specification 13445 – Communications Network for MES and ES requirements.
 7. Data/Power Port:
 - a. Provide a Data/Power port with Ethernet RJ45 jack and 120 VAC GFI outlet to meet Arc flash 70E requirements. Data power port will have a lockable hinged cover with panel mounted hardware and shall be installed on the front of the control panel.
 - b. Control panels with a keyboard shall have a Data/Power port with a USB connection.
 - c. Environmental Rating: To match panel NEMA rating.
 - d. The Data and Power port shall be:
 - i. Grace Engineered Products
 - ii. Hubble "Panel-Safe" Power and Data Access Ports
 - iii. Or equal
 8. 12 and 24 VDC Power Supplies:
 - a. Provide 12 and 24 VDC power supplies in the control panel to power field instruments, panel devices, etc., as required.
 - b. No more than three internal panel devices or external field instruments requiring 12 or 24 VDC power shall be powered from a single 12 or 24 VDC power supply.
 - c. Input voltage: 115 VAC
 - d. Output voltage: 24 or 12 VDC.
 - e. Ripple: <50 mVpp.
 - f. The power supply shall have a NO fault /voltage OK contact.
 - g. Power supply shall be N+1 capable.
 - h. The power supply shall be sized to accommodate 125% of the design load.
 - i. Operating temperature: 32 to 140 °F.
 - j. The power supply shall be provided with a means to protect instruments from over current and over voltage.

- k. Mounting: Din rail mount inside enclosures. Power supply shall be located in the enclosure such that heat generated does not cause other panel components to malfunction or become damaged.
- l. 12 or 24 VDC power supplies shall be:
 - i. Sola SDN
 - ii. Allen-Bradley 1606
 - iii. or Equal
- 9. Hand Switches: HS
 - a. Push buttons and selector switches shall be 30 mm and heavy duty oil-tight.
 - b. Switches shall have the same NEMA rating as the panel that the switch is installed in.
 - c. Contact blocks shall be stackable and provide all necessary contacts as shown on the Drawings.
 - d. Each switch shall be labeled as indicated on the Drawings.
 - e. Equal to:
 - i. Allen Bradley 800H series
 - ii. Eaton Cutler-Hammer HT800 series
 - iii. Or equal
- 10. Potentiometer:
 - a. Potentiometers shall be 30 mm and heavy duty oil-tight.
 - b. Potentiometers shall have the same NEMA rating as the panel that the potentiometer is installed in.
 - c. Potentiometer ohm value shall be compatible with the equipment and application.
 - d. Equal to:
 - i. Allen-Bradley 800H Series
 - ii. Square D 9001 Series
- 11. Indicator Lights: YL, AL
 - a. All indicator lights shall be 30 mm, heavy duty oil-tight, 120 VAC, LED with push to test option. Indicator Lights shall be wired such that they can be tested with Control or UPS Power source.
 - b. Lights shall have the same NEMA rating as the panel that the light is installed in.
 - c. Indicator lights shall be provided with a chrome-plated metal or anodized-aluminum mounting rings, engraved as indicated on the Drawings.
 - d. All indicating lights will use the following light color convention: See Instrumentation Drawing I-1 "Indicator Light Color Legend".
 - e. Equal to:
 - i. Allen Bradley 800H series
 - ii. Eaton Cutler-Hammer HT800 series
 - iii. Or equal
- 12. Fuses:
 - a. Fuses shall be 3AB ceramic body fuses rated for at least 125 volts at the current ratings shown on the Drawings. Fuse size shall be ¼" by 1¼".

- b. Blow time shall be: 110%, 4 hours minimum; 135%, 1-hour maximum; 200%, 15 seconds maximum for 1/8-12 amp fuses and 60 seconds maximum for 15-30 amp fuses.
 - c. Fuses shall be:
 - i. Entrelec
 - ii. Bussmann,
 - iii. Or approved equal.
13. Line Surge Protection:
- a. A UL1449 dedicated surge protection device (non-UPS) shall be installed for main power into a panel.
 - b. A UL1449 dedicated surge protection device (non-UPS) shall be installed for panel powered instruments located outside of the building.
 - c. Surge protection shall protect L-G, L-N and N-G.
 - d. Surge arrestor shall be adequate for intended function and shall be by a nationally recognized manufacturer with a minimum of 3-years' experience in manufacturer of such devices. Technology shall a hybrid of Silicone Avalanche Diodes and MOV or MOV and thermal fusing. GDT or sole MOV technology is not acceptable.
 - e. Surge arrestor to include a dry contact for remote monitoring of a surge event.
 - f. Surge arrestor shall be installed per manufacturer recommendations, as close to incoming power as possible, and incoming leads shall be as short as possible.
 - g. Surge arrestor shall have a positive indication of device operation or failure.
 - h. Surge arrestor shall have a Surge Current rating of 25kA per phase.
 - i. Surge Arrestor shall be:
 - i. Weidmuller SPD series
 - ii. Citel DS40 series
 - iii. Or Equal
14. Analog I/O Surge Protection:
- a. Surge protection shall be installed analog inputs and outputs for signals transitioning to the exterior of the building in which the PLC is installed.
 - b. Surge arrestor shall be adequate for intended function and shall be by a nationally recognized manufacturer with a minimum of 3-years' experience in manufacturer of such devices. Technology shall be Hybrid or MOV, GDT technology is not acceptable.
 - c. Surge arrestor shall include protection for the shield.
 - d. Surge arrestor shall have a Surge Current rating of 5kA.
 - e. Surge Arrestor shall be:
 - i. Citel DLA series
 - ii. Weidmuller VSCP series
 - iii. Or Equal
15. Discrete I/O Fusing:
- a. Fuse discrete inputs and outputs in logic groups of eight

- b. Coordinate fuse rating with individual points and the rating required if all eight points were active.
 - c. Use MDA type fusing
16. Analog I/O Loop Fusing:
- a. Fuse all analog input and output loops individually.
 - b. Use 250ma ACG type fusing or equal.
17. Discrete I/O Surge Protection:
- a. Surge protection shall be installed discrete inputs and outputs for field instruments located outside of the building.
 - b. Surge arrestor shall be adequate for intended function and shall be by a nationally recognized manufacturer with a minimum of 3-years' experience in manufacturer of such devices. Technology shall be Hybrid or MOV, GDT technology is not acceptable.
 - c. Surge arrestor shall have a Surge Current rating of 5kA.
 - d. Surge Arrestor shall be:
 - i. Emerson DRS series
 - ii. Phoenix PT 2X1VA series
 - iii. Or Equal
18. AC Filter:
- a. Provide a low pass EMI filter to protect PLC and instruments from high-frequency noise and low-energy transients.
 - b. Filtering shall only be provided on UPS powered circuits and located after the power supply.
 - c. Filter shall be sized for 125% of full load.
 - d. Filter shall attenuate both common and differential mode noise.
 - e. Attenuation: 30dB @100kHz
 - f. MTBF: >1 million hours
 - g. AC Filter shall be:
 - i. Sola STFV
 - ii. Islatrol/IC+
 - iii. Corcom
 - iv. Or Equal
19. Control Relays:
- a. Scope: Control relays used for relay logic.
 - b. Relays shall be electrically held, Form C, electrically operated with 120 volt coils except as noted otherwise on the Drawings. Contacts shall be rated 10 amps at 600 volts or higher as required by the application.
 - c. The number of poles required shall be determined by the System Integrator depending on specific requirements of what the relay is used for. Each relay will be at minimum DPDT or one spare pole per relay.
 - d. Control relay shall have an energized indicator in either the form of a mechanical flag, or neon lamp (LED for DC applications).
 - e. Relays shall be provided with a suppression diode for inductive loads.
 - f. Control Relays shall be:
 - i. Allen Bradley 700-HF Series
 - ii. Idec RU Series

- iii. Or equal
20. PLC Output Relays:
- a. Scope: Control relays used for PLC outputs (isolation relays)
 - b. Each PLC discrete output shall be protected with an interposing relay including spare PLC discrete outputs. PLC output relays shall be SPDT electrically held, Form C, electrically operated with 120 volt coils. Contacts shall be rated at a minimum 5 amps at 300 volts. System Integrator shall use higher capacity relays for equipment that is being powered directly through the relay's contacts.
 - c. Control relay shall have an energized indicator in either the form of a mechanical flag, or neon lamp (LED for DC applications).
 - d. PLC output relays shall be DIN rail mounted and have a slim profile in order to conserve panel space.
 - e. Relays shall be provided with a suppression diode for inductive loads.
 - f. Control Relays shall be:
 - i. Allen Bradley 700HK Slim Line Series
 - ii. Phoenix Contact PLC relay series
 - iii. Or equal
21. Automatic Transfer Relays (ATR)
- a. Scope: ATRs shall be Contactors or IEC control relays are used for the ATR circuit. Devices shall be IEC listed.
 - b. Relays shall be 4NO and 4NC at a minimum and have an auxiliary contact to indicate to the PLC the ATR fail status. The number of poles required shall be the responsibility of the system integrator.
 - c. Relay coil shall be actuated via 120VAC except as noted otherwise on the Drawings.
 - d. Contacts shall be thermally rated for 16A continuously (for 20A panel, or as required by feeder circuit current) at 120VAC and shall be mechanically linked. Auxiliary contacts shall be rated for 5A at 120VAC.
 - e. Relay shall provide positive safety for the N.O. and N.C. contacts which assure that the N.O. contacts will not close before any N.C. contact opens
 - f. Equal to:
 - i. Allen Bradley 700-CF series
 - ii. ABB N44 series
 - iii. Or equal
22. Loop Isolator:
- a. Provide a loop isolator that receives a 4-20mA signal and provides dual isolated 4-20mA output signals.
 - b. Power:
 - i. Loop Powered, 24VDC, or 120VAC
 - c. Input:
 - i. 4-20mA input
 - ii. Channels: 1
 - d. Output
 - i. 4-20mA output
 - ii. Channels: 2

- iii. Transmission Error: <0.2% Off Full Scale
 - iv. Transient Protection 1.5kV
 - e. Relative Humidity: 5 to 95%
 - f. Temperature: -13 to 167 °F
 - g. Accuracy: 0.05% output span
 - h. Equal To:
 - i. Phoenix Contact
 - ii. Pepperl+Fuchs
 - iii. Or Equal
23. Time Delay Relays:
- a. Time delay relays shall be used as required for use as shown on the drawings or described in the specifications. Time delay relays shall be capable of the following functions:
 - i. On Delay (delay on make)
 - ii. Off Delay (delay on release) / True Off Delay
 - iii. Interval On
 - iv. Single Shot
 - v. Cyclic
 - vi. Single Shot Momentary Interval
 - vii. Or other functions specifically referred to on drawing schematics
 - b. Delay timing relays shall be solid state, Form C, electrically operated with 120 VAC coils except as noted on the drawing.
 - c. The number of poles required shall be determined by the System Integrator depending on specific requirements of what the relay is used for. Each relay will be at minimum DPDT or one spare pole per relay.
 - d. Contacts shall be rated 5 amps at 240 volts.
 - e. Minimum time range shall be adjustable from 1 second to 10 minutes. Other ranges as required by function and as indicated on the Drawings or within the Specifications.
 - i. Final settings shall be indicated on the O&M drawings.
 - f. Provide wiring to the relays as required by the function used.
 - g. Basis of Design: Basis of design are multifunction time delay relays. System Integrator may provide single function relays as required, however a spare is required for every type.
 - h. Time Delay Relays shall be:
 - i. IDEC RTE Series
 - ii. Square D RE Series
 - iii. Magnecraft TDR Series
 - iv. Allen Bradley 700 Series
 - v. Or Equal
24. Loss of Phase Relay:
- a. A phase loss relay shall monitor the status of the three phases of line power. The relay shall be rated for the line voltage of the motors.
 - b. The phase loss relay shall change the state of a contact when there is a loss of phase, phase unbalance, or undervoltage.
 - c. A status light shall be on the relay indicating relay status.

- d. Contacts shall be DPDT and rated 5A at 120VAC.
 - e. The delays and trip points shall be adjustable and determined in the field.
 - f. Equal to:
 - i. Macromatic PMD series
 - ii. Eaton D65 series
 - iii. Or Equal
25. Terminal Blocks
- a. Field terminal strips with box type connectors shall be supplied to make all power, control, and signal connections to and from each control panel.
 - b. All terminals shall be clearly marked for easy identification. A ground terminal strip shall also be provided.
 - c. Field terminal blocks shall be single tier for ease of installation and maintenance.
 - d. At least 20 percent of terminals supplied shall be spare. All wiring in and out of a control panel shall be terminated on field terminal blocks.
 - e. All spare PLC I/O (including interposing relays) shall be wired to terminal blocks.
 - f. Prewired terminal blocks from the PLC manufacturer as also acceptable. The prewired terminal blocks shall also meet the specifications herein.
 - g. Field Terminal Blocks shall be:
 - i. Phoenix Contact UT Series
 - ii. Allen-Bradley 1492 Series
 - iii. Or equal
26. DIN Rail
- a. Size: 35mm
 - b. Material: Aluminum or Bronze
 - c. All field terminal blocks shall be mounted on 2" raised DIN rail
27. Spare Parts and Test Equipment:
- a. The System Integrator shall furnish the following spare parts :
 - i. 2 surge suppressors of each type
 - ii. 1 24 VDC Power Supply of each type
 - iii. 1 Uninterruptible Power Supply
 - iv. PLC Components - Refer to section 13442
 - v. 10 of each type lamp, unless otherwise specified herein
 - vi. 3 of each color indicator light lens.
 - vii. 1-time delay relay (of each type)
 - viii. 5 control relays (of each type)
 - ix. 1 complete selector switch of each type.
 - x. 1 complete push-button of each type.
 - xi. 1 complete speed potentiometer of each type
 - xii. 1 of each different contact block for control units.
 - xiii. 1 box of every type of fuse in every panel provided.

PART 3 - - EXECUTION

3.1 INSTALLATION

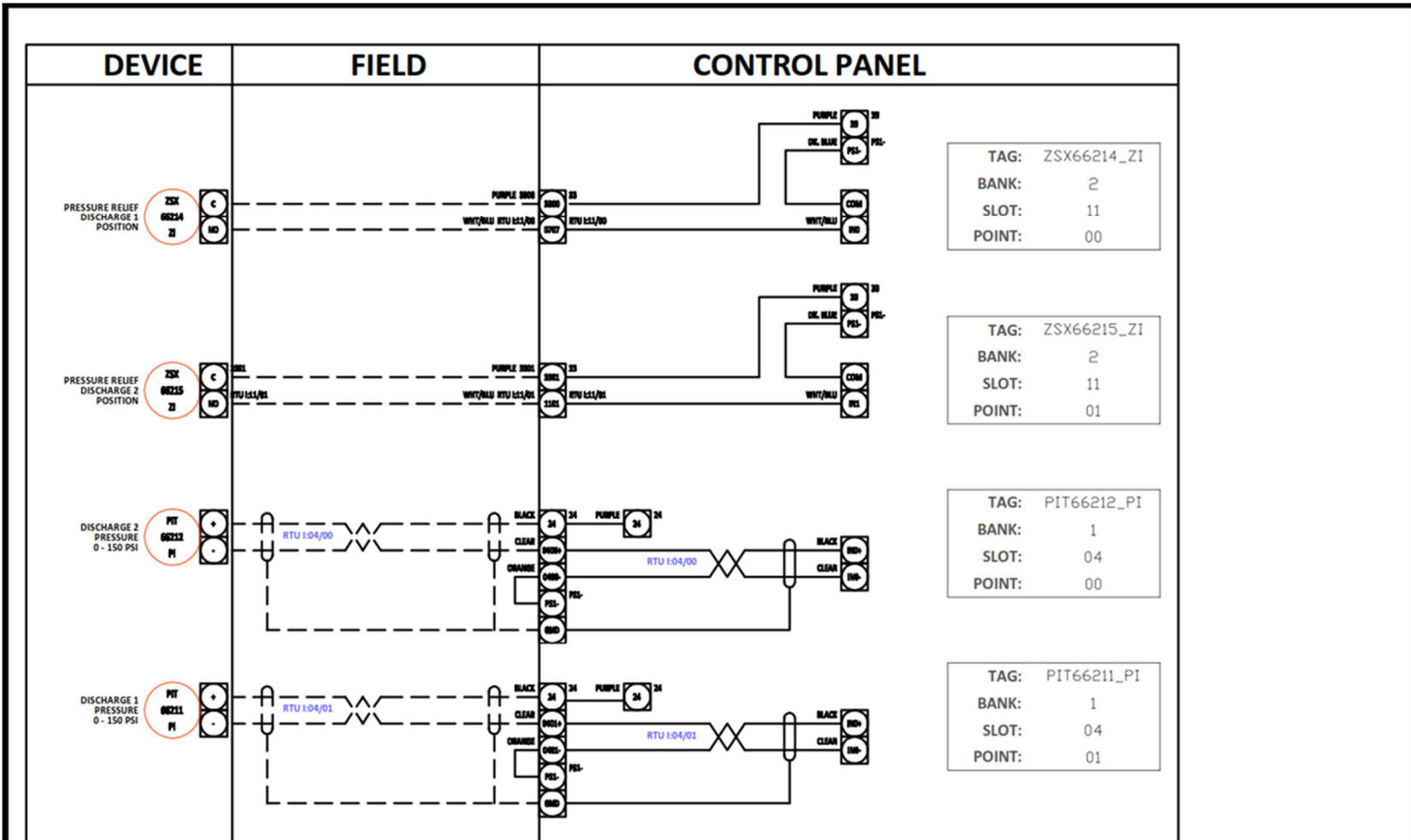
- A. General: Refer to Section 13410 PART 3 - EXECUTION.

PANEL SCHEDULE

<u>Description</u>	<u>Abbreviation</u>	<u>Type</u>	<u>NEMA Rating</u>	<u>Panel Width*</u>	<u>Mounting*</u>	<u>Shelf & Keyboard</u>	<u>Marshaling Shelf</u>
Grease Building Control Panel	GBCP	CP	NEMA 4X	36"	Wall	No	No

*The panel width and mounting are the dimensions and arrangements shown on the electrical plans for reference. System Integrator is responsible for working with the General Contractor and adhering to the specifications.

SAMPLE ISA EQUIVALENT DRAWINGS

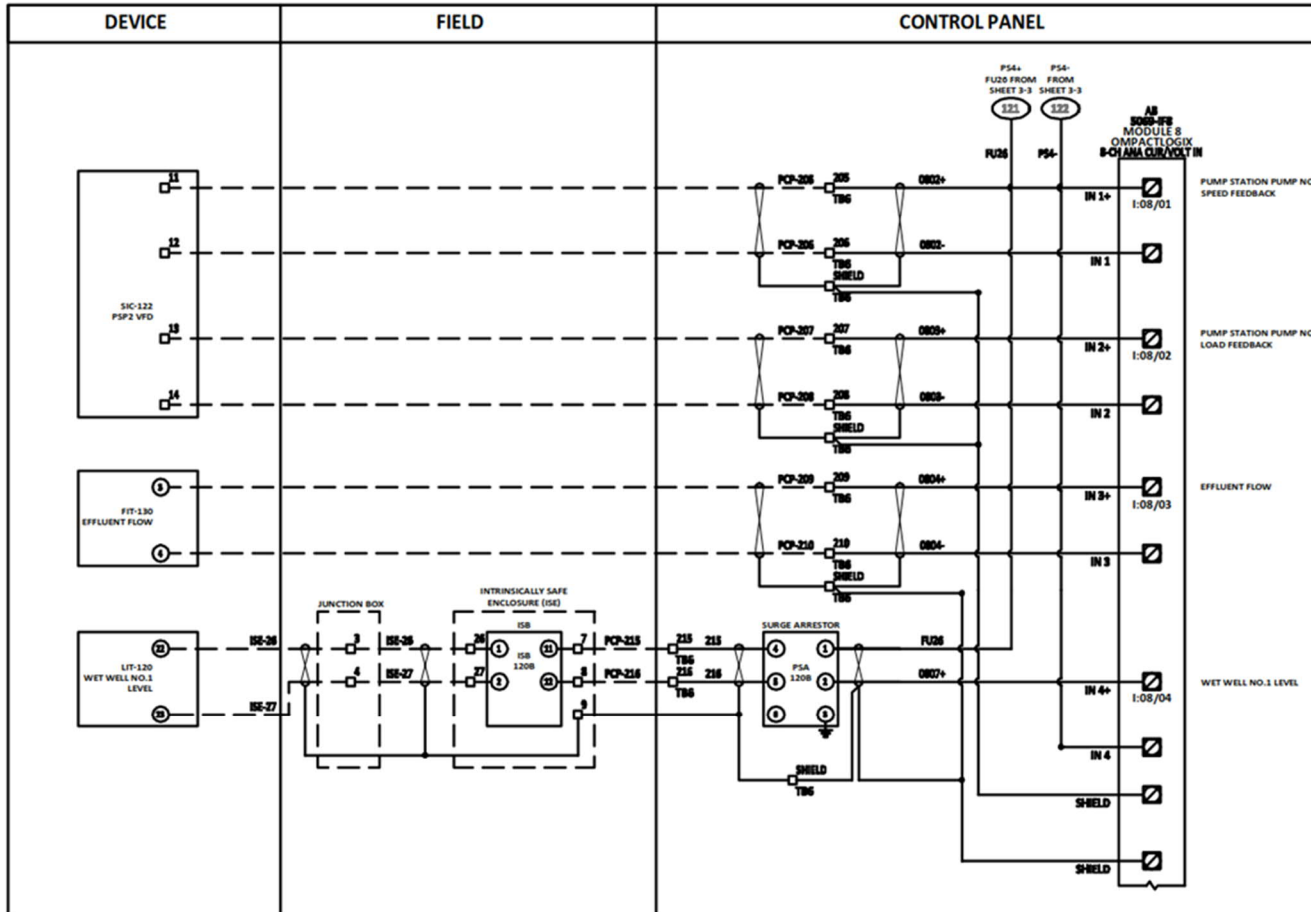


NOTE:
THIS FIGURE IS PROVIDED AS A
GENERAL REPRESENTATION OF
PROJECT WIRING REQUIREMENTS.

**SAMPLE ISA EQUIVALENT DRAWING
SPECIFICATION SECTION 13444**

PROJ NO: OHINST DATE: FEBRUARY 202





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PROJECT WIRING REQUIREMENTS.

**SAMPLE ISA EQUIVALENT DRAWING
SPECIFICATION SECTION 13444**

PROJ NO: OHINST DATE: FEBRUARY 202

WRIGHT-PIERCE 
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SECTION 13445

COMMUNICATION NETWORK

PART 1 - GENERAL

1.1 DESCRIPTION

- A. System Integrator Work Included: Furnish, configure and test a new Hybrid Ring/Star Ethernet communication network consisting of the following:
1. The System Integrator shall furnish and test all hardware and software as specified herein, including, but not exclusive to, network equipment, management software, USB drives, placards, patch cables, etc.
 2. The System Integrator shall configure network equipment described and management software as specified herein and shall coordinate testing during, FAT, startup's, and SAT.
 3. Provide an Ethernet type Process Control Network to allow communication between the control panels stated below and as indicated on the Instrumentation Drawings for control panels and the existing SCADA Server(s).
 - a. GBCP (Div. 13) and PE-COMM-CP (Existing) [FIBER OPTIC]
 4. The System Integrator shall furnish, connect, and test all new CAT6 and fiber optic cables between each control panel (CP), patch panel, and Ethernet devices as shown on the Network Drawing and the Electrical Drawings. Cables shall be installed by the Contractor.
 5. Coordinate with the fiber optic installation and testing. Refer to Specification 13460.
 6. Configure the new managed Ethernet switches and Fiber Patch Panels to communicate with each other in a redundant ring configuration as indicated on the Network Drawing.
 7. Provide a list of all SI configured network devices with IP addresses, usernames, and passwords to access the management tools. Usernames and passwords shall be changed from the default settings and be in best security practices.
 8. Coordinate and test Ethernet switches for communication with Division 11 equipment.
 9. Provide Network Management Software for the communication equipment.
 10. The System Integrator shall provide an individual USB drive with each of the individual managed switch, router, firewall, or cellular router configurations and locate it in the respective control panel or network panel, taped to the door. The configuration shall also be provided in the O&M on a USB drive.
 11. Refer to 13444 for network drawing requirements.
- B. Related Work Specified Elsewhere.

<u>Section</u>	<u>Title</u>
13410	Instrumentation and Process Control General
13441	Control Loop Descriptions
13442	Programmable Logic Controllers
13444	Control Panel

13460 Fiber Optic Cabling

- C. Tests and Procedures Prior to Start-up
 - 1. The CONTRACTOR shall secure the supervisory services of a factory-trained service engineer/technician who is specifically trained on the type of equipment specified herein, shall be provided during construction to assist the CONTRACTOR in methods of installing conduit and special cable; mounting, piping, and wiring of each de-vice, and the methods of protecting all of the equipment prior to placing it into service. Upon completion of the installation, provide the services of a trained service engineer/technician to configure, calibrate, test, and startup the equipment and provide instruction and training for the operating personnel. A sufficient number of service days shall be provided to place the system in satisfactory operation. One additional service call of one 8-hour working day (not including travel time) shall be included for use upon demand of the Owner within the first year's operation.
- D. Demonstration of the Complete Network System
 - 1. Final demonstrations shall be made only after the Engineer is satisfied that the work has been completed in accordance with the intent of the Contract Documents.
 - 2. After the Communication Network is completed, and when directed by the engineer, demonstrate that each of the communication ports on the network is functioning and make final adjustments to the system. If any system or piece of equipment within a system fails to function properly, rectify such defects or inadequacies and make a final demonstration as directed by the Engineer.
 - 3. Provide the services of authorized manufacturers' representatives to instruct the Owner's representatives in the proper operation and maintenance of the system installed under this Contract.
 - 4. Pay all charges or fees, including the cost of any special test equipment, factory engineers, etc., necessary for the proper performance of the specified tests, demonstrations and instructions.
 - 5. All demonstrations and instructions referred to shall be scheduled at the convenience of the Engineer and the Owner and in no case shall be scheduled without at least seventy- two (72) hours written notice.

1.2 QUALITY ASSURANCE

- A. All materials provided under this Contract shall be equal in quality, appearance and performance to that specified herein and shall be subject to the approval of the Engineer. Verify the availability of all materials proposed to be used in the execution of the work prior to submitting same for the Engineer's approval. The discontinuance of production of any material or product after approval has been granted shall not relieve the Contractor from furnishing an Engineer approved alternate of comparable quality and design without additional cost.
- B. Materials and equipment furnished under this Contract shall be standard products of manufacturers regularly engaged in the manufacture of such products and shall be the manufacturer's latest standard design that complies with Specification requirements. Products shall essentially duplicate material and equipment that have been in satisfactory local use at least three years.
- C. The Network Supplier shall have supplied comparable systems to those specified

herein and shall maintain engineering and service departments capable of designing and maintaining these systems. Provide, for a period of twelve (12) months from the date of final acceptance of the work, all necessary supervision, labor, materials, and equipment, in order to correct any defects in any system due to faulty materials, equipment, or workmanship and consequent damage resulting from such defects. This work shall be scheduled during normal working hours and at the convenience of the Owner.

D. Network Supplier:

1. The communication network shall be furnished by one supplier, who shall provide all of the equipment and appurtenances regardless of manufacturer and be responsible to the Owner for satisfactory operation of the entire system.
2. All necessary provisions will be made to ensure a proper interface between the existing control systems and new control panels provided under separate contracts.

E. Acceptable Suppliers:

1. Refer to Section 13410 for acceptable System Integrators.

1.3 SUBMITTALS TO THE ENGINEER

A. Shop Drawings and Samples:

1. Submit Shop Drawings in accordance with General Conditions Section 01340 and as indicated herein.
2. Shop Drawings shall be thoroughly checked for compliance with the Contract Documents. Verify that all furnished equipment and materials will fit into available space and maintain specified clearances, and that all equipment is compatible with the system operation.
3. Shop Drawings shall consist of:
 - a. Project name and location
 - b. Contractor's name
 - c. Index Sheet - Listing the equipment being submitted utilizing equipment designations, or symbols, indicated on the Contract Documents together with the proposed manufacturer, style/type and catalog number.
 - d. Manufacturer's scale or dimensioned drawings along with standard catalog number.
 - e. Equipment ratings, service clearances and configuration.
 - f. Bill of Materials and listing of accessories to be furnished.
 - g. Refer to 13444 for network drawing requirements.
4. All material shall be contained in one submission except for fiber optic cabling. The Network Supplier shall submit a shop drawing for fiber optic cabling within two (2) weeks of award of this contract.
5. Submissions shall be in the form of a binder. Each equipment type shall be separated by index tabs with typewritten titles.
6. Provide samples of instruments, devices, graphics, etc., within ten (10) days upon receipt of request from the Engineer.

B. Maintain properly documented and witnessed test and checkout reports and submit these to the Engineer. These shall include the proper termination and testing of each of the fiber optic cables. No form of energy shall be applied to any part of the

communication system prior to receipt by the Engineer of the supplier's certified statement of approval of the installation and containing their authorization to energize the system, except that the supplier's technician may do so for the purpose of check-out as described herein.

- C. Provide the Owner with a list of local service departments of duly authorized distributors of materials and equipment of the type installed, which will stock the manufacturer's standard parts, etc.
- D. At the completion of the installation, provide reproducible Record Drawings indicating the final configuration of all systems as they were installed. Symbols, equipment designations, etc., shall be consistent with the Contract Documents. Provide exact locations of all work which has been concealed in concrete, masonry or underground.

1.4 DELIVERY, STORAGE AND HANDLING

- A. Coordinate material and equipment delivery with the project schedule. Notify the Engineer immediately, in writing, if material or equipment delivery will adversely affect the project schedule, include documentation from equipment suppliers indicating the revised delivery dates and the reason for the delay.
- B. Coordinate delivery of equipment directly to other vendors where instrumentation supplied under this section shall be installed in panels supplied under other specification sections.
- C. Exercise care during loading, transporting, unloading and handling of materials to prevent damage.
- D. Check for defective or damaged materials, and for incomplete equipment shipments within seven (7) days after equipment delivery to the project site.
- E. Store materials and equipment on the construction site in enclosures or under protective covering in order to assure that materials and equipment are kept undamaged, clean and dry.
- F. Replace or repair, to the satisfaction of the Engineer, all materials and equipment that are defective or that have been damaged during installation, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 COMMUNICATION NETWORK

- A. General:
 - 1. Provide a PLC, OIT/SCADA communications system consisting of a new unmanaged Ethernet hybrid ring/star-network including network panels, managed Ethernet Switches, CAT6, and fiber optic cable and fiber patch panels. Refer to network drawing for layer information. The new equipment should be injected in to the existing network as a spur. Connections shall be made at the following panels and network racks:
 - i. Division 13 Control Panels
 - b. GBCP
 - ii. Existing Control Panels
 - c. PE-COMM-CP

2. The connection to in PE-COMM-CP will first translated from fiber to CAT 6 by use of a Media converter.
 3. Provide the different subnets/networks in the drawings as shown on the drawings. The drawings are not intended on showing every subnet, but the basis of design intent based on the equipment design around. Add additional subnets as required by best practices. Different methods to achieve the same intent may be acceptable with the approval by engineer. Alternative approaches shall be at no cost to Owner.
 4. The networks will use Ethernet protocol and meet 10/100/1000BaseT/FX.
 5. The network equipment will be mounted at each location as shown on the Network Diagrams, Electrical drawings, and as listed below in the Network Schedule.
 6. Network Switch firmware updates shall be of no cost to owner.
 7. The management port of managed switches and routers shall remain open (from other networks) and not used for other purposes.
- B. Fiber Optic Cable and Fiber Optic Patch Panels:
1. Fiber optic cable is specified in section 13460.

2.2 GIGABIT MEDIA CONVERTER:

- A. Provide DIN Rail mounted media converters as shown on the Network Diagram and listed in the Network Schedule.
- B. Power: Redundant 24VDC Inputs
- C. Compliance: Ethernet compatible with the communication protocol of the PLC to be provided
- D. Operating Temperature:
 1. Indoor Mounted: -10 to 60°C
 2. Outdoor Mounted: -20 to 75°C
- E. Communication Ports:
 1. One (1) to Four (4) 10/100/1000BaseTX autosensing RJ 45 Ports
 2. One (1) 1000BaseSX/LX Fiber Optic Channel, two LC connectors
- F. Indicators: Power, Link, and Active LED indicators.
- G. Reliability: MTBF >2million hours
- H. Equivalent to:
 1. N-TRON 1002MC-SX
 2. MOXA IMC-21GA
 3. Or equal

2.3 UNMANAGED ETHERNET SWITCHES

- A. General
 1. Provide unmanaged Ethernet switch(s) for connection to the control network as shown in the Drawings and specified herein.
- B. Physical Features
 1. Copper ports: per network schedule
 2. PoE Copper ports: per network schedule
 3. Fiber ports: per network schedule
 4. Operating temperature: 32 to 130 degrees f
 5. Power: 24 VDC

6. Enclosure: Metal case, DIN-rail mountable
7. Rating: ANSI/ISA Class 1, Division 2 Groups A, B, C, and D
- C. Network Features
 1. Auto sensing duplex and speed
 2. LED link/activity status indication
- D. Acceptable Manufacturers
 1. Phoenix contact
 2. N-Tron
 3. Moxa
 4. Or equal
- E. Basis of design: The drawings are based on generic network equipment. Equivalent alternate equipment (ex. SFP ports, PoE switch in lieu of PoE injectors) will be considered provided that all revisions required to the design, including but not limited to power supplies, fiber optic cable connections, and spare fiber optic jumper cables be accomplished at no cost to the owner.

2.4 SMALL FORM-FACTOR PLUGGABLE INTERFACES (SFP'S)

- A. SFP's shall be manufactured from the same manufacturer of the piece of network equipment they are to be installed into.

2.5 WIRES AND CONNECTORS

- A. Ethernet 10/100/1000 BASE-T/TX Cable.
 1. The unshielded twisted pair (UTP) cable shall be designed for use with a high speed (10/100/1000 Mbps) Ethernet 10/100/1000 BASE-T/TX communications network. The twisted pair cable shall have a nominal impedance 100 ohms at one MHz, a maximum attenuation of 8 dB per 1000 feet at one MHz. The twisted pair cable must have frequency tested up to 250 MHz or more. The twisted pair cable shall be plenum rated and shall have a minimum of four 23 AWG solid copper conductor pairs. All 10/100/1000 BASE-T/TX (RJ-45) terminations on the twisted pair cable shall be done in a professional and workman like manner. Terminations shall provide for proper strain relief on the cable jacket. Strain relief on the wire and/or wire insulation shall not be acceptable.
 2. Identification: Control Panels and networks racks shall use color coded fiber and copper patch cables shall be one color.

2.6 SPARE PARTS

- A. General requirements for spare parts are specified in section 13300.
- B. The following Network and Communications System spare parts shall be furnished
 1. One switch of each type provided.
 2. One media converter of each type provided.
 3. One SFP of each type provided.
 4. Manufacturer's cables - one of each type installed.
 5. Three-6ft CAT 6 patch cables of every color with connectors installed
 6. Three-10ft CAT 6 patch cables of every color with connectors installed

2.7 NETWORK SCHEDULE

ID Tag	Description	Location	Power Supply	10/100TX RJ45 Ports	10/100FX Ports (SC Type)*	10/100/1000 TX RJ45 Ports	10/100/1000 SX/LX Ports (LC Type)*	PoE RJ45 Ports	Managed	Mounting
ES-GBCP	Ethernet Switch	GBCP	24VDC	0	0	4	4	0	No	DIN
MC-PE-COMM-CP	Media Converter	PE-COMM-CP	24VDC			1	1	0	No	DIN

* 1 port is defined as one rx/tx pair

GBCP
Grease Building Control Panel

END OF SECTION

SECTION 13460FIBER OPTIC CABLINGPART 1 - GENERAL1.1 SECTION INCLUDES

- A. Contractor shall provide all labor, materials, equipment and incidentals required to install, and place into successful operation, fiber optic cables and appurtenances for the process and non-process communications systems throughout the plant as specified herein. The system includes, but is not limited to, fiber optic cables, connectors, patch panels, termination kits, enclosures and related appurtenances.
- B. Contractor shall terminate all fibers in the patch panels and equipment designated on the Contract Drawings. Cable runs between termination points shall be continuous. Provide type and quantity of fiber optic cable as shown on the Contract Drawings.
- C. The Contractor shall be responsible to install the equipment specified under this section in accordance with the staging instructions noted in the Contract Documents.
- D. The Contractor shall label all existing Fiber Optic cables referenced on the drawings in accordance with section 3.2.
- E. The Contractor shall provide all terminations, testing, field measurement reports, and implementation of the system.
- F. The Fiber Optic Provider shall provide coordination with the System Integrator for network testing and installation.

1.2 RELATED SPECIFICATIONS

- A. Related Work Specified Elsewhere:

Section	Title
13410	Instrumentation and Process Control General
13441	Control Loop Descriptions
13442	Programmable Logic Controllers
13444	Control Panels
13445	Communications Network
Division 16	Electrical Requirements
	Electrical and Instrumentation Drawings

1.3 QUALITY ASSURANCE

- A. Installers shall be personally experienced in the installation of optical fiber systems and shall have been regularly engaged in the installation of fiber cable for a minimum of the past three years.
- B. Provide all cable in accordance with the listing requirements of Article 770 of the National Electrical Code.
- C. Cable manufacturer shall have a minimum of 20 years in manufacturing optical fiber cable in order to demonstrate reliable field performance. Cable and fiber manufacturer shall be the same company to ensure long-term reliability of the cabled fiber and to ensure the availability of fully integrated technical support.
- D. Testing of any fiber link or connection shall be done by a Bicsi Installer 2, FOA CFOT

or CFOS/T technician, ETA FOT, or equivalent. Certification shall be through Bicsi, FOA, or equivalent body. If the installer does not have trained and certified technicians for testing, a certified third party shall be used. Third party testing agencies are FiberNext, Fiber Optic Cable Specialists LLC, or approved equal.

1.4 SUBMITTALS

- A. Contractor shall submit working drawings, shop drawings and material specifications for the approval of the Engineer in accordance with the requirements of the General Conditions, Article 4 - Contractor's Working Drawings, Design and Shop Drawings, as specified under Detailed Specification 01340, and as specified herein.
1. Manufacturer's product data sheets and complete construction details including physical characteristics of optical fiber, strength members, and jackets.
 2. Overall dimension of cable.
 3. Cable correction factor.
 4. Cable pulling plan, which specifies the sequence of work, tasks, materials, and equipment. The information submitted must include splicing and termination data including the following:
 - a. Detailed bill of materials including fiber optic cable, terminations, patch panels, breakout enclosures, splice kits, connectors, pigtails, and fan-outs.
 - b. Method of connecting cables.
 - c. Details of cable preparation.
 - d. Method of applying materials (including quantities).
 - e. Precautionary measures.
 - f. Drawings showing method of splicing including dimensions.
 5. Cable manufacturer's certified test data for attenuation and bandwidth and the maximum pulling strain allowed.
 6. Provide an optical link analysis for each fiber optic link. Calculate point-to-point (transmit/receive) optical power budget of each fiber link using proposed installed cable lengths. Include all losses through connectors. The power budget shall include transmitter power, receiver sensitivity, connector losses, cable attenuation, and a 2db aging margin. Submit calculated values including sketches graphically showing the proposed cable route.
 7. Installer and field advisor qualification data including name, employer, experience with fiber installations including a list of completed installations, and the names of five references for installations completed that are similar in scope to this project.
 8. Training plan of fiber optic system.
 9. Test reports of any newly installed fiber optic cable.
 10. Test reports of any existing installed fiber optic cable reused for this project.

1.5 DELIVERY, STORAGE, AND HANDLING

- A. Cable Delivery:
1. No cable over one-year-old shall be acceptable for delivery.
 2. Ends of cables shall be kept sealed at all times, except when making splices and terminations. Splice and termination methods approved by the cable manufacturer shall be followed.
 3. Include the following data on each reel:

- a. Facility name and address.
 - b. Contractor's Name.
 - c. Project Title and Number.
 - d. Date of Manufacture.
 - e. Manufacturer's Name.
 - f. Linear Feet.
 - g. Project specific locations specific cable is to be installed.
 - h. Date of manufacture.
- B. Cable Storage: Cable shall be stored at a temperature recommended by the manufacturer for optimum workability.
- C. As the cable reel arrives on site and before the fiber optic cable is removed from the wooden cable reel, the cable shall be attenuation tested at 850nm and 1300nm for multimode fiber (1310nm and 1550nm for single-mode fiber)

PART 2 - PRODUCTS

2.1 GENERAL

- A. All fiber optic cables and connectors specified herein shall meet or exceed the following performance ratings unless otherwise specified:

1. Bandwidth:

Category	Bandwidth
OM1	200 / 500 MHz·Km
OM2	500 / 500 MHz·Km
OM3	1500 / 500 MHz·Km
OM4	3500 / 500 MHz·Km
OS1	3500 / 500 MHz·Km
OS2	3500 / 500 MHz·Km

2. Attenuation:

Wavelength	Bandwidth
850nm	3.5 dB/Km
1300nm	1.5 dB/Km
1310&1550nm	1.0 dB/Km

- 3. Minimum Bend Radius: 20X outside diameter. (installation)
- 4. Minimum Bend Radius: 10X outside diameter. (in-service)
- 5. Cable and connectors are to be fungus resistant.
- 6. Operating Temperature: -20 to +70 degrees C (Indoor Cable) -40 to +70 degrees C (Indoor/Outdoor and OSP Cable)
- 7. Loose-Tube cable shall be dry tube, dry core.
- 8. Cables shall conform to EIA/TIA-568 guidelines and EIA/TIA-455 testing requirements.
- 9. Cables and connectors shall be provided by one of the following manufacturers:
 - a. Optical Cable Corporation
 - b. AFL Global
 - c. Corning Cable Systems
 - d. Or Equal

2.2 FIBER OPTIC INDOOR/OUTDOOR CABLE

- A. Provide graded index loose tuber, gel-free or tight buffered optical glass fiber core

cable compatible with LED and/or VCSEL (category dependent) based transmission system.

- B. Cable shall meet UL OFNP specifications and not require transition splicing upon building entry in order to meet fire codes. Cable shall be suitable for installation in aerial, plenum, and riser environments.
- C. Fanout or Furcation kits shall be used when terminating connectors onto loose tube cables, 900 μ m or 3mm kits will be used. Fanout kit hollow tube colors must match the color of fiber in which it is installed on.
- D. Cable Specifications:
 - 1. Category: OM1
 - 2. Fiber Count: 12
 - 3. Coated Fiber Size: 250 μ m (Loose Tube) or 900 μ m (Tight Buffered)
 - 4. Nominal Cable Diameter:
 - 5. Maximum Tensile Load Short-Term: 600 lbf (2700 N)
 - 6. Maximum Tensile Load Long Term: 200 lbf (890 N)
 - 7. Minimum Crush Resistance: 1800 N/cm

2.3 FIBER OPTIC TERMINAL CONNECTORS

- A. Furnish connectors and components and use specific tools and methods as recommended by the connector manufacturer to form complete and reliable fiber optic cable terminations.
- B. Terminal connector shall be pre-polished with a PC shaped ferrule for multimode fiber optic cable. "Fuse-on" or "FuseConnect" type are recommended as they do not require splice trays. Terminal shall be constructed of a composite housing, ceramic ferrule and a fiber stub permanently bonded into the ferrule.
- C. Connection adapters shall be used sparingly to reduce the amount of attenuation in the fiber optic links. Adapters shall only be used with the approval of the engineer.
- D. Connectors shall be only installed and connected to identical fiber core size cables.
- E. The terminal connector performance characteristics shall be as follows:
 - 1. Reflection: -25dB
 - 2. Durability Delta (1,000 matings) 0.1 dB.
 - 3. Operating Temperature: -40 to +85 degrees C.
 - 4. Cable Retention: 40 pounds.
- F. Specifications:
 - 1. Type: LC, coordinate with the network equipment specified in Section 13445 as applicable.
- G. Terminal connectors shall be provided by one of the following manufacturers:
 - 1. Corning Cable Systems.
 - 2. Optical Cable Corporation.
 - 3. Or approved equal.

2.4 FIBER OPTIC PATCH CABLES

- A. Graded index, fiber optic jumper cables shall of suitable length. Jumpers within control enclosures shall be a minimum of 2ft in length. Jumpers shall be furnished with same type of connectors specified in Section 2.3 and coordinate with equipment, PVC jacket and be furnished by the fiber optic backbone cable manufacturer. Jumper cables fabricated on site shall not be acceptable.

- B. Jumper cables to be of the same category as the other cabling specified herein or as shown on the drawings.
- C. Provide a quantity of jumper cables equal to the total number of fibers terminated in all patch panels.
- D. Jumper cables shall be provided by one of the following manufacturers:
 - 1. Corning Cable Systems.
 - 2. Optical Cable Corporation.
 - 3. Or approved equal.

2.5 CABLE CONSTRUCTION

- A. Riser Cables
 - 1. Riser cables up to 12 fibers: In cables with more than one fiber, the fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord shall be applied between the aramid yarns and the outer jacket to facilitate jacket removal. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.
- B. Plenum Cables
 - 1. Plenum cables up to 12 fibers: The fibers shall be stranded around a dielectric member and surrounded by layered aramid yarns. The aramid yarns shall serve as the tensile strength member of the cable. A ripcord shall be applied between the aramid yarns and the outer jacket to facilitate jacket removal. The outer jacket shall be extruded over the aramid yarns for physical and environmental protection.
- C. The strength member shall be a high modulus aramid yarn. The aramid yarns shall be helically stranded around the buffered fibers. Non-toxic, non-irritant talc shall be applied to the yarn to allow the yarns to be easily separated from the fibers and the jacket.
- D. Cable jacket shall be continuous, free from pinholes, splits, blisters, or other imperfections. The jacket shall have a consistent, uniform thickness; jackets extruded under high pressure are not acceptable. The jacket shall be smooth, as is consistent with the best commercial practice. The jacket shall provide the cable with a tough, flexible, protective coating, able to withstand the stresses expected in normal installation and service.
- E. The cable shall be all-dielectric.

2.6 CABLE IDENTIFICATION

- A. The individual fibers shall be color coded for identification. The optical fiber color coding shall be in accordance with EIA/TIA-598, "Color Coding of Fiber Optic Cables." The coloring material shall be stable over the temperature range of the cable, shall not be susceptible to migration, and shall not affect the transmission characteristics of the optical fibers. Color coded buffered fibers shall not adhere to one another. When fibers are grouped into individual units, each unit shall be numbered in the unit jacket for identification. The number shall be repeated at regular intervals. Outer jacket color shall be standard to the fiber cable category, unless otherwise noted or used in an application where UV stabilization is necessary.
- B. The outer cable jacket shall be marked with the manufacturer's name or UL file

number, date of manufacture, fiber type, flame rating, UL symbol, and sequential length markings every two feet. The markings shall be in contrasting color to the cable jacket.

2.7 FIBER OPTIC CABLE PATCH PANELS (FPPS)

- A. Fiber optic patch panels designated as wall mounted as indicated in the Contract Drawings shall be enclosed in a NEMA 4X wall mounted cabinets for outdoor locations, NEMA 12 for indoor locations, unless otherwise specified. Patch panels shall utilize adapter plates of the same connector type as is identified in Section 2.3 or as shown on drawings. All panels shall be suitable for the cabling specified herein. Where is NEMA 4X FPP is required, it will be acceptable to use a NEMA 12 FPP in a NEMA 4X enclosure as specified in the following section.
- B. Panel mounted fiber optic patch panels shall be mounted directly to the interior subpanel with a minimum of 6" clearance around the patch panel. Panels shall be din-rail mountable and accommodate one connector panel adapter. Din Rail mount patch panels shall be used only if fiber count is twelve or less. Otherwise a wall mounted panel shall be used and mounted in the panel, regardless of what is shown on the contract drawings.
- C. Wall mounted patch panels shall accommodate a minimum of four, six connector panel adapters. Panels shall have a metal enclosure, hinged door, jumper routing guides, strain relief points and lockable door. Appropriate quantities of connector modules shall be furnished.
- D. Distribution rack patch panels shall be mounted in an EIA standard 19-inch width rack enclosure and be on rails. Rack mounted fiber optic patch panels shall accommodate a minimum of three, six connector panel adapters.
- E. Patch panels to use the same type of connectors as specified in Section 2.3.
- F. Splice trays or cassettes shall be installed into any patch panel that contains a splice.
- G. Slack trays or cassettes shall be installed in any rack patch panel that does not use a splice tray or cassette.
- H. Wall mounted and Distribution patch panels shall not be populated any more than 50% of its listed maximum capacity. Panels shall be sized appropriately and be supplied with an appropriate quantity of panel adapters. Blank adapter slots shall be populated with covers for all FPP's.
- I. Strength members of fiber cable shall be secured to the panel.
- J. Zip ties shall not be used to directly clamp cables or tubes onto splice trays. A protective sleeve (such as a felt strip) shall be used to distribute the clamping force. Zip ties shall be hand tightened and trimmed, use of zip tie guns are not permitted.
- K. All patch panels to be installed with a schedule identifying the cable label and fiber number(s). Label is to be visually accurate to the arrangement of the panel.
- L. Install patch panels and fiber in accordance the manufacturer recommendations. Install fiber in panels in accordance with the NEC for any conductive fiber optic cables.
- M. Provide fiber optic cable patch panels as referenced on the Contract Drawings and that meet the following requirements:
 - 1. Furnish panels with the following accessories:
 - a. Splice trays/cassettes (if applicable)
 - b. Slack trays/cassettes (if applicable)

- c. Cable strain relief
 - d. Bend radius protectors
 - e. Routing guides
 - f. Grommetted cable entries
 - g. T adapters and adapter plates
 - h. Sufficient working space for removal of connectors
 - i. Identification label
 - j. All cable management hardware required to accomplish the installation
2. Installation of accessories in a separate enclosure inside the NEMA 4X enclosure shall be permissible.
 3. Furnish each cabinet with a key lock and four (4) keys. All cabinets provided are to be keyed alike so that a single key opens all cabinets.
 4. Furnish cabinets with internal space to store, organize, and strain relieve incoming and outgoing cables.
 5. Ground lug for cable support member and routing supports to maintain allowable cable bend radius.
- N. Where the required number of terminations exceeds the capacity of a single patch panel, multiple patch panels shall be provided.
- O. Product and Manufacturers: Provide one of the following:
1. Corning Cable Systems.
 2. Optical Cable Corporation.
 3. Or approved equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Install cables in the indicated raceway systems. Inspect raceways prior to pulling cables. Rod and swab out conduits and ducts prior to installing cables.
- B. Pull cables prior to attachment of connectors. Terminate all fibers at each patch panel. Install jumper cables at each patch panel as shown on the Contract Drawings, or as directed by the Engineer.
- C. Pull cables using an indirect attachment method such as a "Kellems Grip," along with fiber strength members attached. Pulls with strain directly on the fiber core shall not be allowed. Use swivel when applicable.
- D. Do not exceed maximum pulling strength limits of the cable during installation. Monitor cable pull tensions at all times during the installation of the cable using a remote sensing puller, strain gauge or running line tensiometer. If electronic tension monitoring equipment is used, it shall be calibrated or checked for calibration on a daily basis or prior to any cable pull. If there is evidence of over-tensioning of cable during installation, visible through excessive macrobends, the cable is to be replaced.
- E. To reduce cable friction and minimize pulling forces during installation, use a polymer based, water soluble lubricant when pulling cable.
- F. Do not exceed the minimum bend radius of the cable. Tight loops, kinks, knots, or tight bends shall not be allowed during installation.
- G. For conduit installation, the minimum bending radius shall be 20X when under tension. Use sweeping elbows at all transitions from horizontal to vertical conduit runs.

- H. Provide adequate lengths of cable such that all runs, from termination-to-termination are without splices. Cable splices shall be avoided to the greatest extent possible. Where splice are required they shall be done with the approval of the Engineer and in accordance with the manufactures recommendations. Splicing shall be done with a fusion splicer and have minimal reflections. Splices shall be located in a FPP rated for area.
- I. Provide a minimum of 6ft of service loop for all fibers (used and unused) in every patch panel.
- J. Provide handholds and pull boxes as required by the cable manufacturer or at a minimum of every two hundred feet or at the third 90-degree conduit bend.
- K. Within manholes, route and support fiber optic cable along the inside wall.
- L. Install patch panels at the locations shown on the Contract Drawings.
- M. Unused or disconnected fiber connectors shall be covered to prevent damage to the fiber ends.
- N. Fibers in patch panels shall be neatly coiled in treys.

3.2 IDENTIFICATION

- A. Label each termination point.
- B. Tag each cable in each junction box, pull box, manhole, and handhold. Tags shall solvent and tear resistant, waterproof, and indicate the cable number. Attach tags to cable with cable ties or lacing cord.
- C. Label each patch cord with a wraparound or heat shrink sleeve identifying the cable number and fiber pair within 12 inches of both ends. Labels that have a “tail” will not be accepted. Information shall include cable number as indicated on the Electrical Drawing / Network Drawing and network or control panel the cable is “from” or connected to.
- D. Label each patch cord with a wraparound or heat shrink sleeve identifying the cable number and fiber pair within 12 inches of both ends. Labels that have a “tail” will not be accepted. Patch cords that are 3 feet or less that do not enter a wire way may only use one label.
- E. Label each fiber optic cable.
- F. Duplex patch cords shall use red (transmit) and black (receive) strain relief boots to identify transmit and receive, respectively.

3.3 CHECKOUT AND TESTING

- A. Test fiber optic cables before and after field installation. Tests shall be witnessed by the Engineer and scheduled with 48 hours’ notice.
 - 1. Upon receipt of the fiber optic cable reels, test each fiber separately with an Optical Time Domain Reflectometer (OTDR) to verify fiber length, attenuation and continuity.
 - 2. Test each cable with a launch and receive cable to capture the performance of the entire cable using the OTDR. Both launch and receive cables shall be 150m or greater in length.
 - 3. Test each cable with best practices, including but not limited to:
 - a. Cleaning all connectors prior to each termination and test.

- b. Proper cursor and window settings: Tested cable section (including launch and receive links) is to be greater than 50% of screen, cursors are to be located just before and after first and last link under test connections.
 - c. Pulse width to be appropriate to cable length to minimize dead zones and saturation while still having discernible events. Pulse width is to be 30ns or less for any cable run less than 1km.
 - d. Averaging time to be appropriate to cable length and pulse width to yield a detailed but smooth trace.
 - e. Mandrel installed at end of receive cable in the event of excessive noise.
 - f. Launch cable is not to be included in the OTDR setup and is to start at 0m.
 - g. Indexing gel is not to be used during testing or installation.
4. Test all fibers including spares. Test shall include, but not be limited to the following:
 - a. The test shall be performed on a point to point basis from the head end device to the end device.
 - b. If a section of the fiber optic cable does not meet the testing requirements specified herein or has evidence of micro-bending, the entire link is to be replaced.
 - c. The Contractor shall be responsible for repairing any connector and or cable that does not meet the specifications. Repairs shall meet the requirements specifications.
 5. Furnish certification documents for each test and record the following data. Include printouts from the OTDR with the certification documents.
 - a. Installer's company name and address.
 - b. Installer's name.
 - c. Date of certification.
 - d. Test date and time.
 - e. Attenuation of each fiber link.
 - f. Length of each fiber optic link measured.
 - g. Pulse width.
 - h. Length of Launch and Receive cable.
 - i. Graph of test results with scales labeled on each axis. Graph should take up no less than half of an 8 ½ x 11 page. Cursors shall be located prior to the first event, and after the last event.
 - j. Event table.
 - k. Equipment used to certify the fiber optic link.
 - i. Name of person(s) and certifications of technician(s) recording the test data.
 - l. Digital copies of the OTDR trace results in SOR format shall be available to the engineer upon request.
- B. Power meters shall have calibrations traceable to National Institute of Standards and Technology (NIST) standards.
 - C. OTDR's shall have calibrations traceable to IEC 61746-1 or TIA/EIA-455-226 standard.
 - D. Regardless of core diameter, the maximum cable attenuation for each fiber optic link (device to device) shall not exceed the following losses:

	10/100Base-## (dB)	1000Base-## (dB)
Single Mode Fiber	13.0*	9.0*
Multimode Fiber	7.5*	5.5*

*The attenuation losses include a 3dB aging margin.

- E. The maximum connector and cable attenuation for each fiber optic link shall not exceed the following losses:

	Splice Loss (dB)	Connector Loss (dB)	Cable Attenuation	ORL (dB)
Single Mode Fiber	0.30	0.75	1.0dB /km @ 1310Mhz* 1.0dB /km @ 1550Mhz*	26
Multimode Fiber	0.30	0.75	3.5dB /km @ 850Mhz 1.5dB /km @ 1300Mhz	20

*OSP SM attenuation shall be less than 0.5dB/km at both 1310 and 1550Mhz frequencies for outdoor cable.

3.4 SPARE PARTS AND TEST EQUIPMENT

- A. Contractor shall furnish and deliver the spare parts and test equipment as outlined below, all of which shall be identical and interchangeable with similar parts furnished under this specification.
- B. Spare parts shall be packed in containers suitable for long term storage, bear labels clearly designating the contents and the pieces of equipment for which they are intended.
- C. The following shall constitute the minimum required spare parts:
1. Three (3) (#ft) fiber patch cables of each type used.
 2. Three (3) "One-Click" Mini or equal for use with each type of connector used.
- D. The following shall constitute the minimum required test equipment:
1. None.

END OF SECTION

SECTION 16010ELECTRICAL - GENERALPART 1 - GENERAL1.1 DESCRIPTION

- A. Provide all labor, materials, equipment, operations, methods and procedures as indicated in the Contract Documents, together with all items necessary for or incidental to the completion of the work.
- B. All systems or additions to existing systems indicated in the Contract Documents shall mean all necessary supervision, labor, equipment and materials required to provide complete, properly functioning systems.
- C. All systems shall be adjusted, tested, inspected and turned over to the Owner in perfect working order.
- D. The words "provide", "supply", "supply and install", "install", "furnish" or "furnish and install", as used in DIVISION 16 or as indicated on the Drawings related to DIVISION 16 shall mean a complete and properly functioning Electrical installation performed by the Contractor.
- E. References:
 - 1. Refer to Architectural, Structural, Heating and Ventilating, Plumbing, Process Piping and Instrumentation Drawings to coordinate material and equipment locations and electrical requirements.
 - 2. Applicable portions of DIVISION 0 - BIDDING AND CONTRACT REQUIREMENTS together with DIVISION 1 - "GENERAL REQUIREMENTS", are part of DIVISION 16.
 - 3. Refer to SECTION 00100 - INSTRUCTIONS TO BIDDERS; SECTION 00700 - GENERAL CONDITIONS; SECTION 00800 - SUPPLEMENTARY CONDITIONS; and as specified herein regarding substitutions of materials and equipment.
- F. Division 16 Contract Requirements and Responsibilities:
 - 1. The requirements of Division 16 - Electrical is based on the information provided in the Contract Documents. This information has been outlined in either the specifications or the drawings or both. The contractor's responsibility of Division - 16 Electrical is to review all information in both the specifications and the drawings in order to determine the complete work required. Whether the work is specified in the Specifications or shown on the Drawings it is required as part of the work. No additional compensation or interpretations stating that it was not shown in both locations will be acceptable or allowed. No additional compensation will be allowed when Specifications and Drawings conflict; the project engineer will determine how the installation is to be completed.
- G. Work Specified Herein:
 - 1. Visit and examine the project site and become familiar with all existing conditions pertinent to the work to be performed thereon. No additional compensation will be allowed for failure to be so informed. This contractor is

- responsible to be familiarized with the conditions of the project during the bidding period in order to bring any clarifications or issues to the attention of the Engineer prior to submission of his/her final bid price.
2. The following scope of work is a brief generalization of the type and extent of the work specified under DIVISION 16. Detailed requirements are indicated on the Drawings and in related sections of the Specifications. The work specified under DIVISION 16 includes, but is not limited to the following:
 - a. Provide Electrical Service and Distribution Systems as indicated on the "Single-Line Diagrams", related drawings and schedules, and as specified herein. There is a significant amount of electrical demolition and reconnection of equipment to remain for the work required for this project and therefore a thorough understanding of the existing conditions is critical. It is to be understood that the drawings do not intend to show or provide details for all of the existing conditions or equipment to be demolished. In addition, not all existing condition information may reflect exact conditions due to the accuracy of existing data and information. As an example, there are a significant number of existing branch circuit panelboards which have been listed and shown for this project. The existing panelboard schedules have been shown and noted as could be determined or as noted on existing information. The Contractor's responsibility is to field investigate and determine all existing conditions. Any and all existing equipment which is found to remain shall be reconnected to new panelboards with new conduit and wiring of equal sizing and conditions which presently exists in order to provide a complete system reconnection. No exception will be allowed for any extra compensation to perform this work. This contractor is responsible to be familiarized with the conditions of the project during the bidding period in order to bring any clarifications or issues to the attention of the Engineer prior to submission of his/her final bid price.
 - b. Provide complete lighting system(s), including all necessary fixtures, hangers, wiring, connections, controls and lamps for areas as shown on the Drawings and as specified herein.
 - c. Provide all required 480 Volt, 208 Volt, 240V, and 120 Volt Power and Control wiring, Signal wiring, grounding, and connections for equipment specified under DIVISIONS 11, 13, 14, and 15 except as indicated on the Drawings and specified herein.
 - d. Provide all required and supplemental motor starters, protective device sizes, wire and conduit sizes, holding coil voltages and control voltages specified under DIVISIONS 11, 13, 14, and 15. All rating and sizing shall match the requirements of equipment specified. No additional compensation will be allowed for modifications required due to equipment and devices which differ from those of specified equipment.
 - e. Provide complete branch circuit wiring systems including all raceways, conductors, cables, outlet and junction boxes, wiring devices and device connections as shown on the Drawings and as specified herein.

- f. Provide complete TVSS and/or lightning arrestor and surge capacitor devices for distribution equipment and/or instrumentation devices as shown on the Drawings and as specified herein.
- H. Work Specified Elsewhere:
1. The materials and methods used for all Electrical Work indicated in the Contract Documents shall meet the requirements specified in Division 16.
 2. The following Electrical Work and Work relating to the Electrical Work will be performed under other Divisions of the Contract Documents. This Contractor is to review all the Contract Documents and Drawings and shall coordinate with the other related areas which will affect his/her work under this Contract in order to avoid any and all conflicts:
 - a. Substitutions, product options, cleaning up and project record documents are specified in DIVISION 1.
 - b. Site work and excavation are specified in DIVISION 2.
 - c. Concrete Work DIVISION 3.
 - d. Metals are specified in DIVISION 5.
 - e. Firestops are specified in DIVISION 7.
 - f. Painting is specified in DIVISION 9.
 - g. Process equipment is specified in DIVISION 11
 - h. Special Systems and instrumentation is specified in DIVISION 13.
 - i. Conveying systems are specified in Division 14.
Mechanical equipment is specified in DIVISION 15.
 3. The Engineer will have the authority to make the final determination for unresolved conflicts between Divisions. No additional compensation will be allowed due to the Engineer's determination.
- I. Removals and Relocations and Rearrangements:
1. Examine the existing site, structure(s) and installation(s) for the work of all trades which will influence the cost of the work under DIVISION 16. This work shall include removals, relocations, rewiring and rearrangements relating to the work of all trades which may interfere with, disturb or complicate the performance of the work under DIVISION 16; and relating to the work involving systems, equipment and related service lines which shall continue to be utilized as part of the finished project.
 2. When the Contract Documents indicate elimination of, or structural changes in walls, floors, ceilings, enclosures, pipe chases, etc., remove, relocate, rearrange and reconnect as required, all existing Electrical Work such that systems to remain shall continue to function properly.
 3. Provide in Bid all associated labor, material and costs to include all removals, relocations, rewiring, rearrangements and reconnections herein specified, necessary or required to provide approved operation and coordination of the combined new and existing systems and equipment.
 4. Demolition:
 - a. Disconnect and remove existing equipment, devices, boxes, conduit, and associated electrical equipment as shown on the contract drawings.
 - b. Any demolition, relocation or rearrangement work performed which results in unused openings in control panels, instrument panels, control

- stations, pull or junction boxes, etc., which are to remain shall be plugged by appropriate means such that it maintains the integrity of the NEMA classification of the area, as defined on Drawing E-1.
- c. Any demolition, relocation or rearrangements which results in unused openings in walls, ceilings, floors, etc. shall be sealed using approved methods to maintain the fire rating and NEMA classification of the existing structure.
 - d. Review all Contract Documents and coordinate with all disciplines for a complete understanding of this demolition work. Provide all new work required to modify these changes along with all requirements for installation of the new work, as shown on the Contract Drawings.
 - e. There are areas where the demolition shall require that existing pullboxes, conduit, wiring and associated devices be disconnected, removed, relocated and in some cases, be replaced in order for the new equipment, walls, structures, etc. to be constructed and installed. In most cases, the detail of these existing conditions has not been shown. This Contractor will be responsible to perform all work necessary to demolish all required conduit, wiring, boxes and associated equipment for the noted and intended demolition. At no time shall this Contractor imply that he/she does not understand the responsibility of associated demolition as the Contractor shall visit the site locations and shall become familiar with the areas where this work is to be performed. If there are any concerns or issues regarding this work, they need to be addressed and submitted to the Engineer for clarification prior to submission of the final bid price for the work of this Contract. All costs associated with this work is the responsibility of this Contractor and shall be included as part of the overall costs for the electrical work of this project. No additional costs shall be allowed by this Contractor for any demolition work required under the work of this contract.
 - f. Disconnect and remove all abandoned conduits, wiring, boxes, equipment, controls, hangers, etc. shown or not shown, which is located within the area of construction under this contract.
 - g. Per the request of the Owner, disconnect, remove, protect and return to the Owner specific equipment scheduled for demolition. No additional compensation will be allowed.
5. The Contractor is responsible for temporary power associated with Removals, Relocations, and Rearrangements to maintain the existing facility operational. Refer to section within this section for requirements.
- J. Codes and Fees:
1. Comply with the following codes, standards, regulations and specifications most recently accepted by the Authority Having Jurisdiction:
 - a. National Electrical Code (N.F.P.A. No. 70 - most recent)
 - b. Life Safety Code (N.F.P.A. No. 101 - most recent)
 - c. Occupational Safety and Health Act (O.S.H.A.) - regarding construction practices.
 - d. Utility company standards, specifications and requirements.

- e. Telephone company standards, specifications and requirements.
 - f. Cable company standards, specification and requirements.
 - g. State and local electrical codes, building codes, and fire codes for the locale where the work is to be performed.
 - h. N.F.P.A. 820 Standards for Fire Protection in Wastewater Treatment and Collection Facilities.
2. Compliance with the above codes, standards, etc., does not relieve the Contractor from the requirements of the Contract Documents which may exceed these codes, standards, etc. but which are not contrary to them.
 3. If it is observed that the Contract Documents are at variance with any of the above codes, standards, etc., promptly notify the Engineer in writing, and necessary changes shall be adjusted by appropriate modification. If any work is performed which is contrary to such codes, standards, etc., the Contractor shall assume full responsibility therefore and shall bear all costs in correcting such work in order to comply with such codes, standards, etc.
 4. Secure and pay for all permits, fees and licenses necessary for the proper execution of the work under DIVISION 16.
- K. Tests and Procedures Prior To Start-up:
1. Refer to Section 16950 - Testing Electrical Systems and start-up for testing and scheduling requirements.
- L. Demonstration of Complete Electrical Systems:
1. The Owner will assume no liability or responsibility for any portions of the installation under this Contract until they are demonstrated and accepted in writing. Final demonstrations shall be made only after the Engineer is satisfied that the work has been completed in accordance with the intent of the Contract Documents.
 2. Refer to Section 16950 for additional requirements.
- M. All electrical equipment shall be suitable for the areas where mounted in accordance with Area Classifications indicated on Electrical Drawings. In specific, refer to Drawing E-1 NEMA classification for Electrical Equipment and Enclosures for specific requirements and these specifications. In addition, there are several areas which have been indicated to meet NEC National Electrical Code requirements based on the final location of the equipment. Coordinate and provide these NEMA ratings whether or not specifically stated on the Drawings. Contractor shall assure that the proper type, enclosure, mounting and catalog numbers are provided during the Submittal phase.

1.2 QUALITY ASSURANCE

- A. Supply all new materials, devices and equipment in conformance with:
1. Underwriter's Laboratory, Inc.
 2. National Electrical Manufacturers Association.
 3. American National Standards Institute.
 4. National Electrical Code (NEC).
 5. Local Power Company.
 6. Local Telephone Company
 7. Local Internet Provider
 8. OSHA

- B. All materials provided under this Contract shall be equal in quality, appearance and performance to that specified herein and shall be subject to no exceptions taken by the Engineer. Verify the availability of all materials proposed to be used in the execution of the work prior to submitting same for the Engineer's review. The discontinuance of production of any material or product after the Engineer's review has been made shall not relieve the Contractor from furnishing an alternate of equal quality and design without additional cost.
- C. Materials and equipment furnished under this Contract shall be standard products of manufacturers regularly engaged in manufacture of such products and shall be manufacturer's latest standard design that complies with Specification requirements. Products shall essentially duplicate material and equipment that have been in satisfactory local use at least three years.
- D. The Contractor shall have supplied comparable systems to those specified herein and shall maintain engineering and service departments capable of designing and maintaining these systems. For a period of twelve (12) months from the date of acceptance of the work, provide all necessary supervision, labor, materials, and equipment, in order to correct any defects in any system due to faulty materials, equipment, installation methods, or workmanship and consequent damage resulting from such defects. This work shall be scheduled during normal working hours and at the convenience of the Owner.
- E. All switchboards, motor control centers, panelboards, motor starters, transformers, and distribution equipment shall be by the same manufacturer based on providing the Owner with equipment of the same type. This will allow for replacement and spare parts of the same type and also allow efficient maintenance of this equipment.
- F. All electrical equipment shall be suitable for the areas where mounted in accordance with Area Classifications indicated on Electrical Drawing E-1. Contractor shall assure all equipment is installed in strict accordance with the latest version of the National Electrical Code.
- G. All equipment to be submitted such as low voltage switchboards, motor control centers, panelboards, dry-type transformers, motor starters, disconnect switches, etc. shall be furnished by the same single manufacturer unless otherwise noted. Substitutions of multiple manufacturers for this equipment shall be rejected.

1.3 SEISMIC CONTROL

- A. Design, provide and install Seismic Restraints for Nonstructural Components of electrical systems per Division 13 Specifications.

1.4 SUBSTITUTIONS

- A. General
 - 1. Where new equipment is specified to be provided as part of an extension to an existing system, the manufacturer of the new equipment shall match that of the original. Substitutions will not be considered as equal unless specifically noted so.
 - 2. Certain new equipment and systems have been specified with one or more make(s) followed by the phrase "or equal". In such cases, the Contractor may submit a proposed substitution for review by the Engineer. The decision of equality of a proposed substitution rests fully with the Engineer.

3. Certain new equipment and systems have been specified with one or more make(s) WITHOUT the phrase "or equal". In such cases, only one of the manufactured products listed will be allowed. No other manufacturer is allowed.
4. Where substitutions are allowed as "equal" it shall be the Contractor's responsibility to make any and all necessary modifications required to accommodate the installation of the substituted item(s) at no additional cost to the Owner.
5. The Drawings have been designed and shown with a basis of design being of a specific vendor. This Contractor shall understand that if the submission is by another vendor to be considered as an equal then it shall be his/her responsibility to provide a system which will be thoroughly coordinated to meet the intended design. Any additional equipment, conduit, wiring, controls, etc., required to make the final installation "as equal" will be the responsibility of the Contractor and shall be included at no cost to the Owner.
6. Systems submitted which require extensive work in order to review will be rejected or the Contractor shall be assessed additional costs for additional resubmissions required for obtaining no exceptions by the engineer for the equipment to be considered as an acceptable equal submission.

1.5 SUBMITTALS TO THE ENGINEER

- A. Submit Shop Drawings, O&M documentation, and manufacturer certificates per Section 01340.
- B. Provide all certificates of inspection and approval from all regulatory agencies having jurisdiction over the Work under Division 16.
- C. Maintain properly documented and witnessed test and checkout reports and submit these to the Engineer prior to energizing the Electrical system.
- D. Submit complete documentation for coordination, short circuit, and arc flash study and report immediately upon approval of equipment and prior to start-up and testing of any equipment. Selection of equipment in order to make any necessary changes based on the study's findings before the equipment is approved. No start-up will be allowed without this study and report and without the final recommended system settings being implemented and tested in the field. If equipment needs to be ordered prior to receiving the study, all necessary changes will be the responsibility of the contractor at no additional costs.
- E. Provide copies of all correspondence including verbal communications with the utility company to the Engineer. Correspondence shall verify approval of the utility company for the proposed service, as designed. This must be submitted as soon as possible based on the intended design indicated on the Contract Drawings and part of the approval process for this Section.
- F. Furnish the Engineer with a written statement from the Owner indicating that he is satisfied with the operating instructions given.
- G. These requirements for Shop Drawings are in addition to the standards in Section 01340.
 1. Shop Drawings Shall Consist of:
 - a. Project name and location.
 - b. Contractor's name.

- c. Index Sheet - Listing the equipment being submitted utilizing equipment designations, or symbols, indicated on the Contract Documents together with the proposed manufacturer, style/ type and catalog number.
 - d. Manufacturer's scale or dimensioned drawings along with standard catalog "cut" sheets. These cut sheets shall be marked up to indicate equipment, sizes, types, etc., of equipment and all options being provided.
 - e. Equipment ratings, service clearances and configuration.
 - f. Listing of accessories to be furnished.
 - g. Single-line and schematic diagrams where applicable. All text and symbols shall be easily legible and submitted on a 11"x17" sized drawing(s) as necessary.
 - h. Refer to related sections of the specifications for special shop drawing requirements for individual equipment types.
2. All Cut Sheets shall be marked up to indicate specific equipment, specific sizes, specific types, etc., for all equipment and materials with all options provided for this project. Catalog cut sheets that are not properly marked up or are difficult to read and understand as to what equipment or application that it is used for will be returned un-reviewed for re-submittal.
 3. The contract drawings have provided detailed customized schematic wiring diagrams for all motor control center equipment as well as individual wall mounted starters, control panels, etc. These are very detailed and a lot of effort has been expended to compile these diagrams. The equipment manufacturer/supplier of this equipment as specified shall be responsible to provide the following detailed and customized schematic wiring diagrams.
 - a. A separate customized and detailed schematic for each piece of equipment (i.e. RAS pumps No. 1, No. 2 and No. 3). Even though the schematic appears to be same for this equipment a separate schematic for each will be provided with the referenced title (i.e. RAS Pump No. 1, etc.) noted on the respective schematic.
 - b. Each schematic shall indicate and show the specific devices (hand-off-auto, run light, ETM, etc.) and a reference to where this is located.
 - c. All contacts and interlocks shall be identified as to their location.
 - d. All metering and interface devices such as digital metering, TVSS, lightning protection, etc., shall be shown, identified, and dimensional heights from bottom of equipment shall be noted.
 - e. Failure to provide the proper customized schematic wiring diagrams shall be grounds for automatic rejection. Any delays, scheduling issues and additional contract time and cost associated with these delays due to equipment not being approved or being rejected for these reasons shall be the responsibility of the Contractor.
- H. The following example is provided as a suggested formatting guideline. In addition to expediting the review process, this formatting will help ensure that the vendor has included all items applicable to the submittal, reduce the number of re-submittals and ensure a quality project.
1. Submittal Formatting:
 - a. Project information as required by the contract specifications.

- b. Contact page.
- c. Index sheet - this sheet shall list each page number with a description of its contents, i.e., Page 1 - MCC 12.
- d. Each tab shall be set up as follows:
 - i. Pertinent project specific information and modifications associated with this MCC, with references to the general information tab number.
 - ii. A parts list of all items/devices and accessories associated with this MCC including starters, relays, controls, fuses, etc.
 - iii. A project specific nameplate data sheet for the MCC - this shall include, but not limited to, full project specific title descriptions, starter/feeder information and submitted wiring diagram number.
 - iv. Dimensioned MCC layout plans and elevations pertaining only to this MCC.
 - v. Project specific MCC one line diagram.
 - vi. A complete set of project specific wiring diagrams for all loads associated with this MCC. Wiring diagrams shall include the following general information: The full project specific title of the load served and the submitted applicable compartment number. If more than one motor of a specific load within the applicable MCC is indicated then separate and identified wiring diagrams shall be submitted for each load description and compartment number. All wiring diagram information and notation shall be clearly defined and referenced. Common wiring diagrams will not be acceptable.
2. As shown, this format is set up for a motor control center submittal, however, the same format shall be used for all switchboards, control panels, lighting panels etc.
3. Each submittal shall be neatly bound with typewritten index sheets.
4. Each control panel, system or equipment package shall be submitted in its entirety with all associated controls, devices, panels, layouts, wiring diagrams etc., included.
5. If the contractor relies on the equipment provider to submit this information, it shall be the Contractor's responsibility to ensure the format is as noted above. Submittals which do not clearly indicate, in an organized manner, what is being provided will be rejected, without being reviewed, for the submittal.
6. Equipment submitted which will be used throughout the facility, such as Local Control Stations, junction boxes, conduit, panels etc., shall clearly indicate which areas these will be located or used for, either on the submittal or a cross referenced list i.e., PVC conduit - Chemical Room, or screw type covered stainless steel enclosure - pullbox in NEMA 4X environments, etc.

1.6 RECORD DRAWINGS

- A. At the completion of the installation, provide reproducible Record Drawings indicating the final configuration of all Electrical Systems as they were installed. Symbols, equipment designations, etc. shall be consistent with the Contract Documents. Provide exact locations of all work which has been concealed in concrete, masonry or underground.

- B. Electrical contractor shall provide detailed red-lined instrumentation loop diagrams, control panel diagrams, and motor schematics indicating exact point to point wiring. The electrical contractor shall coordinate and provide red line information to the instrumentation vendor. The instrumentation vendor shall revise diagrams and motor schematics based on red lined information.
- C. The requirements above are in addition to the standards for Record Drawings in Section 01720.

1.7 DELIVERY, STORAGE AND HANDLING

- A. Coordinate material and equipment delivery with the project schedule. Notify the Engineer immediately, in writing, if material or equipment delivery will adversely affect the project schedule, include documentation from equipment suppliers indicating the revised delivery dates and the reason for the delay.
- B. Exercise care during loading, transporting, unloading and handling of materials to prevent damage.
- C. Check for defective or damaged materials, and for incomplete equipment shipments within seven (7) days after equipment delivery to the project site.
- D. Store materials and equipment on the construction site in enclosures or under protective covering and off the ground in order to keep materials and equipment undamaged, clean, and dry. Provide temporary heat for equipment as required per the manufacturer to mitigate exposure to moisture and cold temperatures.
- E. Replace or repair, to the satisfaction of the Engineer, all materials and equipment that are defective or that have been damaged during installation, at no additional cost to the Owner.

1.8 GUARANTEE/WARRANTY

- A. Guarantee all equipment, materials and workmanship in accordance with the General Conditions and Supplemental Conditions of the Construction Contract and Section 11000.
- B. Warrant all material furnished and work executed is in accordance with all applicable laws and regulations.

1.9 COORDINATION, SHORT CIRCUIT AND ARC FLASH STUDY

- A. Furnish and implement a complete and approved coordination, short circuit and Arc Flash study for the complete electrical system.
- B. The following is a summary of the requirements of this study:
 - 1. Bound copy of the complete study information with cover sheet, table of contents, tabbed index markers for each appropriate section, cover letter with stamped and signed PE reference as to the preparer of the study and indication of system responsibility. The professional engineer shall be licensed in the state of which the project is being performed.
 - 2. Short circuit and protective device coordination study including complete arc flash system study for the entire project location including all new and existing electrical systems and equipment and a summary of findings.
 - 3. Tables and listings of all equipment and results of short circuit results summarized for review.

4. Description of the study and overview of system and how the study was performed.
 5. All single line diagrams, devices shown, identification tags, bus tags for a complete description.
 6. Circuit breaker and relay settings table summarizing the final recommendations for breaker coordination settings.
 7. Identifying any discrepancies with the system devices and overall short circuit and coordination settings for the system with recommendations for revisions to the equipment.
 8. Field testing and setting of all equipment with final field walk-through with the Engineer that these settings have been properly performed. A system check off and sign off must be performed for final acceptance that the actual installed equipment is coordinated with the final study requirements and settings.
 9. A complete and acceptable system shall be provided for this portion of the work.
 10. Furnish an Arc Flash Hazard Analysis Study per the requirements set forth in the current version of NFPA 70E -Standard for Electrical Safety in the Workplace. The arc flash hazard analysis shall be performed according to the IEEE Standard 1584 – 2002, the IEEE Guide for Performing Arc-Flash Calculations. Studies shall be performed by a registered engineer in the state that the project is being completed. The engineer shall have 10 or more years of experience in completing Arc Flash Hazard Analysis Studies.
 11. Furnish available fault current lamacoid nameplates at all service equipment including switchboards and all motor control centers within the facility as required by the National Electric Code article 110.24(A).
 12. Arc Flash Hazard Methodology Analysis Results and Recommendations including the details of the incident energy and flash protection boundary calculations, along with Arc Flash boundary distances, working distances, Incident Energy levels and Personal Protection Equipment levels.
 13. Arc Flash Labeling section showing types of labels to be provided. Section will contain descriptive information as well as typical label images. Labeling and Arc Flash results shall be provided for each and every electrical distribution system equipment both existing and new for this facility.
- C. Submittals for Review:
1. The studies shall be submitted to the design engineer prior to receiving final review of the distribution equipment shop drawings and/or prior to release of equipment drawings for manufacturing. If formal completion of the study may cause delays in equipment shipments, review from the Engineer may be obtained for a preliminary submittal of data to ensure that the selection of device ratings and characteristics will be satisfactory to properly select the distribution equipment. The formal study will be provided to verify preliminary findings.
- D. Qualifications:
1. The short-circuit, protective device coordination and arc flash hazard analysis studies shall be conducted under the responsible charge and approval of a Registered Professional Electrical Engineer skilled in performing and interpreting the power system studies.

2. The Registered Professional Electrical Engineer shall be an employee of the equipment manufacturer or an approved engineering firm.
 3. The Registered Professional Electrical Engineer shall have a minimum of five (5) years of experience in performing power system studies.
 4. The approved engineering firm shall demonstrate experience with Arc Flash Hazard Analysis by submitting names of at least ten actual arc flash hazard analyses it has performed in the past year.
- E. Data:
1. Contractor shall furnish all data as required for the power system studies. The Engineer performing the short-circuit, protective device coordination and arc flash hazard analysis studies shall furnish the Contractor with a listing of required data immediately after award of the contract. The Contractor shall expedite collection of the data to assure completion of the studies as required for final review of the distribution equipment shop drawings and/or prior to the release of the equipment for manufacturing.
 2. Source combination may include present and future motors and generators.
 3. Load data utilized may include existing and proposed loads obtained from Contract Documents provided by Owner, or Contractor.
 4. If applicable, include fault contribution of existing motors in the study. The Contractor shall obtain required existing equipment data, if necessary, to satisfy the study requirements.
 5. A complete and acceptable system study shall be provided for final acceptance.

1.10 SUBCONTRACTOR COORDINATION AND RESPONSIBILITY

- A. Coordination with Division 13
1. Instrumentation supplier shall provide point to point wiring schematics to electrical subcontractor to allow completion of all instrumentation and control conduit and wiring between all devices, system control panels, and all equipment provided by Division 11, Division 13, Division 15 and Division 16.
 2. The instrumentation supplier shall coordinate all power, control and signal needs or requirements with the electrical contractor prior to construction.
- B. Coordination with Division 15
1. Electrical subcontractor is responsible to review the HVAC Drawings and Specifications to determine the power conduit and wiring requirements. Electrical subcontractor is responsible to implement conduit and wiring needs to match the functional descriptions in DIV. 15 except that specifically identified as being provided by the HVAC subcontractor. HVAC subcontractor shall be responsible for all control, low voltage 24VDC / 24VAC, conduit and wiring. This shall include, but is not necessarily limited to, wiring for automatic temperature control, and control wiring for plumbing systems. The HVAC subcontractor shall provide all miscellaneous 120VAC control from HVAC control panels to final control devices, as required, unless specifically included in Electrical work per the Drawings and Specifications.
- C. Coordination with Division 2 and Division 3
1. The electrical subcontractor is required to provide a substantial amount of underground work and coordination relating to the following items:
 - a. Underground duct banks and installation

- b. Pad-mounted transformer and Standby Generator
 - c. Electrical manholes and handholes
 - d. Existing and new underground utilities and process equipment
 - i. The electrical manholes and handholes shall be furnished and installed under Division 2 - Site Work. The electrical subcontractor shall coordinate all required elevations, manhole or handhole openings, elevations, wall openings and final locations of these structures with this section to provide for a proper installation. Coordinate and verify that all manhole and hand-hole covers are "stamped" with the proper designation for power, control, signal and other wiring identifications.
 - ii. Excavation, bedding and backfilling shall be furnished and installed under Division 2 - Site Work. The electrical subcontractor shall coordinate all excavation for duct bank locations for both new and existing conditions with this section in order to provide a complete understanding of where and how these duct banks are to be installed.
 - iii. Concrete encasement for duct banks shall be furnished and installed under Division 3 - Concrete. Duct banks shall be formed up neat and tight to provide for proper encasement of conduits. Reinforcing steel shall also be furnished and installed under Division 3 - Concrete.
 - iv. Concrete pads for pad mounted transformers or standby power generators shall be furnished and installed by Division 3 - Concrete. The excavation; bedding and backfill shall be furnished and installed under Division 2 - Site Work. Coordinate pad sizing, openings and orientation with this section for proper installation.
 - D. Coordination with Miscellaneous Divisions
 - 1. The electrical contractor shall coordinate all coring, cutting and patching of openings in existing structures and locations with the General Contractor in a timely manner not to delay scheduling of the project.
 - E. Schedules:
 - 1. The electrical subcontractor shall maintain close contact and coordination at all times with the work of these related Divisions in order to provide a complete electrical system or delay the scheduling of the project.
 - 2. Perform all coordination and scheduling of all cutting, temporary power usage with all other trades. patching, trenching, painting, trench covers, plastering, chases, slots, furring, grounds, masonry foundations, piers, excavating, pole bases, backfilling, pads, duct banks and other work incidental to installation of apparatus as required for electrical work.
- 1.11 CONDUIT LAYOUT PLANS AND DETAILS FOR CONCEALED AND EXPOSED WORK
- A. The Contract documents require that conduit be concealed in walls, floors, ceilings or below floor slab in slab on grade areas due to the configuration and layout of the proposed building construction.
 - B. In areas of exposed conduits, conduits shall be installed via vertical drops down to equipment in order to maintain a clean and consistent look of conduit for this

installation. Horizontal runs shall be limited to ceiling racked installation and shall drop down to equipment. In areas of hung ceilings and accessible space above ceilings conduits shall be installed concealed within these areas with vertical drop down to the equipment to be fed.

- C. A detailed conduit layout plan and routing path for the new addition shall be submitted for review and with no exceptions taken by the engineer prior to performing any work. The plan shall clearly indicate the equipment locations and path of runs along with overall sizes of conduits to be installed for a complete layout plan.
- D. The contract drawings specifically note areas with blackout structural openings for the installation of conduits into and within the proposed building. A coordination review of equipment locations and layouts will be required such that the conduit layout plan has been pre-planned and approved prior to the commencing of the work. There is a significant amount of conduit to be installed under this project and this plan will provide an overview of the intended work to be performed.
- E. The contractor shall be allowed to reduce the number of conduit runs by combining conduit runs and increasing overall conduit sizes based on the National Electrical Code (NEC) allowable sizing and derating requirements. The contract documents will limit this however based on the allowable sizing of conduits within the slab and also this will be limited to smaller branch circuit feeders. Individual motor feeders to equipment such as pumps, process equipment runs, electrical distribution feeders and HVAC larger loads will not be allowed to be combined as further stated within the contract documents.
- F. The Conduit and Wire Schedule has provided a summary of individual conduit runs throughout the project in order to clearly indicate where conduit and wiring is to be installed. The contractor shall utilize the schedule along with the electrical plans to develop the overall Conduit Layout Plan as required under this section. The submitted plans shall be formatted on 2' x 3' full size plans and submitted as part of the shop drawings requirements for this project prior to commencing any and all work.
- G. The electrical contract drawings are diagrammatic and may not specifically show exact locations of the equipment. The contractor shall coordinate all conduit layout, and dimensions with the final equipment locations for the entire project for both concealed and exposed conduit runs.

1.12 TEMPORARY POWER, TELEPHONE, AND TELEMETRY REQUIREMENTS

- A. It shall be required that the Electrical Sub-contractor maintain the existing facility and associated equipment operational during all times of the work of this contract. This Contractor shall be responsible to provide temporary power (both normal and emergency standby power) to energize and maintain system operations.
- B. This shall include all power, control, signal, telephone and telemetry system requirements. There will be a need to provide temporary telephone services to the facility in order to meet the operational requirements of the facility equipment. This shall be based on the sequence of construction required for this project.
- C. Temporary light & power.
 - 1. The Electrical Contractor shall provide all temporary power, and the General Contractor shall pay for all temporary power usage fees typically, the electrical subcontractor will provide the temporary electrical services and exclude energy

usage fees. the general contractor or the owner will typically pay for the energy usage fees associated with the project.

2. Limit power and hand tool usage to motors not exceeding 1/2 HP.
3. Temporary power shall be separate from process power required to maintain the existing facility operational during sequence of construction and the duration of the project.

1.13 SEQUENCE OF CONSTRUCTION

A. Requirements for Sequence of Construction

1. Upon installation and connection of the temporary power and telephone services, the electrical sub-contractor is responsible to extend these services to the existing treatment facility. Extend power capacity based on the service switch size shown on the existing single line diagram or maintain existing service operational until new electrical service is completed and accepted. Provide conduit and feeders equal to the present installation or as required for complete treatment facility system operation. Install and terminate services to existing equipment. All installations shall be safe and installed per NEC requirements.
2. Maintain equipment operations as required under Section 01010A. The electrical sub-contractor shall be responsible to maintain power, telephone, cable, control, signal and telemetry services to equipment as noted in Section 01010A, as well as when sequencing the new electrical system equipment and wiring for the existing treatment facility. All necessary material, labor, equipment and associated costs, etc. necessary to maintain the sequence of operation shall be the responsibility of the electrical sub-contractor as specified.
 - a. It shall be required that this Electrical Sub-Contractor maintain the existing treatment facility operational during all times of the work of this contract. Therefore, this contractor shall be responsible to provide temporary power to control and maintain system operation. All temporary power requirements are the responsibility of this contractor based on the needs for the sequence of construction for this project. This does not include temporary power necessary for construction trailers or job setup as this is a separate item as defined under the General Conditions, Section 01500 - Temporary Facilities and Controls. In order to be clear about this requirement of the project, it is important to understand that all temporary power requirements and systems operation (which is process related for the sequence of construction) is the responsibility of this Contractor based on the needs to complete any and all work of this project. There is a significant amount of work required to provide and maintain temporary power to existing facility operations during all times during the schedule of this Contract. Therefore, a complete understanding of this requirement is critical. This shall include any temporary relocations, conduit, wiring, re-wiring, temporary electrical equipment, etc., required during all demolitions and new installations. This shall include all emergency standby power requirements necessary to maintain emergency standby continuous facility operations at all times also during the schedule of this Contract. All costs associated with this work is the responsibility of this

Contractor and shall be included as part of the overall costs for the electrical work of this project. No additional costs or compensation shall be allowed by this Contractor for any temporary power requirements necessary for this project.

1.14 MEASUREMENT AND PAYMENT

- A. Measurement and payment for the work described in this section and will be made in accordance with the provisions of Section 01150 and DIVISION 1 MEASUREMENT AND PAYMENT.

1.15 REQUEST FOR INFORMATION

- A. When there is a conflict or coordination issue, or if additional information is necessary for the contractor to proceed with the intended work, a Request of Information (RFI) form shall be submitted through the General Contractor to the Engineer. The specific issue shall be described in the RFI and shall be sent to the engineer for review and a response provided in an appropriate time period. RFI form shall be available via the General Contractor through the Engineer as required for this contract. This process shall be used as part of the work of this contract.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Materials shall be as specified in the appropriate Sections of DIVISION 16.
B. No exceptions to the Engineer of materials shall be as indicated in these Sections.

PART 3 - INSTALLATION

3.1 INSTALLATION

- A. Installation shall be as specified in the appropriate Sections of DIVISION 16.

3.2 TESTS

- A. Refer to all related requirements as set forth within SECTION 16950 and additional testing as indicated in the appropriate Sections of DIVISION 16.

3.3 CLEANING

- A. Do not allow refuse and surplus materials to accumulate on the project site during the course of the work. Areas shall be cleaned and picked up on a daily basis.
B. Upon completion of the work, remove all refuse and surplus materials and leave the premises neat and clean on a daily basis.
C. Clean all equipment surfaces and touch up all damaged surfaces to the satisfaction of the Engineer.
D. Clean all lighting fixture reflector assemblies, lenses, louvers and lamps upon completion of the installation.

END OF SECTION

SECTION 16050

BASIC MATERIALS AND METHODS GENERAL

1.1 DESCRIPTION

- A. The Drawings are diagrammatic, unless detailed dimensioned Drawings are included, and show approximate locations of distribution equipment, fixtures, control panels and wiring devices. Equipment layouts shall be submitted prior to work in these areas with sufficient time for a detailed review. All equipment and locations shall be closely reviewed and coordinated. Coordinate all work and equipment locations with the Engineer prior to performing final installations.
- B. While the general run of electrical feeders, branch circuits and conduits are indicated on the Drawings, it is not intended that exact routing be determined there from. Conductors can be combined in conduits for ease of construction as permitted by these specifications and the latest edition of the N.E.C.
- C. Circuit designations can be found on the contract drawings in the combination of any of the following formats:

Single Line Diagrams	"Home Runs"
Electrical Schematics	Wiring Diagrams
Control and Instrumentation Diagrams	Panelboard Schedules
	Conduit and Wire Schedule

The Contractor shall be responsible for reviewing all drawings and may modify these designations subject to field conditions and review of the Engineer.

- D. Measurements shall be made and coordinated with all approved equipment at the site and in the buildings during construction and all systems installed as the work progresses in such a manner that the equipment, piping, vents, ducts, conduit, etc., will fit in the space provided, maintain head room and if in unfinished areas, be as neatly installed, as obscure and "out-of-the- way" as physically possible.
- E. Prior to submission for review any item of equipment, determine whether or not it will fit in the space provided and that no design changes in conduits, wiring or controls will be required. Any changes in the size, location or interconnections of the material or equipment supplied, which may be necessary in order to meet field conditions or in order to avoid conflicts between trades, shall be brought to the immediate attention of the Engineer and no exceptions must be taken before such alterations are made.
- F. All equipment and accessories and its interconnecting piping, ductwork, conduits, etc., shall be installed in such a manner that ample maintenance passage and Code-required space/access will be provided.
- G. Where more than one trade is involved in an area, space or chase, all shall cooperate and install their own work to utilize the space equally between them in proportion to their individual requirements. In general ductwork shall be given preference (except where grading of piping becomes a problem) followed by piping then electrical wiring. If, after installation of any equipment, piping, ducts, conduit, etc., it is determined that ample maintenance and passage space has not been provided, the work shall be rearranged and/or furnished with other equipment as required to

provide this space at no additional cost to the Engineer. The Contractor shall review the drawings for all other trades to determine any potential interferences and identify and coordinate with those with other trades.

- H. When there is a conflict or coordination issue, or if additional information is necessary for the contractor to proceed with the intended work, a Request for Information (RFI) form shall be submitted through the General Contractor to the Engineer. The specific issue shall be described in the RFI and shall be sent to the Engineer for review and a response shall be provided in an appropriate time period. RFI form shall be available via the General Contractor through the Engineer as required for this contract. This process shall be used as part of the work of this contract.

1.2 QUALITY ASSURANCE

- A. In General, the workmanship of the electrical installation shall be as described in the N.E.C.A. Electrical Design Guidelines. All methods of construction, details of workmanship, etc. that are not specifically described therein or indicated in the Contract Documents, shall be subject to the control and approval of the Engineer.
- B. Equipment and materials shall be of the quality and manufacture indicated in their respective sections of the Specifications.
- C. Work determined by the Engineer to be unsatisfactory according to industry standards shall be redone at the Contractor's expense, with no additional compensation.
- D. All efforts shall be made in the location and installations of all raceways and equipment for a neat, logical, and safe installation as it pertains to personnel and operations.
- E. An electrical conduit and associated electrical devices, etc., shall be installed concealed wherever possible in order to provide for a clean and limited amount of exposed conduit runs. Coordinate all work with the Engineer prior to performing this work.

1.3 SUBMITTALS TO THE ENGINEER

- A. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.
- B. The contractor shall be responsible to submit a complete list of conduit type to be used for all locations of the project. A Conduit Layout Plan shall be submitted as a shop drawing with the following:
 - 1. Shall include a column for exposed and concealed conduit heading. Mark up each location with the type of conduit to be used for the respective space in the appropriate heading of exposed and concealed installation.
 - 2. Provide detailed drawings indicating intended routing and combination of conductors. Refer to section 16010 for additional requirements.
- C. Submit a shop drawing for the following equipment, materials, products, etc.:
 - 1. Conduit, Raceway and Tubing.
 - 2. Conductors and Cable
 - 3. Outlet Boxes
 - 4. Pull and Junction Boxes and Terminal Cabinets
 - 5. Wiring Devices

6. Control Devices and Equipment
7. Motor Starters
8. Safety Disconnect Switches
9. Enclosed Circuit Breakers
10. Fuses
11. Ground Rods
12. Metal Framing Channel
13. Hangers and Supports

14. Phase Failure Relays
15. Time Delay Relays (Electro-pneumatic)
16. Submission of written verification that the electrical manholes, handholes and covers, electrical duct banks and transformer pads have been coordinated, reviewed and acceptable with the electrical work to be provided under this Section.
17. Distribution Equipment (medium and low voltage)
18. Motor Control Centers
19. Main Switchboard and Secondary Switchboards
20. Control Panels
21. Miscellaneous Electrical Distribution Equipment
22. Lighting Fixtures
23. Variable frequency drives
24. Transformers
25. Lighting flexible hangers
26. Conduit and wall and floor link seal fittings
27. Conduit cable sealing fittings
28. Medium Voltage Cable
29. Hand Hole
30. Test results on all feeder conductors and heat trace cables as specified in Section 16950.

PART 2 - PRODUCTS

2.1 MATERIALS

A. Conduit, Raceway and Tubing

1. Rigid Heavy Wall Steel Conduit (RSC or RGS) shall be constructed of hot dipped galvanized or electro-galvanized steel. Acceptable Manufacturers: Allied - a division of Atkore, Wheatland, Republic Conduit, or equal.
2. Electrical Metallic Tubing (EMT) shall be constructed of electro-galvanized steel. EMT fittings shall be interlocking compression type of cadmium-plated malleable iron or zinc coated steel, or stainless steel. No die cast, set screw and indenter type fittings shall be used. Acceptable manufactures are Allied - a division of Atkore, Wheatland, Republic Conduit, or equal.
3. Aluminum conduit shall be rigid, heavy wall aluminum. Acceptable manufacturers: Anaconda, Kaiser, VAW, or equal.
4. Flexible Metal Conduit

- a. Flexible Metal Conduit shall be constructed of one continuous length of U. L. Approved electro-galvanized, spirally wound steel strip with interlocking convolutions and interior surfaces free from burrs and sharp edges.
 - b. Flexible metal conduit shall be "liquid-tight" with PVC jacket. Acceptable Manufacturers: Alflex - a division of Southwire, Electri-Flex, Thomas & Betts - a division of ABB, or equal.
 - c. Flexible Metal Conduit installed in outdoors, NEMA 4X, or 4X Corrosive areas shall use PVC coated connectors.
 - d. Flexible metal conduit installed in hazardous, NEMA 7, Class I Div 1 areas shall be UL Listed, and shall have a stainless steel braid covering over a flexible stainless steel inner core. Packing shall be woven cotton braid impregnated with asphalt. Acceptable manufacturer: Crouse-Hinds - a division of Eaton, Killark, Thomas & Betts - a division of ABB -XP Series, or equal.
5. Non-Metallic (P.V.C.) Conduit shall be Schedule 80, extra heavy wall or Schedule 40, heavy wall and UL Listed for the use intended. Acceptable Manufacturers: Carlon, Harrison, JM Eagle, or equal.
6. P.V.C. Coated Rigid Galvanized Steel Conduit
- a. The PVC Coated Rigid Galvanized Steel conduit, shall fully comply with the following industry listings and manufacturer's standards without exception prior to PVC coated application, shall conform to Federal Specifications WW-C-581E, ANSI Standard C80.1, ANSI Standard C80.5 UL Standard #6 and NEMA RN1-2005.
 - b. The PVC coated rigid galvanized steel (RGS) conduit shall comply with the below listed specifications without exceptions allowed. PVC coated rigid galvanized steel (RGS) conduit shall be hot dipped galvanized both internally & externally. The PVC coated rigid galvanized (RGS) conduit shall have hot dipped galvanized threads. The external PVC coating shall be a nominal 40 mils of external PVC coating and 2 mils of blue interior urethane coating. The PVC coating shall be applied by the same manufacturer of the hot dipped galvanized rigid steel (RGS) conduit.
 - c. Conduit bodies and fittings for PVC coated rigid galvanized steel (RGS) conduit shall be from the same manufacturer as the PVC coated rigid galvanized steel (RGS) conduit. Conduit bodies shall be coated on the entire body both internally and externally with 2 mil of blue urethane and exterior coated with 40mil of PVC coating.
 - d. All conduit, conduit bodies, connectors, support systems and accessories in the corrosive areas, above grade or below grade, shall be coated as specified.
 - e. The thickness of the coating is to be a nominal 40 mils except where the configuration or application of the unit dictates otherwise.
 - f. PVC coated conduit shall be UL or ETL Listed.
 - g. During the manufacturing of the PVC coated rigid galvanized steel (RGS) conduit, the factory applied hot dipped galvanized coating of both the internal and external (RGS) conduit shall not be disturbed in any fashion

prior to the application of PVC coating being applied as per UL 6. The PVC coated rigid galvanized steel (RGS) conduit shall comply with all UL listings providing the hot dipped galvanized coating as the primary means of protection of corrosion protection for the conduit, and the PVC coating shall be listed as a secondary means of corrosion protection as required by UL 6 and NEMA RN-1-2005.

- h. Every female opening shall have a plastic sleeve extending one pipe diameter or 2", whichever is less, beyond the opening. The inside diameter of the sleeve shall be the same as the outside diameter of the pipe used with it. The wall thickness of the sleeve shall be the same as the plastic coating.
 - i. Fittings and Accessories:
 - i. Right angle beam clamps and U-bolts will be provided with PVC encapsulated nuts that cover all exposed parts of the threads.
 - ii. U-bolts will be sized to snugly fit the nominal 40 mil coated conduit.
 - iii. The screw heads on Form 8 condulets shall be stainless steel encapsulated by the same manufacturer. All conduit bodies used in wash down, wet or outdoor applications shall be NEMA 4X rated.
 - iv. Couplings shall have longitudinal ribs 40 mils in thickness to protect them from wrenches or channel-locks.
 - v. All coated conduit and fittings must be installed wherever possible by a certified trained installer using a tool available from the manufacturer for the use intended in order to protect the PVC coating.
 - j. The interior coating shall be applied in such a manner so as to allow field bending without cracking or flaking of the interior coating.
 - k. Acceptable manufacturers shall be: Plasti-Bond, Thomas & Betts-a Division of ABB/Ocal, Perma-COTE, or equal.
7. All fittings shall be of the same material as the respective raceway system.

B. Cable Tray:

- 1. Materials and Finishes:
 - a. Aluminum straight section and fitting side rails and rungs shall be extruded from Aluminum Association Alloy 6063. Fabricated parts shall be made from Alloy 5052.
 - b. Pre-galvanized steel straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A446, Grade A and mill-galvanized in accordance with ASTM A525, Coating Designation G90. Covers for all types of steel tray will also be furnished from mill-galvanized steel in accordance with ASTM A525 G90.
 - c. Hot-dip galvanized after fabrication steel straight section and fitting side rails and rungs shall be made from steel meeting the minimum mechanical properties of ASTM A570, Grade 33 for 14 gauge and heavier, ASTM A611, Grade C for 16 gauge and lighter and shall be hot-dip galvanized after fabrication in accordance with ASTM A386.

- d. Stainless steel tray sections, fittings, covers and accessories shall be of AISI Type 316 stainless steel. Transverse members (rungs) or corrugated bottoms shall be welded to the side rails with type 316 stainless steel welding wire.
2. Tray Types:
 - a. Ladder type trays shall consist of two longitudinal members (side rails) with transverse members (rungs) welded to the side rails. Rungs shall be spaced 9 inches on center. Rung spacing in radiused fittings shall be measured at the center of the tray's width. Rungs shall have a minimum cable bearing surface of 7/8" with radiused edges. No portion of the rungs shall protrude below the bottom plane of the side rails.
 - b. Trough type trays shall be of three piece construction consisting of two longitudinal members (side rails) with a corrugated bottom welded to the side rails. The peaks of the corrugated bottom shall have a minimum flat cable bearing surface of 2-3/4" and shall be spaced 6" on center. To provide ventilation in the tray, the valleys of the corrugated bottom shall have 2 1/4" x 4" rectangular holes punched along the width of the bottom.
 - c. Solid bottom trays shall be of three piece construction consisting of two longitudinal members (side rails) with a solid corrugated bottom welded to the side rails. The peaks of the solid corrugated bottom shall have a minimum flat cable bearing surface of 2-3/4" and shall be spaced 6" on center.
3. Trays shall have an overall nominal depth of 5 inches with a minimum usable loading depth of 4 inches.
4. Straight sections side rails shall be I-beam, C rail or Z rails. All straight sections shall be supplied in standard lengths of 12 feet. Widths shall be 12, 18, 24, 30, or 36 inches.
5. Fitting radius shall be 12 inches minimum. Side rails of straight sections and fittings shall be compatible so that standard splice plates can be used to join straight sections and fittings. Fittings shall have 3" tangents beyond the curved section to accommodate the standard splice plates.
6. Splice plates shall be the bolted type, using either square neck or ribbed-neck carriage bolts and serrated flange lock nuts. The resistance of fixed splice connections between an adjacent section of tray shall not exceed .00033 ohm. The cable tray shall be designed so that a splice plate located anywhere along the span shall not decrease the strength of the cable tray system. Covers and other special accessories shall be furnished as required to protect, support, and install a cable tray system. Specify items in accordance with standards shown in catalog accessories section.
7. Bonding jumpers shall be provided, as required between all vertical channel or tray drops to equipment not rigidly attached to the tray system as required by the N.E.C.
Cable trays shall be manufactured by B-Line Systems, Inc. - a division of Eaton, M.P. Husky Corp., Thomas & Betts – a division of ABB, or equal.

C. Cable Bus

1. General: A complete metal enclosed bus system shall be provided; including all necessary fittings, tap boxes, enclosure connectors, entrance fittings, insulated conductors, electrical connectors, terminating kits, and other accessories as required.
2. System Requirements
 - a. The bus system shall be suitable for indoor or outdoor use with conductor spacing and ventilation maintained throughout the system. Cable Bus shall be rated for 480 Volts, 60 Hz, 3phase, 3 wire with a current rating as listed in the drawings.
 - b. All elements of the bus enclosure shall be so designed to eliminate any sharp edges or projections that may injure personnel or conductor insulations.
 - c. All load carrying members of the bus system shall be fabricated from extrusions of aluminum alloy 6063-T6. The maximum allowable stress used in design shall be 10,000 PSI.
 - d. Bus enclosure fittings shall have a radius of 24 inches, unless the minimum bending radius of the conductor requires a larger fitting radius.
 - e. The top and bottom enclosure sections shall be corrugated to provide mechanical strength and slotted for ventilation. The top cover shall be fastened to the enclosure with self tapping screws spaced approximately 2 feet on centers and shall be removed for inspection. The bottom section shall be factory installed by welding.
 - f. Splice joints between sections of the bus enclosure shall be the high pressure splined bolted type of a design, which avoids any structural weakness at the connection and does not exceed the electrical resistance specified.
 - g. Conductor support blocks shall be designed in segments to maintain a minimum of one conductor diameter in both the horizontal and vertical planes as required for free air conductor rating. Horizontal runs will have blocks spaced every 36 inches and vertical runs every 18 inches.
 - h. All current carrying conductors shall be UV and water resistant and have insulation rated for 75 degree Celsius operating temperature for the ampacity and voltage listed in free air as specified in article 310 of the National Electrical Code. Cable Bus shall be listed.
 - i. The conductors shall be phased and supported to maintain low impedance and assure the mechanical strength necessary to prevent cable movement or damage under short circuit currents up to 100,000 RMS symmetrical amps.
 - j. Conductors shall be of continuous length and be pulled in after the bus enclosure is in place. Electrical connectors shall be used only at the termination of conductor runs, or, if necessary, at tap points. All electrical connectors shall be provided by Cable Bus system.
 - k. The bus enclosure shall have a continuous current rating of not less than 1,000 amperes (50-degree Celsius rise) and the resistance across the enclosure section splice shall not exceed 50 microhms.

- l. The bus enclosure shall be grounded at sufficient intervals for the purpose of preventing a potential above ground on the bus enclosure in the event of fault.
 - m. The conductors shall be arranged in a phasing pattern which exhibits minimal interphase and intra-phase imbalance. All transposing of cables must occur at termination points. Transposing of cables will not be done in the bus housing.
 - n. The bus system shall be as manufactured by MP Husky, MDF, Thomas and Betts, or equivalent.
- D. Conductors and Cable
1. All power wiring conductors (P-X on drawings) shall be insulated for 600 volts, Type XHHW insulation, unless otherwise noted. Conductors shall be standard AWG and KCMIL sizes. Conductors shall be 98 percent copper, stranded, heat and moisture resistant with cross-linked synthetic polymer insulation for all sizes No. 12 AWG and larger. Smaller sizes shall not be used except for communications and special systems. For lighting and receptacle circuits, solid wire may be used in lieu of stranded wire, for No. 12 and No. 10 AWG only. Conductors shall be labeled with U.L. approval and be marked with the manufacturer's name, wire size and insulation type. All underground power cables shall be UL Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Okonite, Southwire, Pirelli, or equal.
 2. Variable frequency drive (VFD) motor supply shall be four (4) conductor tinned stranded copper, with cross-linked polyethylene insulation, overall foil (100% coverage) / tinned copper braid (85% coverage) shields, No. 12 AWG tinned copper drain wire, and outer PVC jacket. Cables shall conform to UL specification for 1000 Volt flexible motor supply cable. All underground power cables shall be U.L. Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Belden, Olflex, Houston Wire & Cable, or equal.
 3. Control Wiring:
 - a. All control wiring (120 or 24 volt, AC or DC) conductors within buildings or above grade shall be insulated for 600 volts, unless otherwise noted, and shall be No. 14 AWG minimum size, or larger if so indicated on the Drawings. Conductors shall be 98 percent copper, stranded, heat and moisture resistant, and thermal plastic insulated and shall be type THWN/THHN.
 - b. All conductors for control wiring located below grade shall be 600V, 98 percent copper, stranded, heat and moisture resistant, with cross-linked synthetic polymer insulation type XHHW. All underground control cables shall be U.L. Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Okonite, Southwire, Pirelli, or equal.
 4. Metal clad cable shall consist of thermal plastic insulated copper conductors, of size and quantity indicated, protected by a positive interlocked armor of galvanized steel. The conductors shall be twisted together and shall have an overall moisture and fire resistant fibrous covering. The cable shall have a grounding conductor of copper. The cable shall meet the requirements of Article 330 of the National Electrical Code for "Type MC" Metal Clad Cable

- and shall bear the U. L. Label. Acceptable Manufacturers: Okonite, Pirelli, Houston Wire & Cable, or equal.
5. Multi-conductor Instrumentation (600V), Control (600V) and Power (600V) Armored Direct Burial Cable:
- a. This specification covers multi-conductor power, control and instrumentation cables designed for service at maximum continuous operating temperatures of 90°C for installation in wet or dry locations, indoors and outdoors, surface mounted, aerial or in metal trays. Cables with overall jacket are UL Listed for direct burial in earth and UL Listed as sunlight resistant.
 - b. Cables rated 600V are UL Listed as NEC Type MC-HL, UL 2225 for use in Class 1, Division 1 hazardous locations, pass IEEE-1202/CSA FT4 (70,000 BTU/HR) cable tray flame test and ECEA T-29-520 (210,000 BTU/HR) Ribbon burner flame test, and meets ASTM D746 brittleness temperature at or below -40°C.
 - c. Installation shall be cross-linked polyethylene (XLPE) in accordance with ICEA S-95-658 and UL44 for type XHHW-2)
 - d. Conductor shall be annealed copper, Class "B" strand per ASTM B-3 & B-4. Ground wire(s) shall be annealed copper, Class "B" strand as sized on drawings or per NEC.
 - e. Armor shall be continuously welded and corrugated aluminum alloy sheath per UL 1569 and UL 225 with a flame retardant polyvinyl chloride (PVC) jacket.
 - f. Provide the following cables:
 - i. Power cables [sized as shown on drawings] used for the Well Pumps shall be 600 volt power cables, direct burial, MC-HL as manufactured by USA Wire & Cable.
 - ii. Control cable shall be the same as power cable with #14 AWG wire and number of conductors as shown on the drawings, USA Wire & Cable.
 - iii. Instrumentation cables used for the Well Level Sensors and tamper switches shall be two [2] individually shielded pairs 2/C#16 with overall shield and drain wires, overall armor, overall jacket 600 volt, direct burial, MC-HL Instrumentation cable (SPOS) as manufactured by USA Wire & Cable.
 - g. Cables shall have heat, flame, moisture resistant cross linked polyethylene insulated copper conductors, of size and quantity indicated, non wicking fillers when necessary, binder tape, smooth or corrugated continuously welded sheath, and flame, moisture, sunlight, oil resistant black PVC outer jacket.
 - h. Conductors shall be Class B stranded (per ASTM B8) bare copper per ASTM B3 or tin coated soft copper per ASTM B33 when requested.
 - i. Conductors shall be insulated with cross linked polyethylene meeting the requirements of ICEA S-66-524 and Section II. The minimum thickness at any point shall not be less than 90% of the specified minimum average thickness as shown in ICEA S-66-524 Table 3-1A.

- j. Identification:
 - i. Power Cables: Circuit identification according to ICEA S-19-81 appendix K Method 4.
 - ii. Instrumentation Cables: Two conductor pairs---black and white with printed pair number.
 - iii. Control Cables: Number of conductors color coded with printed numbers for each conductor.
 - k. Legend: Cables shall be printed on jackets with manufacturer's name, gauge size, number of conductors, pairs, and voltage sequentially every two feet, pertinent UL information. Reels shall be labeled and tagged.
 - l. Cable Performance: Cables shall pass IEEE-383/NRC regulation 1.13.1, UL 1581, CSA FT4/IEEE 1202 70000 BTU/hr gas ribbon burner vertical tray flame test, as well as IEEE 383/NELPIA 210000 BTU/hr gas ribbon burner vertical tray corner flame test. Cables shall be in compliance with EPA 40CPR, Part 261.
 - m. Testing: Cables shall be subjected to insulation resistance test in accordance with ICEA S-66-524.
 - n. Cable termination fittings shall be suitable for use with jacketed continuous-armor cable. Terminators shall be watertight, and shall be suitable for bottom, side, or top entry into boxes. O-Z/Gedney – a division of Emerson, PLM, or equal.
 - o. Acceptable Manufacturers: USA Cable and Wire, Rockbestos Guardex, or equal.
6. Tray cable shall consist of 600V copper conductors, of size and quantity as indicated on the Drawings, protected by a positive PVC outer plastic abrasion resistant fire resistant covering. The conductors shall be twisted together and shall have an overall moisture and fire resistant fibrous covering. The cable shall have a grounding conductor of copper. The cable shall meet the requirements of Article 336 of the National Electrical Code for "Type TC" Tray Cable and shall bear the U. L. Label. Acceptable Manufacturers: U.S. Wire & Cable, Houston Wire & Cable, or equal.
7. All instrumentation control cables (4-20 mA signal) referred to on the Drawings as "twisted shielded pairs", shall be rated 600V, 80 deg. C, individually shielded twisted pairs, No. 16 AWG, stranded conductors of tinned copper with polyethylene insulation and aluminum-polyester shielding with #18 awg stranded copper drain wire surrounded by a chrome PVC jacket. Control cable shall be UL listed with 100% shield coverage. All underground instrumentation cables shall be U.L. Listed and Labeled for underground use in wet locations. Acceptable Manufacturers: Belden, Alpha Wire & Cable or equal. Provide instrumentation control cables equivalent to Belden type 8719 or equivalent unless specified otherwise by the instrument manufacturer.
8. Three conductor shielded cable for use with remote potentiometers for varying motor speeds etc. Cable shall be stranded, tinned copper, polyethylene insulated, drain wires with aluminum-polyester shielding with #18 awg stranded copper drain wire surrounded by a chrome PVC jacket. Control cable shall be rated 600 volt and shall be UL listed with 100% shield coverage.

- Acceptable Manufacturers: Belden, Alpha Wire & Cable or equal. Provide three conductor shielded cables equivalent to Belden type 8618 or equivalent unless specified otherwise by the instrument manufacturer.
9. RTD wiring shall be rated 600V, 60 degree, triads 3C#16TWS, with stranded, tinned copper, polyethylene insulated, drain wires with aluminum-polyester shielding with #18 awg stranded copper drain wire surrounded by a chrome PVC jacket. Control cable shall be UL listed with 100% shield coverage. Acceptable Manufacturers: Belden, Alpha Wire & Cable, or equal. Provide RTD wiring equivalent to Belden type 8618 or equivalent unless specified otherwise by the instrument manufacturer
 10. Thermocouple wire shall be 600V, No. 16 AWG, solid duplex, tinned copper, polyethylene insulated of materials to match the characteristics of the thermocouple. Thermocouple lead wire shall have PVC insulation with PVC jacket.
 11. Intercommunication Wiring:
 - a. Conductors for intercommunication wiring in indoor applications shall be 150V, 80 deg C, tinned copper, PVC insulated twisted pair, 24 AWG solid conductor with chrome PVC jacket, two-pair minimum. Acceptable Manufacturers: Belden type 9562, Alpha Wire & Cable, or equal.
 - b. Conductors for underground intercommunication wiring shall 24 AWG solid bare copper, low smoke PVC insulated (1s PVC), twisted pairs (unshielded) conductor surrounded by a white category 3 1s PVC outer jacket, four-pair minimum, U.L. Listed and Labeled for underground wet locations. Acceptable Manufacturers: Belden type 1245A2, Alpha Wire & Cable, or equal.
 12. Data Wiring:
 - a. Cables for data wiring shall be Category 6, 4-pair, 24 AWG solid bare copper conductor, unshielded, FEP insulation, plenum rated. Acceptable Manufacturers: Belden Type 7813LC, Alpha Wire & Cable, or equal.
 13. Fire Alarm Wiring:
 - a. Signaling circuit conductors for fire alarm wiring installed within buildings shall be 300V, 105 deg C, power limited, type FPLR cable, #14 AWG minimum solid bare copper with PVC insulation encased in a red PVC outer jacket. Acceptable Manufacturers: Belden type 9580 (for two conductors), Alpha Wire & Cable, Houston Wire, or equal. See drawings for exact number of conductors.
 - b. Fire alarm wiring installed within buildings indicated on the drawings to be shielded shall be 300V, 105 deg C, power limited, type FPLR cable, #14 AWG minimum solid bare copper with PVC insulation, aluminum-polyester shield and a #16 awg stranded tinned copper drain wire encased in a red PVC outer jacket. Acceptable Manufacturers: Belden, Alpha Wire & Cable, Houston Wire, or equal. Provide fire alarm wiring equivalent to Belden type 9581 (for two conductors). See drawings for exact number of conductors.
 - c. Conductors for fire alarm wiring installed between buildings either aerially or in underground duct banks, or any location in close proximity

with higher voltage wiring, shall be 300V, 105 deg C, power limited, U.L. Listed and Labeled for underground wet locations, type FPLR twisted shielded pair cable. Cables shall be #12 AWG minimum, solid bare copper with PVC insulation, aluminum-polyester shield and a #16 awg stranded tinned copper drain wire encased in a red PVC outer jacket. Acceptable Manufacturers: Belden, Alpha Wire & Cable, Houston Wire, or equal. Provide fire alarm wiring between buildings equivalent to Belden type 9583 (for two conductors) or equal. See drawings for exact number of conductors.

14. Telephone wiring:
 - a. Conductors for telephone wiring in indoor applications shall be 150 V, 80 degrees C, tinned copper, PVC insulated twisted pair, 24 gauge solid conductor with chrome PVC jacket, two-pair minimum or as indicated on the drawings, Belden type 9562, Alpha Wire and Cable or equal.
15. Medium Voltage Cable and Accessories
 - a. 5KV cable system shall consist of single-conductor, shielded, ethylene propylene rubber (EPR) insulated, polyvinyl chloride (PVC) jacketed, rated for 5,000 volts, ungrounded neutral (133% insulation level) service. Conductor shall be Class B, compress-strand copper, size as indicated on the Drawings. The conductor shall be covered with a layer of semiconducting tape completely covering the conductor and firmly bonded to the EPR insulation. Shielding shall consist of a semi-conducting insulating shield applied over the EPR insulation, and a 5 mil thick bare copper tape with a minimum 12.5% overlap applied over this shield, a non-hygroscopic polyester film tape shall separate the shielding from the cable jacket. A PVC jacket shall be applied overall. All cable shall comply with the latest editions of the following standards: ASTM B-496, ICEA S-68-516, AEIC CS6, and UL 1072 for single conductor cable. Acceptable manufacturers: Okonite, Pirelli, South Wire or equal.
 - b. 15KV cable system shall consist of single-conductor, shielded, ethylene propylene rubber (EPR) insulated, polyvinyl chloride (PVC) jacketed, rated for 15,000 volts, ungrounded neutral (133% insulation level) service. Conductor shall be Class B, compress-strand copper, size as indicated on the Drawings. The conductor shall be covered with a layer of semiconducting tape completely covering the conductor and firmly bonded to the EPR insulation. Shielding shall consist of a semi-conducting insulating shield applied over the EPR insulation, and a 5 mil thick bare copper tape with a minimum 12.5% overlap applied over this shield, a non-hygroscopic polyester film tape shall separate the shielding from the cable jacket. A PVC jacket shall be applied overall. All cable shall comply with the latest editions of the following standards: ASTM B-496, ICEA S-68-516, AEIC CS6, and UL 1072 for single conductor cable. Acceptable manufacturers: Okonite, Pirelli, Southwire, Thomas & Betts – a division of ABB Elastimold Cable Accessories, or equal.

- c. Provide medium voltage stress cones rated for the size of conductors shown on the Drawings as required for all medium voltage rated cable installation and as recommended by equipment manufacturer.
16. Fiber Optic Cable:
- a. Provide indoor/outdoor type fiber optic cable with a minimum bending radius of 4 inches and a minimum tensile strength of 300 lb.
 - b. Transmission Distance: up to 2000 km
 - c. Construction: The cable shall be loose tube type design with an inner PVC tube containing the optical fibers and an outer UV resistant, flame retardant Poly jacket.
 - d. Cables shall be outdoor/indoor rated and suitable for installation in buried conduit.
 - e. Optical Fibers: A minimum of three (3) channel (six fibers) multimode, 62.5/125 fibers per cable compatible with IEEE 802.3 10/100 Base F standard.
 - f. Termination: SC connector type to be used on all Fiber connections. Field terminations shall be fused using a splicing device specifically designed for joining fiber optic cable. Chemical fusing shall not be acceptable. The dB loss of each fiber segment shall be tested using appropriately calibrated test equipment and a report shall be submitted to the Engineer of the testing results. Provide calibration certificate showing calibration within past twelve months.
 - g. Fiber Optic Cable Equivalent to:
 - i. Berk-Tek Advetum
 - ii. Corning Fiber Optic Freedom Cable
 - iii. Hitachi Cable
 - iv. Or equal
- E. Outlet Boxes
- 1. Standard, recessed outlet boxes and covers shall be galvanized steel not less than 1-1/2 inches deep, 4 inches square or octagonal, with knockouts. Recessed boxes shall only be used for recessed work. Acceptable Manufacturers: Thomas & Betts, Steel City, OZ Gedney, Raco or equal.
 - 2. Outlet boxes exposed to moisture or used for exposed work shall be cadmium cast alloy complete with hubs and gasketed screw fastened covers.
 - 3. Outlet boxes used in hazardous, Class I, Div 1, Group C & D locations shall be UL Listed Feraloy iron alloy body with electrogalvanized and aluminum acrylic paint or epoxy powder coat complete with hubs as required for the installation. Provide covers to fit the application. Covers to be utilized for pendant mounted light fixtures shall incorporate flexible cushion or ball type fixture hangers rated for the area in which it is to be installed. Acceptable manufacturers: Crouse Hinds, Appleton, or equal.
 - 4. Outlet boxes used in corrosive, NEMA 4X areas, shall have a plastic P.V.C. coating as previously described in the conduit, raceway and tubing section. Acceptable manufacturer shall be Rob-Roy "Plasti-Bond", Thomas & Betts, Ocal, or equal.

5. In no case shall boxes be sized smaller than as indicated in Article 314 of the National Electrical Code for the conductor sizes installed.
 6. Acceptable Manufacturers: Thomas & Betts, Steel City, OZ Gedney, Crouse-Hinds, Raco or equal.
- F. Pull and Junction Boxes
1. Boxes shall be with trim for flush or surface mounting in accordance with the location to be installed. Provide screw-on type flush covers. Boxes with hinges and side clips are not acceptable. Boxes installed in damp locations shall be of watertight construction with gasketed cover and conduit hubs. Refer to the Electrical Drawing E-1 for NEMA rated areas for this project and pullbox type and use required.
 2. Boxes installed in Class I, Div 1, Group C & D locations shall be constructed of copper free aluminum (body and cover), extruded aluminum hinges with stainless steel cover bolts and neoprene gasket. The box shall be UL Listed for the location and sized as required for the application. Provide NEMA 4/7 pullboxes when installed in these areas.
 3. Boxes used in corrosive, NEMA 4X areas, shall have a plastic P.V.C. coating as previously described in the conduit, raceway and tubing section. Acceptable manufacturer shall be Rob-Roy "Plasti-Bond", Thomas & Betts – a division of ABB/ Ocal, Perma-COTE, or equal.
 4. In no case shall boxes be sized smaller than as indicated in Article 317 of the National Electrical Code for Conduit and Conductor sizes installed.
- G. Expansion Fittings
1. Expansion fittings for exposed conduit runs shall be watertight expansion type designed to compensate for up to 8" of movement (4" in either direction). Fittings shall be U.L. listed, shall be malleable iron or ductile iron with exterior and interior zinc plating for corrosion protection. With U.L. listed internal bonding jumper constructed of a tinned copper braid, sized to meet UL fault current test requirements and comply with bonding requirements –NEC 250-.98. Acceptable Manufacturer: Thomas Betts – a division of ABB Type XJG-TB O.Z./Gedney - a division of Emerson- Type EX, Crouse Hinds, or equal.
 2. Expansion/deflection fittings for concealed conduit runs shall compensate for up to 3/4" of movement in any direction. Fittings shall be U.L. listed and be water, rain and concrete tight. Fittings shall be constructed of bronze end couplings, neoprene sleeve with stainless steel bands and an internal braided tinned copper bonding jumper and Ericson type conduit union. Acceptable manufacturer: O.Z. Gedney type a division of Emerson -DX, Thomas Betts – a division of ABB - type XD, or equal.
- H. Wiring Devices
1. Wiring devices shall be specification grade as described herein. Switch handles, receptacles, etc. shall be installed in a single color. New wiring devices installed in existing facilities shall match previous installed devices. Provide device cover plates of satin finish stainless steel in finished areas and cadmium finished sheet steel in unfinished areas. Coordinate cover plate colors and finish with Architect or Engineer in finished office areas. Acceptable manufacturers are: Hubbell Inc., Cooper-Arrow-Hart – a division Eaton, Pass & Semour – a

Division of Legrand, Thomas & Betts – a Division of ABB, or equal. Provide devices as indicated by Contract Documents.

2. Toggle Switches
 - a. 20 Ampere, 1-pole, 277 Volt: Hubbell 1221
 - b. 20 Ampere, 2-pole, 277 Volt: Hubbell 1222
 - c. 20 Ampere, 3-way, 277 Volt: Hubbell 1223
 - d. 20 Ampere, 4-way, 277 Volt: Hubbell 1224
 - e. 20 Ampere, 1-pole, 277 Volt w/Neon Pilot Light: Hubbell 1221-PL
 - f. 20 Ampere, 2-pole, 277 Volt w/Neon Pilot Light: Hubbell 1222-PL
 - g. 20 Ampere, 3-way, 277 Volt w/Neon Pilot Light: Hubbell 1223-PL
 - h. Emergency Boiler Shutoff Switch: Hubbell 1221-RDB w/red device plate and engraved lettering reading "Emergency Boiler Shutoff".
3. Receptacles
 - a. 20 Ampere, 125 Volt, Single Receptacle: Hubbell 5361
 - b. 20 Ampere, 125 Volt, Duplex Receptacle: Hubbell 5362
 - c. 20 Ampere, 125 Volt, Duplex G.F.I. Receptacle: Hubbell GF-5362
 - d. 30 Ampere, 125/250 Volt, Dryer Receptacle: Hubbell 9430A
 - e. 50 Ampere 125/250 Volt, Range Receptacle: Hubbell 9450A
 - f. 20 Ampere, 125 Volt, Duplex, Weatherproof: Crouse Hinds WLGf-FS with GFI receptacle
 - g. 20 Ampere, 125 Volt, Duplex, Explosion proof:
 - i. Crouse Hinds ENR12201 W/(2) ENP5201 Plugs (Dead End Type)
 - ii. Crouse Hinds ENRC22201 W/(2) ENP5201 Plugs (Feed Thru Type)
 - h. 30 Ampere, 600 Volt, 2-wire, 3-Pole Welding Receptacle:
 - i. Crouse Hinds ARE3322 W/APJ3575 Plug (Surface Mount)
 - ii. Crouse Hinds AR332 W/APJ3575 Plug (Flush Mount)
 - i. 30 Ampere, 600 Volt, 3-Wire, 4-Pole Welding Receptacle:
 - i. Crouse Hinds ARE 3422 W/APJ3485 Plug (Surface Mount)
 - ii. Crouse Hinds AR342 W/APJ3485 Plug (Flush Mount)
 - j. 60 Ampere, 600 Volt, 2-Wire, 3-Pole Welding Receptacle:
 - i. Crouse Hinds ARE6323 W/APJ6385 Plug (Surface Mount)
 - ii. Crouse Hinds AR632 W/APJ6385 Plug (Flush Mount)
 - k. 60 Ampere, 600 Volt, 3-Wire, 4-Pole, Welding Receptacle:
 - i. Crouse Hinds ARE6424 W/APJ6485 Plug (Surface Mount)
 - ii. Crouse Hinds AR642 W/APJ6485 Plug (Flush Mount)
 - l. Special duty style and type receptacles greater than 20 ampere shall be submitted for specific applications indicated on the drawings specific for each area and load to be connected.
 - m. Isolated ground type orange coded receptacles rated 20 ampere, 125 volt duplex shall be submitted for all computer power equipment shown on the drawings.
 - n. Metallic and Non-Metallic Pin and Sleeve type devices and Interlocked receptacles shall comply with NEMA 250, UL94, 746C, 840, 1010,1682 and UL1686 and ASTM D570, IEC 309-1 as indicated on detail drawings. Acceptable manufacturers shall be Crouse Hinds – a division of Eaton,

- Hubbell, Thomas & Betts – a division of ABB, Russell Stoll Max Guard, or equal.
4. Telephone/Intercommunication System Outlets
 - a. Provide 4" x 2" outlet box with Hubbell PJ216 telephone plate.
 - b. Provide outlet box with telephone RJ11 and data RJ45 for combination telephone / data outlet, as required. Single telephone RJ11 outlets only shall be provided as indicated on the drawings.
 - c. Telephone/intercommunication system outlets shall be Hubbell, Crouse-Hinds, or equal.
- I. Control Devices and Equipment:
1. Photoelectric Control:
 - a. 120 Volt, SPST, 2000 Watt: Tork Model 2101
 - b. 120 Volt, DPST, 6000 Watt: Tork Model 5403
 2. Lighting and Control Contactors:
 - a. Contactors shall be electrically operated, electrically held and shall switch a load at 277 volts, 60 hertz and shall have the number of N.O. contacts and N.C. contacts shown on the Drawings. Minimum number of contacts shall be 5 N.O. and 1 N.C. contact.
 - b. The contactor shall be continuously rated 20 amperes per pole for all types of ballast and tungsten lighting and resistance loads, and shall not be de-rated for use on high-inrush loads. The coil should be continuously rated and encapsulated.
 - c. The contactor shall have double-break, silver-cadmium-oxide power contacts. Auxiliary arcing contacts are not acceptable. All power contacts shall be convertible from N.O. to N.C. or vice-versa. All contacts shall have clearly visible N.O. and N.C. contact-status indicators.
 - d. The contactor shall be approved per UL 508 and CSA.
 - e. The contactor shall be designed in accordance with NEMA ICS2-211B. They shall be industrial-duty rated for applications to 600 volts maximum.
 - f. The contactor shall have a NEMA Type 1 enclosure unless noted otherwise on the Drawings.
 - g. Refer to Drawings for location, wiring schematics and details.
 - h. Acceptable manufacturers: Square D, Cutler-Hammer, or equal.
 - i. Provide complete system lighting and control panel layout and wiring diagrams for review and approval.
- J. Motor Starters
1. For Single Phase Motors: Fractional Horsepower Manual Motor Starter with Thermal Overload(s) and a red running indicating light unless noted otherwise:
 - a. 120 Volt Single-Pole, Surface Mounted: Square-D FG-1P
 - b. 120 Volt Single-Pole, Flush Mounted: Square-D FS-1P
 - c. 120 Volt, Single-Pole, Surface Mounted, Explosion Proof: Square-D FR-1H
 - d. 120 Volt, Single-Pole, H-O-A Selector, Surface Mounted: Square-D FG-71P
 - e. 120 Volt, Single-Pole Two-Speed, Surface Mounted: Square-D FG-11P
 - f. 240 Volt, Two-Pole, Surface Mounted, Explosion Proof:

- Square-D FR-2H
 - g. 240 Volt, Two-Pole, Surface Mounted: Square-D FG-2P
 - h. 240 Volt, Two-Pole, Two-Speed, Surface Mounted: Square-D FG-22P
 - i. 240 Volt, Two-Pole, H-O-A Selector, Surface Mounted:
Square-D FG-72P
2. For Three Phase Motors: Shall be combination starter/disconnect type, employing magnetic starter (NEMA Size 1 minimum), rated to match the equipment served, with thermal overload protection for each phase and with an M.C.P. type circuit breaker/disconnect sized per the circuit breaker manufacturer's recommendations for coordination with the thermal overload protection, lights, relays and auxiliary devices. Combination starters shall be provided with a 480, 240 or 208-120 volt control power transformer with primary and secondary fusing. Provide 2 N.O. and 2 N.C. auxiliary contacts.
 3. Refer to control wiring diagrams on the drawings for specific requirements and devices.
 4. Acceptable Manufacturers: Square-D, Cutler-Hammer, Allen-Bradley, or equal.
- K. Safety Switches
1. All safety switches shall be NEMA Type HD and Underwriters Laboratories Listed.
 2. The handle position shall indicate whether the switch is "ON" or "OFF".
 3. All current carrying parts shall be plated to resist corrosion and promote cool operation. Switches shall have removable arc suppressers where necessary to permit easy access to line side lugs. Lugs shall be front removable and UL listed for 60°C or 75°C, aluminum or copper wires.
 4. Provisions for padlocking the switch in the "OFF" position with at least three locks shall be provided.
 5. Switches shall have a dual cover interlock to prevent unauthorized opening of the switch door when the handle is in the "ON" position, and to prevent closing of the switch mechanism with the door open.
 6. Disconnect switches, indicated on the drawing to be used for motors controlled by variable frequency drives shall be as indicated above, except shall be 4 pole type switches. The fourth pole shall be wired directly to the disable input, in series with the safety e-stop, in order to lock-out and immediately shutdown the drive. The auxiliary 4th pole shall open prior to any of the other three power poles and shall be designed for proper use with VFD type load circuits.
 7. Enclosures
 - a. Safety switch enclosures for non-hazardous locations painted galvanized steel for NEMA 12 area and stainless steel for NEMA 4X areas. Enclosures shall be provided with "ON" and "OFF" position identification and lockable in the "OFF" position.
 - b. Switches specified as NEMA 7 Class 1, Division 1 shall be furnished in cast aluminum enclosures with conduit provisions as specified. Enclosures shall be provided with a bolted cover and with sealing means for hazardous location protection. "ON" and "OFF" position identification shall be cast into the cover, not painted on or applied with an adhesive.

8. Acceptable Manufacturers: Square-D, Cutler-Hammer, General Electric, Siemens, or equal.
- L. Fusible Disconnect Switches
1. Switches shall be horsepower rated for ac and/or dc as indicated by the plans. All fusible switches rated 100 thru 600 amperes at 240 volts and 30 thru 600 amperes at 600 volts shall have a UL approved method of field conversion from standard Class H fuse spacing to Class J fuse spacing. The switch also must accept Class R fuses and have provisions for field installation of a UL listed rejection feature to reject all fuses except Class R. The UL listed short circuit rating of the switches shall be 200,000 rms symmetrical amperes when Class R or Class J fuses are used with the appropriate rejection scheme. The UL listed short circuit rating of the switch, when equipped with Class H fuses, shall be 10,000 rms symmetrical amperes. The cost of any conversion kit and labor associated with conversion to accommodate the required fuses shall be included in the base bid. In general, U.L. Class H fuses are not to be used. Refer to the paragraph on fuses, this section on further requirements for fuses.
 2. Enclosures
 - a. Safety switch enclosures for non-hazardous locations painted galvanized steel for NEMA 12 area and stainless steel for NEMA 4X areas. Refer to Drawing E-1 for NEMA classifications.
 - b. Switches specified as NEMA 7 & 9 shall be furnished in cast aluminum enclosures with conduit provisions as specified. Enclosures shall be provided with a bolted cover and with sealing means for hazardous location protection. "ON" and "OFF" position identification shall be cast into the cover, not painted on or applied with an adhesive.
 3. Acceptable Manufacturers: Square-D, Cutler-Hammer, General Electric, Siemens, or equal.
- M. Manual Transfer Switch
1. The manual transfer switch shall meet NEMA rating where equipment is to be installed as shown on drawings. Manual transfer switch shall be heavy duty, double throw, quick-make, quick break with voltage, number of poles and ampere rating as noted on the Drawings.
 2. A manual transfer switch manufacturer shall have been regularly engaged in the production of U.L. (Underwriters Laboratory) Standard 1008 Listed transfer switches. The transfer switches shall be documented, and have been offered for sale on the open market for a minimum of five (5) years. The manufacturer shall provide factory trained parts and service support through a factory authorized distributor that is regularly doing business in the area of the installation.
 3. The manufacturer shall supply literature containing diagrams, parts lists and descriptions sufficient for the owner's personnel, or subcontract supplier to install, operate and perform normal maintenance on the equipment.
 4. Manual transfer switch shall be as manufactured by Square D, General Electric, Cutler-Hammer or equal.
- N. Enclosed Circuit Breakers

1. Circuit breakers shall be molded case, thermal-magnetic type, ratings as noted, with over-center, trip-free, toggle-type operating mechanism, quick-make, quick-break action and positive handle indication unless otherwise noted. Multiple pole breakers shall be common trip type. Each circuit breaker shall have a permanent trip unit containing individual thermal and magnetic trip elements in each pole. Breakers shall be calibrated for operation, an ambient temperature of 40°C and shall be suitable for mounting and operating in any position. Breakers shall have removable lugs, U. L. listed for copper and aluminum conductors.
 2. Breakers shall be installed in enclosures as specified in Section 16160, with NEMA ratings as indicated on the Drawings.
 3. Breakers shall be provided with manufacturer installed neutral and ground kits and shall be U.L. listed and labeled for service entrance duty as noted on the drawings and where required by the N.E.C. Short circuit ratings of equipment shall be as noted on the drawings or shall be rated equal to the equipment or motor control center which they feed. The minimum rating shall be 42,000 A RMS symmetrical unless otherwise noted or determined by the Engineer.
 4. Enclosures for circuit breakers shall meet the NEMA requirements where being installed and have side handle operating mechanism.
 5. All side mounted handle operators shall be pad-lockable in both the “ON” and the “OFF” position.
 6. Acceptable Manufacturers: Square-D, Cutler-Hammer, General Electric, Siemens, or equal.
- O. Power Distribution Fuses
1. All fuses rated 600 volts and below shall be rejection type dual-element, time-delay type. Acceptable Manufacturers are Bussman, Littlefuse and Shawmut or equal.
 2. Fuses shall be U.L. Class and rating as shown on the drawings or as required by the manufacturer of the equipment they are protecting. In general, fuses shall be:
 - a. U.L. Class RK1 for service entrances and feeders supplying combination motor loads.
 - b. U.L. Class RK5 for motor branch circuits.
 3. Provide two (2) complete sets of fuses for all fusible disconnect switches.
- P. Ground Rods, Ground Cable, Ground Fittings
1. Ground Rods shall be copper-clad steel at least 3/4-inch in diameter and 10 feet long. The rods shall have a hard, clean, smooth, continuous, surface throughout the length of the rod.
 2. Ground System Cable and taps shall be copper stranded, sized as indicated on Drawings and/or in Section 16450. Exothermic welding connections shall be required for underground connections; mechanical fittings are acceptable for above ground connections only. Acceptable manufactures are Erico-Cadweld, Thomas & Betts-Blackburn, Galvan, or equal.
 3. Irreversible compression connectors must be factory filled with an oxide inhibitor and installed with the same manufacturers die so that the die index matches the listed index on the connectors. Connector must be fully crimped

with a 14 ton or larger hydraulic tool so that the index number is indented on the connector. Connectors must comply with IEEE837, UL467 and CSA22.2. As manufactured by: Thomas & Betts-Blackburn, Hubbell-Burndy, Erico, or equal.

- Q. Phase Failure Relay
 - 1. Phase failure relays shall be three phase, three wire rated for use at the voltage indicated on the Drawings. When the relay is in an energized condition, a loss of power or a phase unbalance of more than 10% and/or phase reversal shall cause the output relay to de-energize, returning NO contacts to their passive state. The relay shall automatically reset when the correct conditions are re-established. Phase failure relays shall be equipped with a built-in 0.2 second time delay to prevent nuisance tripping. Phase failure relays shall be open-type to be mounted within motor starter compartments. Relays shall be Cutler-Hammer Type P, Square D, or equal.
- R. Electrical and Telephone Manholes Conduit Racks:
 - 1. Each manhole structure shall be provided with PVC heavy duty cable racks, cable supports, cable wraps, and mounting hardware for grounding each manhole.
- S. Link Seal
 - 1. Conduit wall and floor seals for cored holes and sleeved openings shall be Link Seal, Innerlynx, Crouse Hinds, or equal. Refer to the contract drawings for additional requirements.
- T. Cable Seals
 - 1. Conduit sealing bushings shall be OZ Gedney Co., Type CSB Series, Crouse Hinds, Killark, or equal.
- U. Conduit Seals-Offs
 - 1. Provide Class I, Div. 1, Group D and Class 1, Div. 2 seals as required by the N.E.C. Material shall match the conduit in which being installed. Acceptable manufacturers are Appleton, Crouse-Hinds, Killark, or equal.
- V. Hand Hole
 - 1. Electrical hand holes shall be Composolite as manufactured by Strongwell Corporation or equivalent. Precast concrete hand holes as detailed on the Drawings shall also be acceptable. Hand holes shall be sized per the N.E.C. according to number and sizes of entering conduits. All hand holes shall be rated for ANSI H-20 wheel loading in roadways, and parking areas, and Tier 22 for all other locations. Separate hand holes and conduit systems shall be provided for power, control, and instrumentation systems.
- W. Terminal Cabinet
 - 1. The enclosure shall meet NEMA rating listed on Drawing E-1 which shall include a fully hinged door with a key lockable handle with no side clips around the edge. In no case shall enclosure be sized smaller than as indicated in the National Electrical Code for Conduit and Conductor sizes installed.
 - 2. Provide a lamacoid Name Plate at the top center of the cabinet.
 - 3. All terminal strips shall be numbered on both sides and numbering shall not be repeated within the same enclosure. Provide tags to indicate destination of cable on either side of terminal connections.

4. Provide an internal backboard for all enclosures
5. Provide separate terminal strips for power, control, and signal wiring. Also provide separation between all terminal strips. In addition, separation and separate terminal strips shall be provided for 120V and 24V control wiring.
6. Enclosure shall be free standing with the minimal dimensions as follows:
 - a. 90 inches high, 36 inches wide, and 24 inches deep. This will allow for future equipment to be installed.
 - b. Three point lockable handle.
 - c. Large nameplate at top center of panel.
 - d. 60 spare terminals.
 - e. Create terminal strips to allow for additional equipment to be mounted on back panel.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Unless otherwise noted, wiring for all systems indicated in the Contract Documents shall consist of insulated conductors installed in raceways in accordance with the manufacturer's instructions.
 1. Raceways shall be continuous from outlet box to outlet box and from outlet box to cabinet, junction or pull box. Secure and bond raceways to all boxes and cabinets such that each system of raceways will be electrically continuous throughout.
 2. Contract drawing E-1 NEMA CLASSIFICATIONS FOR ELECTRICAL EQUIPMENT AND ENCLOSURES indicates the NEMA ratings of each location at the facility.
- B. Unless otherwise indicated on the Drawings and Conduit Installation Schedule on E-1, install all wiring in the following applicable raceway system:
 1. Wiring above 600 volts in indoor dry locations (NEMA 1 or 12) Heavywall aluminum conduit. Galvanized heavy duty rigid steel conduit as approved by the Engineer.
 2. Wiring 600 volts or less in dry concealed non hazardous locations [hung above ceilings, attic areas, or within CMU block walls] (NEMA 1 or 12): Galvanized electrical metallic tubing (for raceway sizes up to and including 2" trade size) or galvanized rigid heavy wall steel conduit.
 3. Wiring 600 volts or less in dry exposed indoor locations (NEMA 1 or 12): Rigid heavy wall aluminum conduit. Galvanized rigid heavy wall steel conduit as approved by the Engineer.
 4. Wiring 600 volts or less in indoor wet locations or outdoor above grade locations (NEMA 3R or 4X): Rigid heavy wall aluminum conduit. Galvanized rigid heavy wall steel conduit as approved by the Engineer.
 5. Wiring 600 volts or less in indoor or outdoor corrosive chemical areas (NEMA 4X Corrosive): use PVC-coated rigid steel conduit in these areas less than 8 feet from finished floor. Use PVC Schedule 80 conduit in these areas 8 feet or more from finished floor in corrosive chemical areas. Where conduits transition, a NEMA 4X stainless steel or PVC coated junction box or pull box must be installed. The metal conduit shall be provided with a grounding bushing and

the metal conduit and metal box shall be bonded to the ground conductor within the raceway per NEC.

6. Wiring 600 volts or less in hazardous locations (NEMA 7, Class 1, Div.1):, PVC coated galvanized rigid steel conduit, installed per Article 501 of NEC. Attics and other concealed locations adjacent hazardous locations shall be considered hazardous areas as well unless otherwise defined by the Engineer.
 - a. PVC coated rigid galvanized steel (RGS) conduit: manufacturer shall provide field installers certification training. All installers shall be field certified from manufacturer and provide proof of certification for installation upon request.
 - b. All field installation and repairs of PVC coated rigid galvanized steel (RGS) conduit shall conform to manufacturer's recommendation and use of manufacturer patch and repair kits in order to guarantee certified products are used and compliance with all factory warranty guidelines are met.
 7. Wiring 600 volts or less in hazardous locations (NEMA 7, Class 1, Div.2): Galvanized rigid heavy wall steel conduit or heavy wall aluminum conduit installed per Article 501 of NEC. Attics and other concealed locations adjacent hazardous locations shall be considered hazardous areas as well unless otherwise defined by the Engineer.
 8. Use of Miscellaneous Conduit Types
 - a. Flexible "liquid tight" metal conduit shall be used for final connection to the following:
 - * all motors
 - * rotating or vibrating equipment
 - * dry type transformers
 - * recessed lighting fixturesLengths of liquid tight flexible metal conduit shall be kept to a minimum (12 to 18 inches) and maximum length of 2'-6" except when dictated otherwise by a particular installation approved by the Engineer and as allowed by NEC.
 - b. PVC Schedule 80 non metallic conduit shall be used as shown on drawings.
 - c. Conductors for fire alarm circuits shall be routed in rigid galvanized steel conduit unless otherwise noted on the drawings. Minimum conduit size shall be 3/4".
 - d. Armored direct burial cable shall be installed underground to equipment as shown on drawings.
 - e. Metal Clad cable (MC) shall be installed in the following locations:
 - i. Used for whips for concealed lights above hung ceiling limited to 3' in length.
 - ii. Within studded concealed wood frame walls for receptacles and light switching.
 9. All signal wiring shall be installed in rigid galvanized steel or PVC coated rigid galvanized steel conduit.
- C. Cable Tray
1. When shown on drawings, cable tray system shall be utilized for routing conductors.

2. Provide bonding and grounding, as required of all raceway systems to ensure electrical continuity back to the power source for a complete system.
 3. Conductor drops to electrical loads from the tray system shall be accomplished using either tray, channel or conduit with approved pullbox transition section and fittings and bonding to the tray system to maintain electrical continuity for a complete system.
 4. Cable tray shall be installed level, parallel or perpendicular to walls, ceilings and floors.
 5. Cable trays installed in a stacked manner shall leave a minimum of 9 inches between top of tray and bottom of additional trays.
 6. Fittings and hardware used in connection of tray sections or supports shall be constructed of the same materials as the tray system.
 7. Refer to the contract drawings for general cable tray layout and requirements.
- D. Conduits Installed Below Grade or in Slab
1. Underground raceways
 - a. All underground raceways shall be Schedule 80 heavy wall PVC.
 - b. All underground conduits where they are directed toward a building or structure shall transition from non-metallic conduit to metallic rigid galvanized conduit of the same diameter 15'-0" from the respective building or structure for all locations. The same type of metallic conduit shall continue to its final location per the NEMA rating of the areas that it is installed in. Provide proper transition connections for this change in conduit type. No exceptions will be allowed.
 2. Underground Raceways in Duct Banks:
 - a. All underground raceways shall be Schedule 40 heavy wall PVC conduit unless otherwise noted on the drawings. All signal conduits shall be installed within rigid galvanized steel conduit.
 - b. Encase all underground raceways in a concrete envelope.
 - c. Refer to drawings for specific encasement duct bank details and requirements.
 - d. All underground duct banks where they are directed toward a building or structure shall transition from non-metallic conduit to metallic rigid galvanized conduit of the same diameter 15'-0" from the respective building or structure for all locations. The same type of metallic conduit shall continue to its final location per the NEMA rating of the areas that it is installed in. Provide proper transition connections for this change in conduit type. No exceptions will be allowed.
 - e. For all underground raceways, bottom of trench shall be solid undisturbed earth. Earth showing extensive signs of peat, cinders, rubble or any conditions not suitable for a stable foundation should be reported to the Engineer for recommendation. Small packets (up to 1 cu. yd.) of unsuitable soil shall be excavated and replaced with compacted gravel borrow maximum rock size 2 inches. In areas which have had fill work completed during the progress of work under this contract, verify that the bottom of trench is 95 percent compaction minimum. If compaction is less than 95 percent provide additional compaction in bottom of trench.

- f. Provide underground electrical marking tape for the full length of all trenches for underground raceways. Marking tape shall be SETON #85517 Electrical, Telephone, or equal.
 - g. Raceways extending vertically out of slab or grade shall transition to PVC coated rigid galvanized steel sweeps and remain the same material 12 inches past the penetration, where it shall transition to approved materials per the area classification. Such conduit shall be encased using flowable fill to ensure high compaction.
 - h. PVC raceways installed under slab shall be buried no more than 36" from the bottom of the slab to the top of the raceway. Raceways buried deeper shall be rigid galvanized steel.
3. Raceways in Slabs:
- a. Raceways for embedment within a slab, wall or beam, other than those merely passing through, shall satisfy the following:
 - i. Power and control conduits shall be rigid heavy wall Schedule 40 PVC conduit.
 - ii. Instrumentation conduits shall be rigid galvanized steel or PVC-coated rigid galvanized steel conduit.
 - iii. Shall not be larger in outside diameter than one-third (1/3) the thickness of the slab, wall or beam.
 - iv. Raceways shall not be spaced closer than 3 diameters on center.
 - v. Shall not impair significantly the strength of the concrete.
 - vi. Conduits installed in slab on grade shall have a 3 inch concrete envelope and reinforcing and coverage all sides poured monolithic with the slab. Where raceways are going to remote locations it shall not be required to pour the envelope monolithic with the floor slab.
 - b. Raceways beneath above grade concrete slabs shall be supported from the underside of the structural slab by means of galvanized pipe hangers spaced 5'-0" on center, maximum. After installation pipe hangers shall be coated with asphalt mastic. Installation shall maintain integrity of waterproofing membrane.
 - c. Raceways which extend out from a slab, penetrate concrete floor slabs, walls, ceilings, etc., shall transition from PVC to PVC coated rigid galvanized steel 90 degree bends and shall extend a minimum of 12-inches on both sides of the concrete structure prior to transitioning to an approved raceway material as specified for the specific location and NEMA area designated.
4. General Concrete Encasement of Raceways:
- a. All concrete work required for concrete encasement of electrical duct banks shall be provided under Division 3 - Concrete, including all reinforcing steel requirements. All excavation and backfill for electrical duct banks shall be provided under Division 2 - Site Work. This Contractor shall coordinate all requirements noted herein with those Divisions for proper installation.
 - b. For all underground raceways, bottom of trench shall be solid undisturbed earth. Earth showing extensive signs of peat, cinders, rubble or any

- conditions not suitable for a stable foundation should be reported to the Engineer for recommendation. Small packets (up to 1 cu. yd.) of unsuitable soil shall be excavated and replaced with compacted gravel borrow maximum rock size 2 inches. In areas which have had fill work completed during the progress of work under this contract, verify that the bottom of trench is 95 percent compaction minimum. If compaction is less than 95 percent provide additional compaction in bottom of trench.
- c. Form concrete envelope around raceways, 3-inch minimum thickness concrete at top, bottom and sides of duct bank 3 inch minimum (outside to outside) spacing between raceways. Concrete shall be full width of trench. Top raceway shall be not less than 30 inches below finished grade, except where under building slabs. Open trench for its complete length before concrete is poured; if any obstructions are encountered, make provisions to avoid them. Support raceways minimum 3 inches above bottom of trench before pouring concrete. Provide 12" separation between Power and Control/Signal conduits.
 - d. Refer to structural drawings for specific concrete encasement and reinforcing requirements and details. All duct banks shall be formed with wooden forms and no other method of installation shall be allowed. Coordinate with Division 2 and 3 for final installation.
 - e. Furnish and install precast concrete, plastic or fiber spacers in order to achieve consistent spacing between raceways. Stagger couplings. Securely tie raceways in place to prevent floating. Pour concrete as soon as possible after placing and securing of raceways.
 - f. Pull iron-shod mandrel, not more than 1/4 inch smaller than bore of raceway, through each raceway to remove concrete and other obstructions. Clean raceway by drawing through properly sized cylindrical brushes as many times as necessary to remove dirt.
 - g. All duct banks shall be installed to slope back to the respective manholes, handholes, etc. and away from buildings or structures.
- E. General Raceways Installation Requirements:
1. Sized as indicated on the Drawings. Where sizes are not indicated, raceways shall be sized per the National Electrical Code in accordance with the quantity, size, type and insulation of conductors to be installed. However, raceways shall be minimum three quarter (3/4") trade size for all installation unless otherwise noted.
 2. Provide adequate grounding between all outlets and the established electrical system ground. Bond conduit systems per NEC.
 3. Cut square, free of burrs due to field cutting or manufacture, and bushed where necessary. Spray all ends of threaded conduit with cold galvanizing spray compound.
 4. Installed with exterior surfaces not less than six inches (6") from any surface with a temperature of 200 degrees F or higher.
 5. Plugged at the ends of each roughed-in raceway with an approved cap or disc to prevent the entrance of foreign materials during construction.
 6. Concealed throughout except where exposure is permitted by the Engineer.

7. Installed parallel or perpendicular to floors, walls and ceilings.
 8. Installed with a minimum of bends and offsets. All bends shall be made without kinking or destroying the cross section contour of the raceway. Factory made bends shall be used for raceways one-inch (1") trade size and larger.
 9. Installed with U. L. Listed raintight and concrete-tight couplings and connectors.
 10. Firmly fastened within three feet of each outlet box, junction box, cabinet or fitting. Raceways shall not be attached to or supported by wooden plug anchors or supported from Mechanical Work such as ductwork, piping, etc.
 11. Arranged in a neat manner for access and allow for access to work installed by other trades.
 12. If it is necessary to burn holes through webs of beams or girders, call such points to the attention of the Engineer and receive written approval both as to location and size of hole before proceeding with work. All holes shall be burned no larger than absolutely necessary.
 13. Where raceways puncture roof, install pitch pockets as required in order that the roof warranty is maintained.
 14. Where raceways penetrate fire-rated walls, floors, or ceilings, install firestops equal to the rating of the wall, floor, or ceiling, per specification section 07270, "Fireproofing".
 15. For Raceways installed outdoors:
 - a. Conduit entry shall not extend from above and turn down to the equipment causing a path of moisture or liquid to follow down to the equipment.
 - b. Install drip loops in liquid tight conduit connections and extend up to equipment to avoid moisture or liquid travel to the equipment.
 - c. Seal all conduits with duct seal or cable seals that extend from heated to non-heated locations at both ends of all conduits.
- F. Wiring Methods
1. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Engineer and receive written approval for splicing prior to installation of feeder(s). Refer to Splicing Methods listed below.
 2. Do not pull conductors into raceways until raceway system, including all outlets, cabinets, bushings and fittings, is completed. Verify that all work of other trades which may cause conductor damage is completed. Use only U.L. approved cable lubricants when necessary. Do not use mechanical means to pull conductors No. 8 or smaller.
 3. In general, conductors shall be the same size from the last protective device to the load.
 4. All wiring systems shall be properly grounded and continuously polarized throughout, following the color coding specified. Connect branch circuit wiring at panelboards, as required, in order to provide a "balanced" three-phase load on feeders.
 5. All feeder connections shall be made to bus and other equipment using solderless, pressure type terminal lugs, as manufactured by Burndy, National, O.Z., T. & B., or equal.

6. All conductors shall be carefully handled to avoid kinks or damage to insulation.
7. Alarm wires shall be uniquely identified at each end with wire markers. A typed list of the numbers used and their function (alarm served) shall be submitted to the Engineer by the Contractor.
8. After installation of service conductors seal conduits with duct seal.
9. Contractor may group certain wiring with the approval of the Engineer, as follows.
 - a. Power 120V may be grouped with power 120V
 - b. Control 120V may be grouped with control 120V
 - c. Control 24V may be grouped with control 24V
 - d. Instrumentation may be grouped with instrumentation
 - e. Specialty wiring may be grouped with like systems
 - f. Power wiring at 480V shall not be grouped
 - g. Fire alarm system wiring shall not be grouped with other systems

The installation shall be installed in accordance with all requirements of the NEC (including wire ampacity derating factors), manufacturer's requirements, and the Engineer. Excessive grouping which interferes with functionality and reliability will not be allowed. The wiring configuration as shown on the drawings is the baseline requirement for the work.

G. Conduit Support

1. Support adequately by malleable iron pipe clamps or other approved methods. **In exterior or wet locations and along outside wall supports shall allow not less than 1/4 inch air space between raceway and wall.** Firmly fasten raceway within 3 feet of each outlet box, junction box, cabinet or fitting. The following table lists maximum spacing between supports. Additional supports may be required due to field conditions, strength of supporting members, etc. Furnish and install such supports at no additional cost to Owner.

<u>Conduit Trade Size</u>	<u>Type of Run</u>	<u>Horizontal Spacing in Feet</u>	<u>Vertical Spacing in Feet</u>
3/4"	Concealed	7	10
1", 1-1/4"	Concealed	8	10
1-1/2" & lgr.	Concealed	10	10
3/4"	Exposed	5	7
1", 1-1/4"	Exposed	7	8
1-1/2" & lgr.	Exposed	10	10

H. Installation of Concrete Envelope

1. Wherever a cluster of four or more raceways rise out of floor exposed, provide neatly formed 6" high concrete envelope with chamfered edges around raceways.

I. Installation of Spare Conduits

1. At each flush mounted panel-board, terminal cabinet, control cabinet, etc., provide four (4) spare three-quarter inch (3/4) raceways from panel-board, etc.

to an area above the nearest accessible ceiling space and floor space in the specific room location. Make 90 degree turn above the ceiling or below the floor and cap all conduits.

2. Where drawings indicate a "Spare" conduit, install a #14 AWG fish wire in all runs to facilitate future installation of conductors.

J. Installation of Grounding Bushings

1. Provide grounding type insulated bushings on all power conduits regardless of size.
2. Provide grounding type insulated bushings on all control conduits and signal conduits regardless of size.
3. Install cable seal bushings in conduits for all outdoor locations and NEMA 4X locations to prevent moisture from entering enclosures and equipment.
4. Install cable seals in all conduits where there is a change in temperature such as transitioning from a room to the attic.
5. Provide a bushing at each conduit termination unless fitting at box where conduit terminates has hubs designed in such a manner to afford equivalent protection to conductors.
6. Any installations not provided with these requirements shall be removed and reinstalled at no additional cost to the Owner.

K. Myers Hubs

1. Myers Hubs shall be of grounding type and installed on junction boxes and enclosures which do not have cast hubs in non-classified areas. All Myers Hubs shall be capable of receiving wire bonding jumper regardless of conduit size.

L. Expansion Fittings

1. All conduit installations where conduits extend up out of the ground at buildings, structures or equipment shall be provided with expansion fittings.
2. Expansion/deflection type fittings shall be provided at all horizontal or vertical expansion joints, located in new or existing buildings and structures.
3. Expansion fittings shall be watertight expansion type, designed to compensate for conduit movement. Expansion fittings shall be provided to allow movement of 4 inches in both directions for a total of 8 inches. Fittings shall have flexible copper braid bonding jumpers, neoprene sleeve and stainless-steel bands. Acceptable Manufacturer: O.Z./Gedney Type EX, Thomas & Betts, or equal.
- 4.

M. Conduit Seals

1. Conduit seals shall be installed in all explosion proof areas Class 1 Division 1, and Class 1, Division 2 areas. The conduit seal shall be installed per the National Electric Code Article 501.15 as well as what is shown on the drawings.
2. Upon installation of sealant, the contractor shall mark the conduit seal with glyptal or permanent marker to indicate that the conduit seal is filled properly.

N. Link Seals

1. All penetrations through existing and new concrete floors, and walls shall be core drilled and sleeved, and installed with a link seal.
2. Refer to all details shown on the Contract Drawings for conduit sealing fittings and weatherproof conduit seals. All conduit penetrations are required to be

provided with seals as noted on the Contract Drawings and as specified. Any installations not provided with these requirements shall be removed and reinstalled at no additional cost to the Owner.

O. Raceways through Wall Bond Outs

1. In specific areas wall bond outs have been designed and shown on the electrical and structural drawings for conduit installations.

P. Splicing Methods

1. Feeder conductors shall be continuous from point of origin to load termination without splice. If this is not practical, contact the Engineer and receive written approval for splicing prior to installation of feeder(s).
2. For splices and taps, No. 10 AWG and smaller, use solderless "Thread-On" connectors having spiral steel spring and insulated with a vinyl cap and skirt, as manufactured by 3M Co. (pre-insulated "Scotch-Lock") or Ideal ("Wing-Nuts").
3. For splices and taps, No. 8 and larger, use solderless "Split Bolt" type connector as manufactured by Anderson, Burndy, Kearney, Thomas & Betts, or equal.
4. Use cast connections, Cadweld or Thermoweld, for ground conductors.
5. Make all splices and connections in accessible boxes and cabinets only.
6. Cover uninsulated splices, joints and free ends of conductor with rubber and friction tape or PVC electrical tape. Plastic insulating caps may serve as insulation.
7. Where feeder conductors pass through junction and pull boxes, bind and lace conductors of each feeder together. For parallel sets of conductors, match lengths of conductors as near equal as possible.
8. Branch circuit conductors installed in panelboards, and control conductors installed in control cabinets and panels shall be neatly bound together using "Ty-Raps" or equal.
9. Underground Splicing
 - a. This work will require that all splices be tested and also provide the splices with a compression connector on the conductor. Insulate and waterproof using one of the following methods which are suitable for continuous submersion in water:
 - b. Provide cast-type splice insulation by means of molded casting process employing a thermosetting epoxy resin insulation in a packaged form ready for convenient mixing without removing from the package.
 - c. Gravity poured method shall employ materials and equipment contained in an approved commercial splicing kit which includes a mold suitable for the cables to be spliced when the mold is in place around the joined conductors, prepare the resin mix and pour into the mold.
 - d. Provide heavywalled heat shrinkable splice insulation by means of a thermoplastic adhesive sealant material which shall be applied by a clean burning propane gas torch.
 - e. Provide a cold-shrink rubber splice which consists of EPDM rubber tube which has been factory stretched onto a spiraled core which is removed during splice installation. The installation shall not require heat or flame, or any additional materials such as coverings or adhesives. It shall be

designed to be used with in-line compression type connectors, indoor, outdoor, direct-burial or submerged locations.

- Q. Installation of Ceiling Hung Devices
 - 1. Lighting fixtures, detectors, etc., in Mechanical Equipment, Boiler and Pump Rooms shall be installed with exposed conduit after equipment, ductwork, piping, etc., are in place.
- R. Grouping of Conductors
 - 1. Contractor may group certain wiring with the approval of the Engineer, as follows.
 - a. Power 120V may be grouped with power 120V
 - b. Control 120V may be grouped with control 120V
 - c. Control 24V may be grouped with control 24V
 - d. Instrumentation may be grouped with instrumentation
 - e. Specialty wiring may be grouped with like systems
 - f. Power wiring at 480V shall not be grouped
 - g. Fire alarm system wiring shall not be grouped with other systems

The installation shall be installed in accordance with all requirements of the NEC (including wire ampacity derating factors), manufacturer's requirements, and the Engineer. Excessive grouping which interferes with functionality and reliability will not be allowed. The wiring configuration as shown on the drawings is the baseline requirement for the work.

- S. Light Switches
 - 1. All light switches shall be installed in close proximity of the door opening where indicated on drawings. Where lights are shown adjacent to strike side of door, locate edge of switch box approximately 6 inches from door frame.
 - 2. Install cover plates for all single and multi-gang switch boxes for all light switches.
- T. Outlet Boxes
 - 1. On termination at branch circuit outlets, leave a minimum of eight inches (8") free conductor for installation of devices and fixtures.
 - 2. Consider location of outlets shown on Drawings as approximate only. Study Architectural, Mechanical, Plumbing, Process, and Structural Drawings and note surrounding areas in which each outlet is to be located. Locate outlet so that when fixtures, motors, cabinets, equipment, etc., are placed in position, outlet will serve its desired purpose. Where conflicts are noted between Drawings, contact Engineer for decision prior to installation. Comply with Article 314 of National Electrical Code relative to position of outlet boxes in finished ceilings and walls.
 - 3. Prior to installation, relocate any outlet location a distance of five feet in any direction from location indicated on Drawings if so directed by the Engineer. Prior to completion of wall construction, adjust vertical height of any outlet from height indicated if so directed by Engineer. The above modifications shall be made at no additional cost to the Owner.

4. Where outlets at different mounting heights are indicated on Drawings adjacent to each other (due to lack of physical space to show symbol on Drawings), install outlets on a common vertical line.
5. Where switch outlets are shown adjacent to strike side of door, locate edge of outlet box approximately 3 inches from door frame.
6. Outlet boxes in separate rooms shall not be installed "back-to-back" without the approval of the Engineer.
7. Outlet boxes installed in plaster, gypsum board or wood paneled walls shall be installed with raised plaster covers or raised tile covers.
8. Outlet boxes installed in tile, brick or concrete block walls shall be installed with extra-deep type raised tile covers or shall be 3-1/2 inches deep boxes with square corners and dimensions to accommodate conductors installed.
9. Surface ceiling mounted outlet boxes shall be minimum 4 inches square, 1-1/2 inches deep, galvanized sheet metal.
10. Surface wall mounted outlet boxes shall be cast type boxes having threaded or compression type threadless hubs. Exterior boxes shall be cast type with threaded hubs and gasketed cover plates secured by non-ferrous screws.
11. Install a device cover plate over each and every outlet indicated on Drawings. Do not install plates until painting, cleaning and finishing of surfaces surrounding the outlet are complete. Cover plates shall completely cover all edges of openings in the wall around the outlet box for a neat/finished installation.

U. Junction and Pull Boxes

1. Install junction and pull boxes in readily accessible locations. Access to boxes shall not be blocked by equipment, piping, ducts and the like. Provide all necessary junction or pull boxes required due to field conditions and as required by the National Electrical Code, Article 314.

V. Equipment Mounting Heights

1. Unless otherwise noted, mount devices and equipment at heights measured from finished floor to device/equipment base as follows: (Device base to be set at CMU joint unless otherwise noted. The Contractor shall verify all dimensions noted with the Engineer for final approval prior to performing or installing any of this work.)

A. Toggle switches (up position "on")	48"
B. Receptacle outlets (long dimension vertical,	
C. ground pole nearest floor)	16"
D. Receptacle outlets, above baseboard heaters	30" min.
E. Receptacle outlets, hazardous areas	48"
F. Receptacle outlets, at countertops	48"
G. Receptacle outlets, weatherproof, above grade	24" min.
H. Telephone/intercommunication outlets,	
I. wall mounted	48"
J. Telephone and data outlets and cable T.V. outlets	16"
K. Fire alarm manual station	48"
L. Fire alarm Audio/Visual Station	96"
M. Branch circuit panelboards, to top of backbox	72"

- | | | |
|----|--|-----|
| N. | Distribution panelboards, to top of backbox | 72" |
| O. | Terminal cabinets, control cabinets, annunciator panels, to top of backbox | 72" |
| Q. | Disconnect switches, motor starters, enclosed | |
| R. | circuit breakers, to top of box | 60" |
- Where structural or other interferences prevent compliance with mounting heights listed above, consult Engineer for review to change location before installation.
- W. Hangers and Supports
- Provide steel angles, channels and other materials necessary for the proper support and erection of motor starters, distribution panelboards, large disconnect switches, pendant-mounted lighting fixtures, etc.
 - Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors, preset inserts or beam clamps. Do not use spring steel clips and clamps.
 - Use expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
 - Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
 - Do not use powder-actuated anchors.
 - Fabricate supports from stainless steel channel rigidly welded or bolted to present a neat appearance. Use stainless steel hexagon head bolts with spring lock washers under all nuts.
 - Panelboards, cabinets, large pull boxes, cable support boxes and starters shall be secured to ceiling and floor slab and not supported from conduits. Small panelboards, etc., as approved by Engineer, may be supported on walls. Racks for support of conduit and heavy electrical equipment shall be secured to building construction by substantial structural supports with PVC end caps as noted above.
 - When flush-mounting panelboards and cabinets, studs shall be bridged top and bottom with framing channel to support the installation.
 - Install surface-mounted cabinets and panelboards with minimum of four 316 stainless steel anchors or as shown on drawings. Provide 316 stainless steel channel supports to stand cabinet 1 inch off wall.
 - All vertical supports for stanchion mount structures and control stations shall be 4" angle channel.
 - Light fixtures which are pendant mounted shall be supported with 3/4" conduit supports and 360° swivel connectors at cast boxes. All fixtures shall be installed with weathertight conduit hubs.
 - Provide PVC end caps for all protruding angles, channels, struts, etc. for personal safety for the entire project installation.
- X. Identification of Conduit Systems
- Provide lamacoid nameplates to mark intrinsically safe conduit systems for all applicable conduit systems for project.
- Y. Grounding Connections

1. Exothermic welding connections shall be provided for underground connections.
2. Mechanical fittings and irreversible compression fittings shall be provided for above ground connections.
3. Make connections to equipment with mechanical connections shall be made by means of approved bronze clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A, or equal.

3.2 TESTS

- A. For testing requirements, refer to Section 16950.
- B. For grounding requirements, refer to Section 16450.

END OF SECTION

SECTION 16060ELECTRICAL EQUIPMENT ENCLOSURESPART 1 - GENERAL1.1 DESCRIPTION

- A. Provide aluminum equipment enclosure to house electrical equipment. Enclosure configuration may be either a double door single sided enclosure or a back to back enclosure with single doors.

1.2 QUALITY ASSURANCE

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance.
- B. Equipment to be UL Listed and Labeled.
- C. Work determined by the Engineer to be unsatisfactory according to industry standards shall be redone at the Contractor's expense, with no additional compensation.
- D. Acceptable manufacturers are Hoffman, Saginaw, or equal.

1.3 SUBMITTALS TO THE ENGINEER

- A. Shop drawings are required for all items provided under this section. Submit shop drawings in accordance with Sections 01340, 16010 and as specified in this section.
- B. Submit a final, dimensioned layout plan with all equipment and conduit shown for verification by the engineer and coordination of final sizing.

PART 2 - PRODUCTS2.1 MATERIALS

- A. Provide a free standing heavy-duty 316 stainless-steel weather tight and corrosion resistant pedestal enclosure. The enclosure shall not have any side clips around the edges and the only means of entrance shall be a key lockable handle. Devices requiring mechanical coins or quarter turn latches are not acceptable.
- B. Pedestal enclosure shall be made of 12-gauge 316 stainless-steel with ¼ inch by 2 inch by 2 inch channel support on walls, roof and base. The enclosure shall be sized to house all equipment as shown on the Drawings and shall be located as shown on the Drawings. Final sizing shall be submitted as a shop drawing with all equipment shown to scale and dimensioned for performing a final review. The Contractor is responsible to coordinate and provide the correct sizing at no additional cost to the Owner.
- C. The enclosure shall be U.L. listed and labeled as a complete assembly. The final sizing of the enclosure based on the supplied equipment to be selected by the contractor shall be the responsibility of the contractor.
- D. Enclosure shall have full height hinged doors. Doors shall have vault type key lockable operating handles with three-point latch.
- E. Doors shall be fully gasketed with opening of sufficient size to permit ready removal of any of the equipment installed in the compartments. Number of doors and arrangement shall be based on overall width of enclosure. Support posts shall not

interfere with clearance access between doors to equipment. The enclosure shall have an aluminum mounting backboard with ground lug assembly mounted to backboard and enclosure for system grounding.

- F. Six sets of keys for each lock shall be furnished.
- G. Pedestal roof shall slant to the rear of the enclosure.
- H. Drip shield shall extend over door opening.
- I. All exposed hardware shall be stainless steel.
- J. Dimensions if shown on the drawings are for reference only. The electrical enclosure shall have sufficient space to mount all equipment with proper clearances and height requirements as required per NEC. The final sizing is the responsibility of the contractor.
- K. Heat dissipation is required to remove excess heat from within the enclosure for the Power Equipment Enclosure. This has not been shown on the drawings for clarity. Provide a complete system to include thermostat, fan, in-take louver, and out-take louver required to properly cool the enclosure. The system specified below is manufactured by Hoffman/miscellaneous equipment:
 - 1. Cooling Fan Package, Hoffman Catalog #TFP61SS (115 volt, Type 1 washable foam filter, 140 CFM @ 60 HZ, SS grille, composite air plenum, finger guard).
 - 2. Exhaust Grille, Hoffman Catalog #TEP6SS (stainless steel w/ Type 1 washable foam filter).
 - 3. 2-fan shroud kits, (1 on intake and 1 on exhaust), Hoffman Catalog #T103RSS.
 - 4. Line voltage thermostat: Honeywell T631C1103.
 - 5. Fractional 120V Manual Motor Starter: Square-D FG-1P
 - 6. The fan shall be controlled by a thermostat and power shall be obtained from a circuit breaker from the lighting panel within the electrical equipment enclosure.
 - 7. The enclosures shall be insulated and heated as a factory-installed requirement. Field installations after the fact will not be acceptable. Insulate the inside of all exterior surfaces with 1 inch thick rigid fiberglass insulation board having a maximum thermal conductivity ("k" value) of 0.35 BTU-in/hr-ft²-°F. The insulation shall be finished with manufacturer's standard all service jacket. Coverings containing foil will not be acceptable.
 - 8. For outdoor locations, heat/sun shields fabricated from 0.125 marine grade aluminum shall be installed on front, back and sides of enclosures and control panels that house electrical components. Holes shall be cut in shield for alarm light and horn. Heat shields shall also have white polyester powder coat finish on all sides. Provide cut-outs in the back of the enclosure to accept VFD aluminum mounting plates. Mounting plates shall be attached to studs on the back of the enclosure and gasketed. VFD enclosures located outside shall be NEMA 12/3R with the VFD heat sinks vented out the back. Consult VFD manufacturer's installation guide for flange mount cut-out dimensions and recommended instructions. The rear sunshield shall have a removable cover with handles to allow access to the VFD heat sinks for cleaning and maintenance. The heat shield shall have studs with wing nuts for attached the removable cover. Seal all penetrations

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Enclosure is to be installed on an outdoor concrete pad.
- B. Enclosure is to be anchored to the concrete pad with epoxy anchors as recommended by the manufacturer.
- C. Ground equipment enclosure as required by Article 250 of the National Electric Code.

END OF SECTION

SECTION 16061MODIFICATIONS TO EXISTING ELECTRICAL EQUIPMENT ENCLOSURESPART 1 - GENERAL1.1 DESCRIPTION

- A. The work of this section includes the furnishing, installing, and testing of modifications to existing electrical equipment enclosures as specified herein and as shown on the contract drawings.
- B. Modifications to existing electrical equipment enclosures are not required to be of the same manufacturer as the motor control centers provided for the project as applicable. These devices take exception to the Quality Assurance Statement of Section 1.2.E of Specification 16010.

1.2 QUALITY ASSURANCE

- A. The equipment specified herein is based upon the first manufacturer named after the phrase "Acceptable Manufacturer's". Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer. Equipment of other acceptable manufacturers shall be equivalent in every way to that of the equipment specified.
- B. Suppliers deemed equivalent shall be responsible to support and supply equivalent equipment which shall meet the intended design. Any extensive modifications or rework of the design drawings in order to facilitate acceptability shall be the responsibility of this Contractor at no additional cost to the Owner.
- C. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

1.3 SUBMITTALS TO THE ENGINEER

- A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

1.4 REFERENCE TO OTHER SECTIONS

- A. Refer to Section 16010 for identification nameplate requirements.
- B. Refer to Section 16010 for coordination, short circuit, and arc flash study requirements.

PART 2 - PRODUCTS2.1 MATERIALS

- A. Modifications to Existing Electrical Equipment Enclosures:
 - 1. The modifications to the existing motor control centers and the manufacturer are shown on the contract drawings.
 - 2. This Contractor shall visit the site to become thoroughly familiar with the work required and specified herein. All modifications shall be performed without jeopardizing the integrity of the existing equipment. All work to be performed

MODIFICATIONS TO EXISTING ELECTRICAL EQUIPMENT ENCLOSURES

- shall be complete and shall meet with all standards and guidelines for installation to this equipment.
3. The contract drawings indicate that specific equipment in enclosures is to be modified. The modifications shall include new equipment and/or modifications to existing equipment installed. All new equipment and modifications to existing equipment to complete the work shown in the contract drawings shall be provided.
 4. The short-circuit ratings of all new and modified devices shall be equal to or greater than that of the existing equipment. This is to be verified by this Contractor and the information furnished and included in the shop drawing submittals for this equipment.
 5. The Contractor shall be allowed to replace equipment as required in its entirety. This shall be verified with the Contractor and brought to the attention of the Engineer prior to final cost submittal.
 6. Provide lamacoid nameplates for all revised items as required for all devices and as noted on contract drawings.
 7. The requirements noted have been outlined for this section. If any information on existing equipment cannot be verified then this shall be brought to the attention of the Engineer and verified prior to submitting bid for this project.

PART 3 - EXECUTION3.1 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code.
- B. Ground all enclosures in accordance with the National Electric Code and as specified in section 16450.
- C. Enclosures shall be installed on outdoor concrete pads.
- D. Enclosure is to be anchored to the concrete pad with epoxy anchors as recommended by the manufacturer.
- E. Install Safety Labels in compliance with NEMA 260.

3.2 TESTS

- A. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16070ELECTRICAL HANGERS AND SUPPORTSPART 1 - GENERAL1.1 SUMMARY

- A. Section Includes
 - 1. Support channel
 - 2. Fastening hardware
 - 3. Anchor bolts

1.2 SUBMITTALS

- A. Submit shop drawings, product data, and reports.

1.3 QUALITY ASSURANCE

- A. Support systems shall be adequate for weight of equipment and conduit, including wiring, which they carry.

PART 2 - PRODUCTS2.1 SUPPORT CHANNEL

- A. Channel for all locations shall be roll formed from stainless steel AISI Type 316. Channel shall be 1-5/8" and comply with the following industry standards: NFPA70, Fed Spec: W-C-582, WW-H-171, MFMA-4, and ASTM B633
- B. Metal Channel framing in Class 1, Div. 1 areas and NEMA 4X-corrosive areas shall be fiberglass or PVC Coated.
- C. Use 316 stainless steel fittings and hardware of the same material as channel. Fittings shall be by same manufacturer.
- D. All metal framing channel ends shall be furnished and installed with plastic caps for the entire installation of this project at all ends of framing.
- E. Provide a complete 4" "C" angle 316 stainless steel channel mounting channel and hardware system as shown on the drawings and for all vertical supports. Refer to the electrical detail drawings for structural sizing and rigidity of "C" channel.
- F. Metal framing shall be B-Line Systems, Inc., Thomas & Betts-Super Strut, Unistrut, or equal.

2.2 FASTENING HARDWARE

- A. All fastening hardware shall be 316-stainless steel unless noted otherwise.

2.3 ANCHOR BOLTS

- A. Anchor bolts, nuts, washers, bolt sleeves, and assembly hardware shall be Type 316 stainless steel. Expansion bolts shall be "Kwik Bolt II" or "HVA Adhesive Anchor" by Hilti, Tulsa, OK; Redhead "Trubolt Wedge" or "Epcon Adhesive Anchor" by ITW Ramset / Red Head, Wood Dale, IL; or Parabolt as manufactured by the Molly Division Emhart Corp., or approved equal.

- B. All expansion/adhesive bolts and associated hardware are to be stainless steel.

2.4 PIPE CLAMPS AND STANDOFFS

- A. Pipe clamps and standoffs shall be one hole type. They shall be of the same manufacturer and shall be designed to be used together.
- B. The finish shall be 316 stainless steel type suitable for the piping system being supported. If PVC or PVC coated conduit is being supported, PVC coated clamps and standoffs shall be used.

2.5 THREADED RODS

- A. Threaded hanging rods shall be 316 stainless steel and be one piece. The size shall be suitable for the loads being supported.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Fasten hanger rods, conduit clamps, and outlet and junction boxes to building structure using expansion anchors, preset inserts or beam clamps. Do not use spring steel clips and clamps.
- B. Use expansion anchors or preset inserts in solid masonry walls; self-drilling anchors or expansion anchor on concrete surfaces; sheet metal screws in sheet metal studs; and wood screws in wood construction.
- C. Do not fasten supports to piping, ductwork, mechanical equipment, or conduit.
- D. Do not use powder-actuated anchors.
- E. Fabricate supports from stainless steel channel rigidly welded or bolted to present a neat appearance. Use stainless steel hexagon head bolts with spring lock washers under all nuts.
- F. Install freestanding electrical equipment on 4-inch concrete housekeeping pads.
- G. Install surface-mounted cabinets and panelboards with minimum of four 316 stainless steel anchors or as shown on drawings. Provide stainless steel channel supports to stand cabinet 1 inch off wall.
- H. Bridge studs top and bottom with stainless steel channels to support flush-mounted cabinets and panelboards in stud walls.
- I. Use standoffs on surface mounted conduit to maintain ¼" inch space between conduits and walls.
- J. Light fixtures which are pendant mounted shall be supported with ¾" conduit supports and 360° swivel connectors at cast boxes. All fixtures shall be installed with weathertight conduit hubs.

END OF SECTION

SECTION 16075

CONDUIT, CABLE, AND WIRING IDENTIFICATION AND TAGGING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Provide labels and tags to identify all conductors, conduits, and equipment in accordance with designations specified in this Section and in the contract documents.
- B. Identification:
1. All distribution equipment (switchboards, motor control centers, distribution panelboards, transformers, transfer switches, disconnects, starters, control panels, control stations, etc.) shall have an engraved lamacoid tag, permanently mounted adjacent to the manufacturer's nameplate, indicating the equipment's designation (as called out on the Drawings) and identification number per the Contract Documents.
 2. All switchboard and distribution panel overcurrent devices, motor control center devices, individually mounted motor controllers, disconnect switches, control devices, etc., shall be provided with permanently attached engraved lamacoid tags indicating the equipment which they serve or control per the equipment designation and identification number indicated in the Contract Documents, and in accordance with OSHA requirements.
 3. All branch circuit panelboards shall have, on the inner side of the door, a permanently attached, engraved lamacoid tag with the identification number of that panelboard. Provide and mount under plastic, in the directory frame of each panelboard, a neatly typewritten directory identifying the branch circuit overcurrent devices and the circuits, devices and areas which they serve.
 4. All individually mounted panelboards, disconnects, motor controllers, control stations, etc. shall have a second engraved lamacoid tag below the first one which identifies from where the equipment is receiving power. This second label shall be smaller in height.
 5. Label and identify with branch circuit and source panel all light switches, manual motor starters, and receptacles
 6. Nomenclature on these nametags shall be project specific and wherever possible shall be full and complete. Excess abbreviations will not be allowed.
 7. Power conductors shall be continuously polarized and color coded throughout using the following scheme:
 - a. White - All neutral conductors, 208/120V systems
 - b. Gray - All neutral conductors, 480/277 volt systems.
 - c. Green - All ground conductors
 - d. Phase Conductors

208/120V Systems

Phase A - Black
Phase B - Red
Phase C - Blue

240/120V Systems

Phase A - Black/(Red)
Phase B - Red/(Blue)

480/277V Systems

Phase A - Brown
Phase B - Orange
Phase C - Yellow

- e. Regardless of conductor size, conductor insulation color shall correspond to the color coding required in this section.
8. Control Conductors shall be continuously polarized and color coded throughout using the following scheme:
- a. 120 Volts – Red
 - b. DC Controls – Dark Blue
 - c. Intrinsically Safe – Light Blue
9. All individual conductors shall be identified using unique numerical tags corresponding to conductor designations indicated on approved shop drawings of schematic diagrams for all terminations. This includes all process- and non-process-related wiring done as part of the work, such as fire alarm panels. Conductors shall be clearly identified at each terminal block, equipment connection and junction. Markings shall utilize the equipment designation and terminal block number in the device higher upstream in the system hierarchy. Markings shall follow the format “Device Tag-Equipment Served Tag-Device Terminal Block No.” Refer to Division 13 for communication and manufacturer instrument cable labeling requirements.
- a. System hierarchy shall be defined as follows:
 - i. Master Terminal Unit
 - ii. Remote Terminal Unit
 - iii. Motor Control Center
 - iv. Transmitters, Local Control Stations
 - v. Elements
 - b. Refer to attached figure showing sample wire labeling convention.
10. All feeder cables shall be marked indicating load for each feeder for all junction boxes, handholes, and manholes.
11. Conduits shall be marked at both ends utilizing a stamped tag manufactured from 316 stainless steel with designations corresponding to the conduit schedule on approved drawings. Attach tags to conduits with 316 stainless steel wire. Such marking shall include the designation of the conduit, the destination of the conduit, and the type of conductors in the conduit, being power (P), control (C), or signal (S). The format for the marking shall be “Conduit Designation-Equipment Designation.”
- a. For example, conduit P79 provides a power connection from Control Panel CP-CF to LIT-172. The marking at CP-CF shall therefore read “P79-LIT712.” The corresponding marking at LIT-712 shall read “P79-CPCF.”
 - b. Conduit C90 provides a control connection from Motor Control Center MCC-1 to Control Panel CP-M. The marking at MCC-1 shall therefore read “C90-CPM.” The corresponding marking at CP-M shall read “C90-MCC1.”
 - c. Conduit S37 provides a signal connection from Control Panel CP-CF to CFP-800. The marking at CP_CF shall therefore read “S37-CFP800.” The corresponding marking at CFP-800 shall read “S37-CPCF.”

- d. Refer to Table 1 – Cable Identification and Tagging Schedule. A copy of this schedule will be supplied to the contractor. The attached Table 1 located at the end of this specification section has been provided as an example of the requirements to be provided as an example of the requirements to be provided for the project. They shall be provided for all cables which are power, control, and signal to be supplied for the entire project.
12. The following safety signage shall be provided for the following equipment. Signage shall be lamacoid plastic (Large Letters) yellow background with red engraved letters:
- a. All switchboards, motor control centers, VFD equipment, automatic transfer switches, solid-state, reduced-voltage starters, enclosed circuit breakers, etc., shall be provided with signage to read "DANGER - HIGH VOLTAGE". Each section (vertical component of multi-section enclosure) shall be furnished with an individual signage. Final requirements shall be determined at the discretion of the Engineer.
 - b. All motor control center motors starters, individual motor starters and/or control panels shall be provided with signage to read "CAUTION - This Enclosure Contains Voltage Sources from Outside of This Enclosure".
 - c. All switchboards, motor control centers, panel boards, transformers control panels, etc., shall have Arc Flash labels as provided and determined by the Arc Flash Study.

1.2 QUALITY ASSURANCE

- A. Supply all new materials, devices and equipment in conformance with:
 - 1. Underwriter's Laboratory, Inc.
 - 2. National Electrical Manufacturers Association.
 - 3. American National Standards Institute.
 - 4. National Electrical Code (NEC).
 - 5. Local Power Company.
 - 6. Local Telephone Company
 - 7. Local Internet Provider
 - 8. OSHA

1.3 SUBMITTALS TO THE ENGINEER

- A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Wire Markers:
 - 1. Provide Perma Sleeve Heat Shrink Tubing by Brady or equal. All markers to be type written.
- B. Labels and tags shall be typewritten and pre-manufactured for the intended purpose. Labels and tags with "tails" will not be accepted. All labels and tags must be installed

CONDUIT, CABLE, AND WIRING IDENTIFICATION AND TAGGING

prior to site acceptance.

- C. Lamacoid tags shall be nominal 1" x 4" with 3/8" white lettering on black background, unless specified otherwise.

PART 3 - INSTALLATION

3.1 INSTALLATION

- A. Labels and tags shall be installed per manufacturer guidelines to maximize the life of the label.

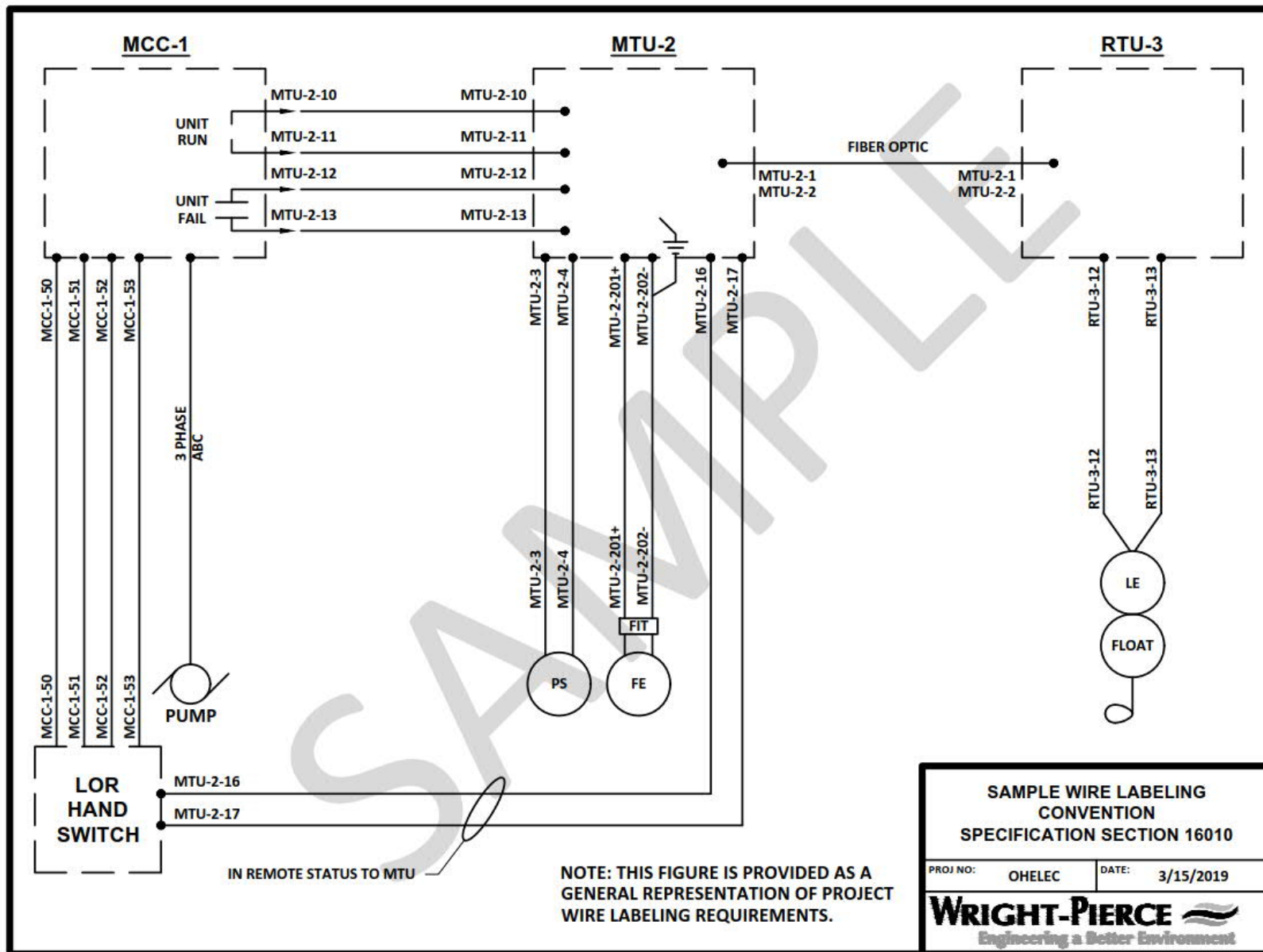


TABLE 1 – CABLE IDENTIFICATION AND TAGGING SCHEDULE

<i>Internal Recycle Pump - 1</i>												<i>IRP-6010</i>		LOOP √	PURPOSE
PLC-1		MCC-6A		VFD-IRP-6010		LCS-6010		Disconnect IRP-1		Term #	Wire #				
Term #	Wire #	Term #	Wire #	Term #	Wire #	Term #	Wire #	Term #	Wire #			Term #	Wire #		
DISCRETE	6010-1	1			11	1								Run Status	
	6010-2	2			12	2								Rub Status	
	6010-3	3			13	3								VFD Fault	
	6010-4	4			14	4								VFD Fault	
	6010-5	5							NC	5				Disconnect Off	
	6010-6	6							NC	6				Disconnect Off	
	6010-7	7			17	7								Seal Leak	
	6010-8	8			18	8								Seal Leak	
	6010-9	9			19	9								Overtemp	
	6010-10	10			20	10								Overtemp	
CONTROL	6010-11	11			21	11								Run Command	
	6010-12	12			22	12								Run Command	
	6010-13	13			23	13	LOR	13						Local	
	6010-14	14			24	14	LOR	14						Remote	
	6010-15	15					NC	15						In Remote	
	6010-16	16					NC	16						In Remote	
ANALOG	6010-AI-1	Cable 1			25	Cable 1								Speed	
	6010-AI-1	Cable 1			26	Cable 1								Speed	
	6010-AO-1	Cable 2			27	Cable 2								Speed Reference	
	6010-AO-1	Cable 2			28	Cable 2								Speed Reference	

PROJECT NAME: _____

CHECKED BY: _____ **DATE:** _____

END OF SECTION

SECTION 16160CABINETS AND ENCLOSURESPART 1 - GENERAL1.1 DESCRIPTION

- A. The purpose of this Specification is to provide details of cabinets and enclosures for non-hazardous indoor and outdoor locations which will protect internal equipment from environmental conditions. This section is also to intend to provide consistency between enclosures supplied under different Divisions of this Contract. An exception is control panels provided by Division 11 and Division 13 which are specified within their specifications.

1.2 QUALITY ASSURANCE

- A. Supply cabinets and enclosures in accordance with the following:
1. Underwriter's Laboratory, Inc. listed.
 2. National Electrical Manufacturers Association Standard 250-1991.
 3. American National Standards Institute.
 4. National Electrical Code.
- B. Cabinets and enclosures supplied under this Section shall conform to the requirements of Specification Section 16010, "Quality Assurance".
- C. Stock cabinets and enclosures shall be manufactured by Hoffman Engineering Company, Saginaw Control and Engineering or approved equal. Custom fabricated enclosures shall be equal in quality, appearance and performance to stock enclosures. All enclosures shall be subject to the review of the Engineer.

1.3 RELATED WORK

- A. Additional details for panels and enclosures associated with process equipment are provided in the individual specification sections in Division 11.
- B. Additional details for panels and enclosures associated with HVAC equipment are provided in the individual specification sections in Division 15.
- C. Miscellaneous panel and enclosure auxiliary equipment, such as lights, switches, receptacles, fuses, etc. are contained in Section 16050, 16900, and as noted on the Contract Drawings.

1.4 REFERENCES

- A. ASTM C177 - Test Method for Steady-State Heat Flux Measurements and Thermal Transmission Properties by Means of the Guarded-Hot-Plate Apparatus.
- B. ASTM D149 - Test Methods for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies.
- C. ASTM D256 - Test Methods for Determining the Izod Pendulum Impact Resistance of Plastics.
- D. ASTM D495 - Test Method for High-Voltage, Low-Current, Dry Arc Resistance of Solid Electrical Insulation.
- E. ASTM D570 - Test Method for Water Absorption of Plastics.

- F. ASTM D638 - Test Method for Tensile Properties of Plastic.
- G. ASTM D648 - Test Method for Deflection Temperature of Plastics Under Flexural Load in the Edgewise Position.
- H. ASTM D790 - Test Method of Flexural Properties of Unreinforced and Reinforced Plastics and Electrical Insulating Materials.
- I. ASTM D792 - Test Method for Density and Specific Gravity (Relative Density) of Plastic by Displacement.
- J. UL94 - Test for Flammability of Plastic Materials for Parts in Devices and Appliances.
- K. UL508A - Industrial Control Panels.
- L. The enclosures shall meet all requirements for UL508A - Industrial Control Panels as follows:
 - 1. All components within the enclosures shall be UL Listed and Labeled.
 - 2. The enclosure and all components as an entire "assembly as a system" shall be UL Listed and Labeled as UL508A compliant.

1.5 SUBMITTALS TO THE ENGINEER

- A. Shop drawings for this section are not required. The items listed below shall be included with the specific control being submitted to show compliance with this section in order to perform a complete review for equipment being submitted.
 - 1. Provide documentation, as applicable, from a UL certified fabricator that the control panel has been tested, fabricated, and labeled as a complete functioning system and is in compliance with all UL listings and standards.
 - 2. Scaled and dimensioned enclosure layout drawings (internal and external) along with catalog cut sheets shall be provided.
 - 3. Enclosure NEMA ratings, project specific identification, where located, etc., shall be clearly and properly identified on each panels cut sheet.
 - 4. Listing of all accessories to be furnished with each panel and properly identified.
 - 5. Provide a complete wiring diagram for all items located within the enclosure such as panel lights, duplex receptacles, panel heaters, cooling fans, relays, control devices, protective devices, etc., where applicable.
 - 6. Provide heating requirement calculations for all exterior panels and panels located in unheated spaces, and cooling requirement calculations for heat dissipation from panels containing VFD's and other heat generating equipment as necessary.
 - 7. Submit all control panel faceplate arrangements for review and acceptance.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Delivery, storage and handling of electrical/instrumentation cabinets, enclosures and equipment contained within shall be in accordance with the general conditions Specification 11000 and specification 16010.
- B. Replace or repair, to the satisfaction of the Engineer, any cabinets and enclosures which are defective or have been damaged during storage or installation, at no additional cost to the Owner.

PART 2 - PRODUCTS

2.1 MATERIALS

A. General for all Enclosures:

1. NEMA classifications for panels and enclosures shall be as noted on Drawing E-1, unless otherwise specifically called out within the Drawings or Specifications.
2. Panels and enclosures shall be furnished factory-wired and tested with all equipment and appurtenances mounted thereon.
3. Control panels and enclosures shall be U.L. listed and labeled as a complete and functioning system.
4. Panels larger than 36-inches in any dimension shall not be wall mounted.
5. Provide two doors if panel is larger than 36-inches wide.
6. Refer to the drawings and pertinent specifications for minimum control panel faceplate requirements. In the absence of specific details, faceplates shall be arranged in such a manner as to provide a neat, workable and operator friendly panel.
7. Doors shall have side mounted, stainless steel, continuous length, piano-type hinges and pins.
8. Latches shall be T-handle or quick-release type only. Latches which require use of tools or coins for access, utilize wing-nuts, clips around the outside of enclosure etc., will not be acceptable.
9. Panels/enclosures shall be equipped with map pockets located on the inside of the door.
10. Enclosures shall be equipped with provisions for locking the access doors.
11. Enclosures shall be sized as required to contain the necessary apparatus for the particular installation except as noted on the drawings. Final panel/enclosure dimensions shall provide for easy access and workability to all internal components with ease of maintenance and future modifications considered. Conflicts with panel sizing and available spacing shall immediately be brought to the attention of the Engineer prior to proceeding.
12. Provide door and body stiffeners where necessary for a rigid enclosure. Large enclosures shall be provided with lifting eyes and, where floor-mounted, with 12-inch floor stands. No floor stands are to be provided for free-standing models.
13. Enclosures larger than 16 inch in any dimension shall utilize a three point latching system.
14. Enclosures 16 inch wide and larger shall be equipped with heavy duty, zinc plated stop arm kits to lock the external door in the open position.
15. Panel front-mounted pilot lights, selector switches, push button control stations and appurtenances shall be provided in accordance with Section 16900.
16. Where required, enclosures shall be provided with an interior panel, painted white, for mounting of internal components.

B. General NEMA Class and Requirements for Indoor Installations:

1. NEMA Type 1 Enclosures
 - a. Enclosures shall be sheet steel, 16 gauge for box widths up to and including 18", 14 gauge for box widths of 24", and 12 gauge for box

- widths of 30" and greater. Enclosures shall have continuously welded seams ground smooth; supplied with or without knockouts and shall have door and body stiffeners where necessary for a rigid enclosure.
- b. Panels/enclosures shall be factory coated inside and out with ANSI 61 gray polyester powder coating over phosphatized surfaces.
2. NEMA Type 12 Enclosures:
 - a. Enclosures shall be sheet steel, 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 60" by 36", and 12 gauge for box sizes greater than 60" by 36". Free-standing enclosures shall be 12 gauge minimum. Enclosures shall have continuously welded seams, ground smooth, supplied with no holes or knockouts and a rolled lip around door and enclosure opening. Enclosures to be installed in areas with the potential for dripping liquids shall be provided with drip shields.
 - b. Provide oil-resistant door gaskets.
 - c. Enclosures shall be coated inside and out with ANSI 61 gray over phosphatized surfaces.
 3. NEMA Type 3R Enclosures:
 - a. Type 3R enclosures shall not be used to house controls or electronics that require heating. See the specific "Special Requirements" for outdoor panels below.
 - b. Enclosures shall be steel, 16 gauge for box widths up to and including 12", 14 gauge for box widths between 15" and 24", and 12 gauge for box widths of 30" and greater. Free-standing enclosures shall be 12 gauge minimum. Enclosures shall have drip shield top; seam free sides, front, and back; and furnished with knockouts or factory installed cut outs in bottom only.
 - c. Panels/enclosures shall be factory coated inside and out with prime and finish coats. Finish coat color to be ANSI 61 gray. Two prime coats shall be applied. Prime coat shall be rust inhibitive primer equal to Koppers Inertol Rust inhibitive Primer 621. Finish coat shall be compatible with prime coat and shall be an alkyd applied in two coats with a minimum dry film thickness of 1.5 mils per coat. Alkyd coating shall be equal to Koppers Glamortex 501 Enamel. Surface preparations shall be in accordance with manufacturer's requirements.
 4. NEMA Type 4 Enclosures:
 - a. Enclosures shall be sheet steel, 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 60" by 36", and 12 gauge for box sizes greater than 60" by 36". Free-standing enclosures shall be 12 gauge minimum. Enclosures shall have continuously welded seams ground smooth; supplied with no holes or knockouts. Provide with door and body stiffeners as required for a rigid installation and with rolled lip around door and enclosure opening. Enclosures to be installed outdoors shall be provided with drip shields.
 - b. Provide oil-resistant, water tight door gaskets.
 - c. Enclosures shall be factory coated inside and out with prime and finish coats. Finish coat color to be ANSI 61 gray. Two prime coats shall be

applied. Primer shall be rust inhibitive primer equal to Koppers Inertol Rust inhibitive Primer 621. Finish coat shall be compatible with prime coat and shall be an alkyd applied in two coats with a minimum dry film thickness of 1.5 mils per coat. Alkyd coating shall be equal to Koppers Glamortex 501 Enamel. Surface preparations shall be in accordance with manufacturer's requirements.

5. NEMA Type 4X Enclosures:
 - a. Type 4X enclosures shall be 316 stainless steel or aluminum. No other metals will be allowed.
 - i. Type 316 stainless steel enclosures shall be 16 gauge for box sizes up to and including 24" by 24", 14 gauge for box sizes larger than 24" by 24" up to 36" width, and 12 gauge for box widths greater than 36 inches. Free-standing enclosures shall be 12 gauge minimum.
 - ii. Aluminum enclosures shall be type 5052 H-32 aluminum, minimum 0.080-inch thick.
 - b. Metal enclosures shall have continuously welded seams, ground smoothed.
 - c. Enclosures shall be supplied with no holes or knockouts; shall have door and body stiffeners where necessary for a rigid installation and a rolled lip ground door and enclosure opening.
 - d. Enclosures to be installed outdoors shall be provided with drip shields.
 - e. Provide oil-resistant door gaskets all around door openings. All enclosure hinges, clamps, etc. shall be stainless steel.
 - f. Enclosures shall be provided unpainted, with metal enclosures having a smooth brushed finish.
- C. Special Requirements
 1. Enclosures located in unheated spaces or general outdoors
 - a. When components requiring a minimum temperature in which to operate, such as solid state devices, are to be installed inside the enclosure, the enclosure shall be NEMA 4X or NEMA 4 minimum when not available.
 - b. The enclosures shall be insulated. Insulate the inside of all exterior surfaces with 1-inch thick rigid fiberglass insulation board having a maximum thermal conductivity ("k" value) of 0.35 BTU-in/hr-ft²-°F. The insulation shall be finished with manufacturer's standard all service jacket. Coverings containing foil will not be acceptable.
 - c. Enclosures shall be equipped with a factory installed built-in heater and adjustable thermostat with low temperature alarm. Field installations after the fact will not be acceptable. The heater shall be sized to maintain the temperature inside the panel at 40°F (or higher if required) with an outside ambient temperature of -30°F and a 15 MPH wind. The heater shall include a fan to circulate the air within the enclosure to prevent hot spots. Thermostat shall measure air temperature, not surface temperature. Heater shall be similar to Hoffman Engineering Co. series D-AH, Genesis automation, or approved equal.
 - d. Provide strip heater with thermostat for condensation control.

- e. Provide heating requirement calculations for review and acceptance to be included as part of the shop drawing review for this equipment.
 - f. Enclosures shall have a lockable outer door with a separate hinged NEMA 1 dead front inner door.
 - g. The panels inner door latches shall be T-handle or quick release type only.
 - h. All control devices and the main circuit breaker operating handle shall be mounted through the interior panel door. The main circuit breaker handle shall have a lock arrangement to prevent the inner door from being opened when in the "on" position.
 - i. Enclosures 16-inch wide and larger shall be equipped with heavy duty, zinc plated stop arm kits to lock the external door in the open position.
2. Instrument and Control Panels
- a. All instrument and control enclosures shall have the proper NEMA rating for the areas in which they will be installed or as specified in Division 11.
 - b. All front-mounted instruments and devices shall be installed in such a way as to maintain the NEMA rating of the enclosure.
 - c. Panels which are to be installed outdoors shall meet the special requirements of "Outdoor Control Panels and Panels located in Unheated Spaces".
 - d. Panels shall be supplied with a GFI type duplex convenience receptacle and a panel light with an easily accessible on-off switch. The receptacle and panel light shall be provided with a separate overcurrent protective device and connected in such a manner so as to not disconnect control, instrumentation, or PLC power in the event that the GFI outlet should trip.
 - e. Panel lights for panels located in outdoor or unheated spaces shall be LED and suitable for the installation.
 - f. Panel lights for panels located in heated spaces shall be LED and suitable for the installation. The length of the lamp shall be a minimum of 75% of the width of the enclosure.
 - g. Provide a separate, dedicated, single pole receptacle for connection of the UPS System as required. This receptacle shall be labeled - "For UPS System Only".
3. Special Cooling Requirements
- a. Enclosures which contain Variable Frequency Drives or other heat-producing equipment shall be provided with modifications and/or accessories designed to dissipate excess heat and allow for proper equipment cooling, while maintaining the enclosures NEMA rating. Following are several accessories which may be used, depending upon the ambient temperature and NEMA rating of the area installed.
 - i. Cooling fans with dust filters, for NEMA 1 enclosures.
 - ii. Heat exchangers with circulating fans and filters, for NEMA 12 enclosures.
 - iii. Air conditioners, for NEMA 12 enclosures in areas with high ambient temperatures.
 - iv. Air Conditioners, for NEMA 4X enclosures in both 4X areas and 4X-corrosive areas shall be cooled with the use of a side mounted

air conditioner. The air conditioner shall be controlled by an internal thermostat in parallel with the run contact.

- v. Air conditioners shall have a drain tubing installed in order to drain to the nearest floor drain. Tubing shall be plastic PVC flex tube or PVC schedule 40.
- b. Cooling fans shall be wired such that they only operate when the VFD or heat producing equipment is running.
- c. Air conditioners where used in enclosures shall operate off of an internal thermostat.
- d. Provide heat dissipation calculations and cooling method proposal for review and acceptance to be included as part of the shop drawing review for this equipment. Design ambient air temperature shall be 95°F.

4. Heat Shields

- a. For outdoor installations, heat/sun shields fabricated from 0.125 marine grade aluminum shall be installed on front, back and sides of enclosures and control panels that house electrical components. Holes shall be cut in shield for alarm light and horn. Heat shields shall also have white polyester powder coat finish on all sides. Provide cut-outs in the back of the enclosure to accept VFD aluminum mounting plates. Mounting plates shall be attached to studs on the back of the enclosure and gasketed. VFD enclosures located outside shall be NEMA 12/3R with the VFD heat sinks vented out the back. Consult VFD manufacturer's installation guide for flange mount cut-out dimensions and recommended instructions. The rear sunshield shall have a removable cover with handles to allow access to the VFD heat sinks for cleaning and maintenance. The heat shield shall have studs with wing nuts for attached the removable cover. Seal all penetrations

D. Nameplate/Identification:

- 1. All panels/enclosures, and all contained equipment/instrumentation shall be provided with a nameplate providing project specific identification of the unit or device. Identification wording shall be as noted on the drawings. In the absence of specific identification of name tag wording, provide general descriptive information of unit function.
- 2. Provide nametags as specified in 16010.
- 3. Name tags shall be permanently mounted below panel mounted items (interior and exterior as appropriate), or in as appropriate location as to clearly identify its function.

E. Control Panel Wiring:

- 1. All wiring shall conform to the latest requirements of NEC, all state and local code requirements, and as described on the Drawings and in the Contract specifications.
- 2. All control wires internal to panels shall be minimum No. 14 AWG. Wires carrying line voltage shall be minimum No. 12 AWG. All conductors shall be copper. Wiring in close proximity to heating devices shall be Type AVA U.L. approved. All wiring shall be run in PVC wiring channels and bundled with nylon cable ties. Line voltage wiring must be run separately from control,

- signal and intrinsically safe wiring. PVC wiring channels shall be properly sized for the capacity of wires being installed based on the overall project needs and shall not be over filled.
3. Bundles of wires must be secured to the panel structure every 8 inches minimum. All interior wiring will be point to point with no splices.
 4. Shielded wire shall be separated from other wires and equipment with suitable barriers and with terminal blocks for continuous shield grounding to the connecting cables.
 5. Intrinsically safe wiring shall be separated by barriers from all other wiring and shall be identified as required by the N.E.C. and installed with proper separation per U.L. 508A requirements.
 6. Wires to the front of panel devices shall be looped, extra flexible, bundled and located in a manner to prevent damage due to opening and closing the door.
 7. All wires shall be marked at both ends with numbers by Perma Sleeve Heat Shrink tubing by Brady slip-on style markers or equal. All markers are to be type written. Color coding shall include the following:
 - a. Red wires - Interior control circuits
 - b. Orange wires - Interlocks powered from external sources
 - c. Dark Blue wires - DC voltages
 - d. See Section 16075 for additional color coding.
 8. Terminals shall be arranged in alphabetic and numeric order in columns on removable subplates. A maximum of two connections shall be made to each side of a terminal, including jumpers. Provide an additional 20 percent spare terminals with the following minimum requirements:
 - a. Power terminals - 2 spares
 - b. Control terminals - 10 spares
 - c. Signal terminals - 12 spares
 9. Provide ground terminal for each panel.
 10. All control panels shall be provided with spare mountings for additional relays. Number of spare mountings will correspond to 5% of the total number of relays within each panel, with a minimum of one (1) spare mounting.
 11. All control panels shall be provided with an appropriately sized surge arrester to protect panel internals. Surge arrester shall be equal to Square D Model SDSA1175 or Model SDSA3650 (as applicable) in quality and appropriately sized for function.
 12. All control panels will be suitable for use with 120V, 1 phase power, unless noted otherwise on the Drawings. The panels shall be equipped with an internal power supply fuse or circuit breaker and a thru-the-door, lockable, disconnect switch. Fuse blocks will be provided as required to allow a separate fuse for each piece of equipment within the panel requiring power.
 13. Provide complete "As Built" wiring diagrams to be provided with the O&M manuals and in the enclosures for all control panels.
 14. All wiring entering and leaving control panels shall be terminated on field terminal blocks and labeled.
 15. Provide large letter lamacoid plastic name plate as specified in Section 16075 at the top center of each control panel with properly identified nametag which

corresponds to the contract designation name. Verify final name designation with the Engineer prior to installation.

- F. Spare Parts/Materials:
1. Provide 1 gallon of paint for each enclosure/panel topcoat color utilized.
 2. Provide the following spare parts for each panel/enclosure provided. Spare parts shall be contained in the panel/enclosure in such a manner as to permit accessibility and prevent accidental damage without interfering with internally mounted equipment.
 - a. Provide 10 of each lamp type used.
 - b. Provide one of each type relay used.
 - c. Provide one control switch, indicating light and/or push-button of each type used.
 - d. Provide 1 set of each fuse type and size used.
 - e. Provide 1 of each color and type light lens used.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All interconnecting wiring between panels, unless specifically detailed otherwise on the drawings, shall be installed by the electrical contractor regardless of source of the panel itself. All conduit, wiring and installation requirements for each enclosure shall be completely and thoroughly coordinated with all applicable trades prior to equipment installation.
- B. Install enclosures in locations as shown on the Drawings.
1. All floor mounted enclosures either free standing or on floor stands shall be mounted on a 4" high, concrete, maintenance pad.
 2. Securely fasten each floor mounted enclosure to the maintenance pad.
 3. Small enclosures may be supported on walls using stainless steel metal framing channels or similar hardware to provide a minimum 1/4-inch air space between enclosure and wall.
- C. Equipment Mounting
1. All framing channels and mounting hardware shall be 316 stainless steel - no exception.
 2. Use 316 stainless steel fittings and hardware of the same material as the channel. All fittings supplied shall be by same manufacturer as the channel.
 3. Provide cross bracing as required using unistrut securely fastened to the mounting structure or building structure to provide for a rigid mounting assembly.
 4. The ends of all framing channels/strut shall be provided with PVC end caps for protection of personnel.
 5. Backboards used for mounting of equipment shall be constructed of 3/4 inch thick fiberglass, unless otherwise specified on the drawings.
 6. All channels or unistrut installed in such a manner that parts are located below grade shall be coated with a black bitumastic waterproofing material for the below grade portion and extending a minimum of 6 inches above grade. The exposed portion of the channel shall be taped off prior to coating for a neat, even, finished appearance.

7. NEMA 4X installations require a 1/4" spacer between the enclosure and mounting support to prevent moisture from collecting.
- D. Equipment mounting heights shall be as shown on the contract drawings or the tops placed a maximum of 72 inches above finished floor or platform when the elevation is not shown.
- E. Provide special protection for all devices and terminal blocks when cutting, drilling, and/or installing any device in the control panel.
- F. All conduits entering exterior enclosures or in NEMA 4X environments shall be suitable gasketed on the outside and conduits shall be sealed (inside) using a pliable duct seal to prevent the entrance of water.
- G. All lifting eyes, hooks, brackets, devices etc., used to install, lift, transport, etc., the control panel shall be removed after installation and all resultant holes shall be plugged with threaded bolts for a finished, permanent installation. All methods of plugging the holes shall maintain the NEMA rating of the enclosure.

3.2 TESTS

- A. Testing of the enclosures themselves is not required, however, all equipment and controls which are mounted in or on the enclosures shall be tested as a complete assembly as specified in the applicable sections of DIVISIONS 11, 14, 15 and 16.
- B. Each enclosure shall be fully tested by the manufacturer.

3.3 CLEANING

- A. Do not allow excess debris, water or other fluids to accumulate inside the enclosures during the course of construction.
- B. Upon completion of the work, remove all debris and surplus materials from inside the enclosures and leave them clean.
- C. Clean all enclosure surfaces and touch up any scratched or damaged areas to the satisfaction of the Engineer.
- D. Clean or replace all filters located in enclosures which contain ventilation fans.

END OF SECTION

SECTION 16408INTEGRATED TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICE(S) LOW
VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTERPART 1 - GENERAL1.1 DESCRIPTION

A. This section describes the materials and installation requirements for an integrated Surge Protective Device (SPD), also referred to as Transient Voltage Surge Suppressor (TVSS), in a Low Voltage Motor Control Center (MCC) and Low Voltage Switchboards (SWBD). These devices are used to protect AC electrical circuits from the effects of lightning induced currents, substation switching transients and internally generated transients resulting from inductive and/or capacitive load switching.

1.2 QUALITY ASSURANCE

A. The equipment specified herein is based upon the first manufacturer named after the phrase "Acceptable Manufacturers". Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer. Equipment of other acceptable manufacturers shall be equivalent in every way to that of the equipment specified. The electrical basis of design indicated on the Contract Documents is based on equipment layouts and modifications as provided by Square D Company. Suppliers deemed or equal shall be responsible to support and supply or equal equipment which shall meet the intended design. Any extensive modifications or rework of the design drawings in order to facilitate acceptability shall be the responsibility of this Contractor at no additional cost to the Owner.

B. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.

1.3 REFERENCES

A. UL 1283 Electromagnetic Interference Filters
B. UL 1449 Surge Protective Device 3rd Edition
C. ANSI/IEEE C62.41 - 1991 - IEEE Recommended Practice on Surge Voltages in Low Voltage AC Power Circuits and ANSI/IEEE C62.45 – 992 – IEEE Guide on Surge Testing for Equipment Connected to Low-Voltage AC Power Circuits

1.4 SUBMITTALS TO THE ENGINEER

A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

1.5 WARRANTY

A. Devices shall have a warranty for a period of ten (10) years, incorporating unlimited replacement of suppressor parts. Warranty shall be the responsibility of the electrical distribution equipment manufacturer and shall be supported by their respective field services organization.

INTEGRATED TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICE(S) LOW VOLTAGE SWITCHBOARDS AND MOTOR CONTROL CENTER

1.6 REFERENCE TO OTHER SECTIONS

- A. Refer to Section 16443 for Motor Control Centers
- B. Refer to Section 16406 for Low Voltage Switchboards

PART 2 - PRODUCTS2.1 MATERIALS

A. Surge Protective Device - TYPE 1

1. Integral Surge Protection Device (SPD):

- a. Devices shall be Listed and Component Recognized in accordance with UL 1449 to include Section 37.3 highest short circuit current rating (SCCR) of 200kA. TVSS devices shall be UL 1283 listed.
- b. Devices shall be independently tested with the Category C3 high exposure waveform (20kV-1.2/50 μ s, 10kA-8/20 μ s) per ANSI/IEEE C62.41 – 1991.
- c. The manufacturer of the SPD shall be the same as the manufacturer of the MCC in which the devices are installed and shipped.
- d. Devices shall provide surge current diversion paths for all modes of protection; L-N, L-G and N-G in MCCs with neutral connected loads or L-L and L-G in MCCs without neutral connections.
- e. Devices shall be modular in design. Each mode including N-G shall be fused with a 200kAIR UL recognized surge rated fuse and incorporate a thermal cutout device.
- f. The unit shall include a UL Recognized circuit breaker disconnect switch and shall connect to the MCC vertical power bus through a spring reinforced stab-on connector.

B. Transient Voltage Surge Suppression Device Surge Protective Device :

1. Integral Surge Protection Device (SPD):

- a. Devices shall be Listed and Component Recognized in accordance with UL 1449 Third Edition to include Section 37.3 highest short circuit current rating (SCCR) of 200kA. TVSS devices shall be UL 1283 listed.
- b. Devices shall be independently tested with the Category C3 high exposure waveform (20kV-1.2/50 μ s, 10kA-8/20 μ s) per ANSI/IEEE C62.41 – 1991.
- c. The manufacturer of the SPD shall be the same as the manufacturer of the MCC in which the devices are installed and shipped.
- d. Devices shall provide surge current diversion paths for all modes of protection; L-N, L-G and N-G in MCCs with neutral connected loads or L-L and L-G in MCCs without neutral connections.
- e. Devices shall be modular in design. Each mode including N-G shall be fused with a 200kAIR UL recognized surge rated fuse and incorporate a thermal cutout device.
- f. The unit shall include a UL Recognized circuit breaker disconnect switch and shall connect to the MCC vertical power bus through a spring reinforced stab-on connector.
- g. The unit mounting shelf shall include hanger brackets to support the unit weight during installation and removal. The TVSS plug-on units shall be

INTEGRATED TRANSIENT VOLTAGE SURGE SUPPRESSION DEVICE(S) LOW VOLTAGE
SWITCHBOARDS AND MOTOR CONTROL CENTER

- installable without the assistance of a camming device so as to allow maximum accessibility with the unit installed.
- h. A cast metal handle operator must be provided on the disconnect. With the unit stabs engaged into the vertical phase bus and the unit door closed, the handle mechanism shall allow complete ON/OFF control of the unit disconnect with clear indication of the disconnects status. The circuit breaker operator shall include a separate TRIPPED position to clearly indicate a circuit breaker trip condition. It shall be possible to reset a tripped circuit breaker without opening the control unit door.
 - i. A mechanical interlock shall prevent the operator from opening the unit door when the disconnect is in the ON position. Another mechanical interlock shall prevent the operator from placing the disconnect in the ON position while the unit door is open. It shall be possible for authorized personnel to defeat these interlocks.
 - j. A non-defeatable interlock shall be provided between the handle operator and the structure to prevent installing or removing a plug-on unit unless the disconnect is in the OFF position.
 - k. The plug-in unit shall have a grounded stab-on connector which engages the vertical ground bus prior to, and releases after, the power bus stab-on connectors. The grounded stab-on connector shall be cabled directly to the modules.
 - l. Provisions shall be provided for locking the disconnect in the OFF position with up to three padlocks.
 - m. Handle mechanisms shall be located on the bottom left side of the unit and operate horizontally to encourage operators to stand to the left of the unit being switched.
 - n. Unit construction shall combine with the vertical wireway isolation barrier to provide a fully compartmentalized design.
 - o. Devices shall meet or exceed the following criteria:
 - i. Minimum surge current capability (single pulse rated) per phase shall be per phase
 - ii. UL 1449 3rd Edition Suppression Voltage Ratings:
- | <u>VOLTAGE</u> | <u>L-N</u> | <u>L-G</u> | <u>N-G</u> | <u>L-L</u> |
|----------------|------------|------------|------------|------------|
| 208Y/120V | 700V | 700V | 700V | 1200 |
| 480Y/277V | 1200V | 1200V | 1200V | 2000 |
| 600Y/347V | 1500 | 1500 | 1500 | 2500 |
- p. Pulse life test: Capable of protecting against and surviving 5000 ANSI/IEEE C62.41 Category C3 transients without failure or degradation of clamping voltage by more than 10%
 - q. TVSS shall be designed to withstand a maximum continuous operating voltage (MCOV) of not less than 115% of nominal RMS voltage.
 - r. Devices shall have a minimum EMI/RFI filtering of -50dB at 100kHz using MIL-STD-220A methodology.

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- s. Devices shall be provided with one set of NO/NC dry contacts. The output of the dry contacts shall indicate a failure of a phase or the entire unit.
 - t. The MCC shall include a neutral and ground connection terminals for MCC neutral (when specified) and necessary ground connections.
 - u. There shall be a display panel mounted on the door of the TVSS unit which shall display the status of the unit and shall contain pushbuttons to control the function of the audible alarm.
 - v. Visible indication of proper SPD connection and operation shall be provided. The indicator lights shall indicate which phase as well as which module is fully operable. The status of each SPD module shall be monitored on the front cover of the MCC as well as on the module. A push-to-test button shall be provided to test each phase indicator.
 - w. The display panel shall clearly indicate in English or appropriate pictograms/icons each component on the display. Markings on the display shall contrast with the background color so as to be easily read.
 - x. The display shall have LED's to indicate the surge suppression status of each phase: Green = Full protection to that phase, Red = No protection to that phase.
 - y. The unit shall be equipped with an audible alarm which shall activate when any one of the surge current modules has failed. An alarm on/off button shall be provided to silence the alarm. A button shall be mounted on the display to test the audible alarm. The buttons and alarm shall be located on the front cover of the MCC. The alarm shall emit a minimum sound level of 50dB at one (1) meter from the front of the unit.
 - z. A surge counter shall provide a means to record the total number of transient line to ground, line to neutral, and line to line voltage surges since the counter was last reset.
 - aa. The surge counter shall be physically located on the diagnostic display panel and display digits from 0 to 999,999 at a minimum in clearly readable text.
 - bb. A reset switch shall control the surge counter. When pressed the surge counter will reset to zero.
 - cc. In the event of a power loss to all phases the surge counter will retain the last number in its memory for a minimum of 30 days after such a power loss.
2. Manufacturers are Square D Company IMA Series, Cutler Hammer, General Electric, or equal.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and National Electrical Code.
- B. Install Safety Labels in compliance with NEMA 260.

3.2 TESTS

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SWITCHBOARDS AND MOTOR CONTROL CENTER

- A. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16442PANELBOARDSPART 1 - GENERAL1.1 DESCRIPTION

- A. The work of this section includes the furnishing and installing of all panelboards as specified herein and as shown on the drawings. All panelboards shall be indoor type unless otherwise noted on the drawings.

1.2 QUALITY ASSURANCE

- A. The equipment specified herein is based upon the facilities existing SqD(Schneider Electric) equipment. No equal will be accepted. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer.
- B. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.
- C. Refer to equipment manufacturer requirements under 16010, Section 1.2.

1.3 SUBMITTALS TO THE ENGINEER

- A. Submit Shop Drawings for equipment as specified in section 16010.
- B. Refer to Section 01340 for shop drawing formatting requirements.

1.4 REFERENCE TO OTHER SECTIONS

- A. Refer to Section 16010 for identification nameplates requirements.
- B. Refer to Section 16010 for coordination, short circuit, and arc flash study requirements.
- C. Refer to Section 16450 for grounding requirements.
- D. Refer to Section 16950 for testing requirements.

PART 2 - PRODUCTS2.1 MATERIALS

- A. Panelboards - Lighting and Distribution 480Y/277 volt, 208Y/120 volt, 240/120 volt
 - 1. General
 - a. Panels identified for use as service entrance equipment shall be so labeled.
 - b. Panelboards shall comply with the applicable sections of UL, NEC and NEMA.
 - c. The existing facilities power distribution system equipment is SqD(Schneider Electric). All new power distribution equipment shall be SqD(Schneider Electric). No equal will be accepted.
 - 2. Interiors
 - a. Interior shall be completely factory assembled with bolt-on devices. They shall be designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.

- b. Unless otherwise noted, full size insulated tin-plated copper neutral bars shall be included. Bus bar taps for panels with single pole branches shall be arranged for sequence phasing of the branch circuit devices. Neutral bussing shall have a suitable lug for each outgoing feeder requiring a neutral connection.
 - c. Main bus bars shall be tin-plated copper sized in accordance with UL standards to limit temperature rise on any current carrying part to a maximum of 50 degrees C above an ambient of 40 degrees C maximum.
 - d. A ground bus shall be included in all panels.
 - e. Main circuit breakers located within panelboards shall be center mounted, separate from the feeder section. Main circuit breakers installed as part of the feeder section are not acceptable.
3. Boxes
- a. Boxes shall be at least 20 inches wide made from galvanized steel. Provide minimum gutter space in accordance with the National Electrical Code. Where feeder cables supplying the mains of a panel are carried through its box to supply other electrical equipment, the box shall be sized to include the additional required wiring space. At least four interior mounting studs with adjustable nuts shall be provided.
 - b. Boxes shall be provided with removal blank ends.
4. Trims
- a. Trims for lighting and appliance panelboards shall be supplied with a hinged door over all circuit breaker handles. Doors in panelboard trims shall not uncover any live parts. Doors shall have a semi-flush cylinder lock and catch assembly. Doors over 48 inches in height shall have auxiliary fasteners.
 - b. Distribution panelboard trims shall cover all live parts. Switching device handles shall be accessible.
 - c. Surfaces of the trim assembly shall be properly cleaned, primed and a finish coat of gray ANSI 61 paint applied.
 - d. Surface trims shall be same height and width as box. Flush trims shall overlap the box by 3/4 of an inch on all sides.
 - e. A typed directory card with clear plastic cover shall be supplied mounted on the inside of each door.
 - f. Provide an engraved nameplate for each panel section.
5. Panelboard Ratings
- a. Panelboards rated 240 VAC or less shall have short circuit ratings as shown on the drawings or as herein scheduled, but not less than 10,000 amperes rms symmetrical.
 - b. Panelboards rated 480 VAC shall have short circuit ratings as shown on the drawings or as herein scheduled, but not less than 14,000 amperes rms symmetrical.
 - c. Breakers shall be a minimum of 100 ampere frame. Breakers 15 through 100 amperes trip size shall take up the same pole spacing.

- d. GFCI circuit breakers shall be a minimum of 100 ampere frame when indicated on the panelboard schedule. Breakers 15 through 100 amperes trip size shall take up the same pole spacing.
- e. Panelboards shall be labeled with a UL short circuit rating. When series ratings are applied with integral or remote upstream devices, a label shall be provided. Series ratings shall cover all trip ratings of installed frames. It shall state the conditions of the UL series ratings including:
 - i. Size and type of upstream device
 - ii. Branch devices that can be used
 - iii. UL series short circuit rating

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and the latest edition of the National Electrical Code accepted by the Authority Having Jurisdiction.
- B. All panelboards shall be installed so that the top circuit breaker handle is not higher than 6'-6" above finished floor.
- C. Panel shall be mounted to unistrut stainless steel framing channels. Panels shall not be hung directly off walls.
- D. Panels to be installed in finished areas shall be recessed with flush trim covers.
- E. Loads shall be balanced on all phases and branch circuiting rearranged, if balancing is required.
- F. All wiring connections shall be made in accordance per manufacturer's requirements.
- G. Install panelboards as shown on the Drawings.
- H. At each flush mounted panelboard, provide four (4) spare three-quarter inch (3/4) raceways from panel-board, etc. to an area above the nearest accessible ceiling space and floor space in the specific room location. Make 90 degree turn above the ceiling or below the floor and cap all conduits.
- I. Install panelboards in accordance with manufacturer's instructions.
- J. Install Safety Labels in compliance with NEMA 260.
- K. Ground all panelboard in accordance with the National Electric Code and as specified in section 16450.

3.2 TESTS

- A. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16443MOTOR CONTROL CENTERSPART 1 - GENERAL1.1 DESCRIPTION

- A. The work of this section includes the furnishing, installing, and testing of motor control centers as specified herein and as shown on the contract drawings and indicated on the "Single Line Diagrams" and "Motor Control Elevations".
- B. The contract drawings provide elevations for each motor control center for the project. The number of "Spaces" shown in the elevation(s) are to be provided as part of the motor control center. These spaces will be utilized for future expansion.

1.2 QUALITY ASSURANCE

- A. The equipment specified herein is based upon the facilities existing SqD(Schneider Electric) equipment. No equal will be accepted. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer.
- B. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.
- C. Motor Control Center(s) shall have been tested in a high power laboratory to prove adequate mechanical and electrical capabilities. All major components shall have been individually design tested and guaranteed by the manufacturer.
- D. Refer to equipment manufacture requirements under 16010, Section 1.2.

1.3 SUBMITTALS TO THE ENGINEER

- A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010, and as specified in this section.

1.4 REFERENCE TO OTHER SECTIONS

- A. Refer to Section 16010 for shop drawing formatting requirements.
- B. Refer to Section 16010 for identification nameplates requirements.
- C. Refer to Section 16010 for coordination, short circuit, and arc flash study requirements.
- D. Refer to Section 16407 for Solid State Reduced Voltage Starters
- E. Refer to Section 16469 for Variable Frequency Drives
- F. Refer to Section 16408 for Transient Voltage Surge Suppressors
- G. Refer to Section 16900 for Control Devices

PART 2 - PRODUCTS2.1 MATERIALS

- A. Motor Control Centers:
 - 1. General

- a. Motor Control Center(s) shall be Square D(Schneider Electric), no equal will be accepted. Wiring shall be NEMA Class 2B+2S.
 - b. The type of enclosure shall be in accordance with NEMA Standards for Type 1A with gasketed doors. All enclosing sheet steel, wireways and unit doors shall be gasketed.
 - c. The Motor Control Center shall be 600 volt class suitable for operation on a three phase, 60 Hertz system. The system operating voltage and number of wires shall be as indicated on the drawings.
 - d. Equipment shall meet the applicable NEMA, ANSI and UL standards.
2. Structure Arrangement
- a. Structures shall be totally enclosed deadfront, free standing assemblies. They shall be 90 inches high, 20 inches wide, and 20" deep unless otherwise noted on the contract drawings.
 - b. Structures shall contain a horizontal wireway at the top and bottom, isolated from the horizontal bus and shall be readily accessible through a hinged cover. Adequate space for conduit and wiring to enter the top or bottom shall be provided without structural interference.
 - c. Compartments for mounting control units shall be incrementally arranged such that not more than six size 1 starters can be mounted within each vertical structure. Guide rails shall be provided.
 - d. A vertical wireway with minimum of 35 square inches of cross sectional area shall be adjacent to each vertical unit and shall be covered by a hinged door. Wireways shall contain steel rod cable supports.
3. Bus Arrangement
- a. Each structure shall contain a main horizontal tin-plated copper bus, with minimum ampacity of 600 amperes or rated as shown on the drawings. Vertical busses feeding unit compartments shall be tin-plated copper and shall be securely bolted to the horizontal main bus. All joints shall be front accessible for ease of maintenance. The vertical bus shall have a minimum rating of 300 amperes for front mounted units.
 - b. The vertical bus shall be completely isolated and insulated by means of a labyrinth design barrier. It shall effectively isolate the vertical busses to prevent any fault generated gasses to pass from one phase to another.
 - c. Busses shall be braced for 65,000 amperes rms symmetrical (minimum), or as shown on drawings.
 - d. All MCCs shall contain a fully rated tin-plated copper neutral bus.
4. Unit Construction
- a. All full voltage starter units through NEMA size 5 shall be of the draw out type which include a positive guide rail system and stab shrouds. Drawout units shall have a tin-plated stab assembly for connection to the vertical bus. No wiring to these stabs shall extend into the bus compartment.
 - b. All drawout units shall be secured by a spring loaded quarter turn indicating type fastening device located at the top front of the unit.
 - c. Interior of all units shall be painted white. Units shall be equipped with side-mounted, pressure pull-apart type control terminal blocks rated 480 volts. Provisions shall be made for the addition of future terminal blocks.

- d. Each unit compartment shall be provided with an individual front door.
 - e. An operating mechanism shall be mounted on the primary disconnect of each starter unit. It shall be mechanically interlocked with the unit door to prevent access unless the disconnect is in the OFF position. A defeater shall be provided to bypass this interlock.
 - f. An interlock shall be provided to prevent inadvertent closing of the disconnect when the door is opened. A second interlock shall be provided to prevent removal or re-insertion of the unit while in the ON position.
 - g. Padlocking facilities shall be provided to positively lock the disconnect in the OFF position with from one to three padlocks with the door open or closed. In addition, means shall be provided to padlock the unit in a partially withdrawn position with the stabs free of the vertical bus.
5. Combination Starters
- a. Combination starter units shall be full voltage non-reversing (FVNR), full voltage reversing (FVR) or two speed two winding (2S2W) as shown on the Drawings and shall utilize Motor Circuit Protectors Type HMCP.
 - b. The HMCP shall provide adjustable magnetic protection and be provided with pin insert to stop the magnetic adjustment at 1300% motor nameplate full load current to comply with NEC requirements. All HMCP combination starter units shall have a "tripped" position on the unit disconnect and a push-to-test button on the HMCP. Type HMCP motor circuit protectors shall include transient override feature for motor inrush current.
 - c. Each combination unit shall be rated 65,000 AIC symmetrical at 480V.
 - d. Linestarters shall be electrically operated, electrically held, three pole assemblies with arc extinguishing characteristics and shall have silver-to-silver renewable contacts. They shall have provisions for a total of eight NO or eight NC auxiliary contacts.
 - e. The overload relay assembly shall be of the thermal bimetallic type. Overload relays shall be reset from outside the enclosure by means of an insulated button. The overload relay shall have a built-in push-to-test button.
6. Reduced Voltage Solid State Motor Starters
- a. Provide reduced voltage solid state starters where shown on Drawings. Refer to section 16407 for requirements.
7. Feeder Circuit Breakers
- a. Individual feeder breakers shall be molded case type sized as shown on contract drawings.
 - b. Interrupting capacity shall be a minimum of 65,000 AIC or as indicated on the drawings.
 - c. Circuit breakers 1200 amps and over shall have Reduced Arc Flash Energy Let Though or RELT capability.
8. Variable Frequency Drives
- a. Various Variable Frequency Drive units have been specified as being installed within the motor control center(s). The MCC manufacturer shall be responsible for providing a completely UL Listed MCC which contains

- VFD's and related devices as specified in Section 16469 and as shown on the Drawings.
9. Power Monitor
 - a. Provide microprocessor metering as shown on the drawings for power metering and loss of normal power monitoring. Metering shall be Allen-Bradley #1426 Power Monitor 5000.
 10. Finish
 - a. The control center shall be given a phosphatizing pretreatment. The paint finish shall be an anionic, thermoset acrylic. Manufacturer's standard color shall be used.
 11. Nameplates
 - a. Each unit will have 1.0 x 2.5 inch hot stamped nameplate. The lettering shall be white 3/16 inch high, in a black background.
 12. There are specific circuit breakers which are required to be electrically operate for load shedding purposes and are to be installed within specific motor control centers as shown on the contract drawings. Refer to switchboard section for description and operation of these breakers.
 13. Anti-Static and Non-Conductive Floor Mats
 - a. Floor mats shall meet minimum stands Type II, ASTM D178 Class 2. Minimum thickness shall be ¼" and 3 feet wide, black rubber with corrugated surface pattern. Provide Northax electrical hazardous mat Model 830C0036-75 or equivalent. Provide customized lengths to be installed in front of all new motor control centers. Contractor to coordinate the location and installation of floor mating with the Owner at each building.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and the latest edition of the National Electrical Code accepted by the Authority Having Jurisdiction.
- B. Ground all motor control centers in accordance with the National Electric Code and as specified in section 16450.
- C. Motor control centers shall be mounted on 4" high concrete pads which shall extend 2" on exposed sides. Securely bolt each unit to its pad for proper horizontal and vertical alignment. Install two continuous runs of Unistrut the entire width of the MCC in the concrete pad with 1/16" reveal to provide a level mounting surface. Coordinate strut installation with concrete contractor. Use shims where necessary.
- D. Install Safety Labels in compliance with NEMA 260.

3.2 TESTS

- A. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16445MODIFICATIONS TO EXISTING MOTOR CONTROL CENTERSPART 1 - GENERAL1.1 DESCRIPTION

- A. The work of this section includes the furnishing, installing, and testing of modifications to existing motor control centers as specified herein and as shown on the contract drawings as indicated on the "Single Line Diagrams".
- B. Modifications to existing motor control centers are not required to be of the same manufacturer as the motor control centers provided for the project as applicable. These devices take exception to the Quality Assurance Statement of Section 1.2.E of Specification 16010.

1.2 QUALITY ASSURANCE

- A. The equipment specified herein is based upon the first manufacturer named after the phrase "Acceptable Manufacturer's". Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer. Equipment of other acceptable manufacturers shall be equivalent in every way to that of the equipment specified.
- B. Suppliers deemed equivalent shall be responsible to support and supply equivalent equipment which shall meet the intended design. Any extensive modifications or rework of the design drawings in order to facilitate acceptability shall be the responsibility of this Contractor at no additional cost to the Owner.
- C. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.
- D. Motor Control Center(s) shall have been tested in a high power laboratory to prove adequate mechanical and electrical capabilities. All major components shall have been individually design tested and guaranteed by the manufacturer.

1.3 SUBMITTALS TO THE ENGINEER

- A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

1.4 REFERENCE TO OTHER SECTIONS

- A. Refer to Section 16010 for identification nameplates requirements.
- B. Refer to Section 16010 for coordination, short circuit, and arc flash study requirements.

PART 2 - PRODUCTS2.1 MATERIALS

- A. Modifications to Existing Motor Control Centers:
 - 1. The modifications to the existing motor control centers and the manufacturer are shown on the contract drawings.

MODIFICATIONS TO EXISTING MOTOR CONTROL CENTERS

2. This Contractor shall visit the site to become thoroughly familiar with the work required and specified herein. All modifications shall be performed without jeopardizing the integrity of the existing equipment. All work to be performed shall be complete and shall meet with all standards and guidelines for installation to this equipment.
3. The contract drawings indicate that specific compartment section(s) are to be modified. The modifications shall include new equipment and/or modifications to existing equipment installed. Each compartment is to be replaced and/or existing equipment modified in order to retrofit the compartment sections as required by the contract documents.
4. The short-circuit ratings of all new and modified devices shall be equal to or greater than that of the existing equipment. This is to be verified by this Contractor and the information furnished and included in the shop drawing submittals for this equipment.
5. The Contractor shall be allowed to replace the sections as required in their entirety. This shall be verified with the Contractor and brought to the attention of the Engineer prior to final cost submittal.
6. Provide screwed on nameplates for all revised sections as required for all front compartment devices and as noted on contract drawings.
7. All new equipment shall maintain the UL listing of the MCC.
8. The requirements noted have been outlined for this section. If any information on existing equipment cannot be verified then this shall be brought to the attention of the Engineer and verified prior to submitting bid for this project.
9. Refer to Section 16900 for control device and equipment requirements.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and the latest edition of the National Electrical Code accepted by the Authority Having Jurisdiction.
- B. Ground all motor control centers in accordance with the National Electric Code and as specified in section 16450.
- C. Motor control centers shall be mounted on 4" high concrete pads which shall extend 2" on exposed sides. Securely bolt each unit to its pad for proper horizontal and vertical alignment. Install two continuous runs of Unistrut the entire width of the MCC in the concrete pad with 1/16" reveal to provide a level mounting surface. Coordinate strut installation with concrete contractor. Use shims where necessary.
- D. Install Safety Labels in compliance with NEMA 260.

3.2 TESTS

- A. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16450

GROUNDING

PART 1 - GENERAL

1.1 DESCRIPTION

- A. Work Included: Provide and install all grounding and appurtenances as shown on the Drawings, manufacturer's installation manuals and guidelines, and as specified herein.
- B. The Contractor is responsible to provide a complete interconnected grounding system which provides for a common potential grounding system. All components shall be bonded to the same potential via the grounding system for the entire facility. Review all connections and drawings along with requirements of the Authority Having Jurisdiction's accepted edition of the National Electrical Code (NEC) for final grounding requirements. A complete and integrated grounding system shall be the responsibility of the Contractor to furnish, install, and integrate into the sequence of construction for this the facility. All work shall be in compliance with NEC requirements and as indicated on the drawings.

1.2 PRODUCT HANDLING

- A. All materials shall be shipped, stored, handled and installed in such a manner as not to degrade quality, serviceability, or appearance.

PART 2 - PRODUCTS

2.1 MATERIALS

- A. Refer to Section 16050 - Basic Materials for material to be used under this section.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. Grounding electrode conductors shall be run in rigid steel conduits. All metal conduit used for the installation of the grounding electrode conductor shall be bonded with the use of a bonding bushing at both ends.
- B. Grounding conductors shall be run with feeders where shown on the drawings or hereinafter specified.
- C. Conduits stubbed-up below a motor control center shall be fitted with insulated grounding bushings and connected to the motor control center ground bus. Boxes mounted below motor control centers shall be bonded to the motor control center ground bus. The grounding wire shall be sized in accordance with article 250 of the National Electric Code.
- D. Liquid tight flexible metal conduit in sizes 1 inch and larger shall have bonding jumpers. Bonding jumpers shall be external, run parallel (not spiraled) and fastened with plastic tie wraps. Tie wraps shall be installed 12 inches apart and not more than 6 inches from ends.
- E. Connect the following equipment by separate wire or cable directly to the grounding

system:

1. Frame of each transformer
 2. Neutral of each transformer for a separately derived system as defined by NEC article 250.
 3. Service entrance line compartment
 4. Low voltage switchgear
 5. Cable tray system
 6. Boiler stacks and the like
- F. Connect the following equipment by separate wire or cable to the ground bus in the distribution equipment servicing the equipment:
1. Motor Control Centers and Switchboards
 2. Panelboards
 3. 480 Volt motors
 4. Control panels
 5. Bus Duct
 6. All feeders and branch circuit installed in non-metallic raceways
 7. Receptacle circuits
- G. The following equipment shall be grounded through the metallic raceway systems with permanent and effective ground connections:
1. All metal cases and support frames
 2. Lighting system
 3. All motors
 4. Radio Antennas
- H. Bond the following N.E.C. approved electrodes together to form a ground system:
1. Metallic water main
 2. Building steel frame
 3. Steel reinforcing rods
 4. Grounding rods and plates
 5. Buried bare copper conductors
- I. Grounding electrodes shall be driven where shown on the drawings. Spacing between electrodes shall be equal to or greater than the length of the electrodes. Exposed grounding connections shall be made by means of approved bronze clamps. Exposed connections between different metals shall be sealed with No. Oxide Paint Grade A, or equal.
- J. Make connections to equipment with mechanical connections by means of approved bronze clamps. Exposed connections between different metals shall be sealed with No-Oxide Paint Grade A, or equal. Make connections for all service entrance ground connections and all ground rods with an exothermic welding process. All buried connections shall be made by an exothermic welding process equal to Cadweld. Molds used for the welding process shall be new having no prior usage. Molds shall be the specific type for the connection to be made. Added section under installation section of 16050 to specify types of connections for grounding. All buried conductors shall be laid slack in trenches. The earth surrounding the cables shall be void of sharp objects which may injure the cables. Backfill material shall be natural earth. Where cables are exposed to mechanical injury they shall be protected by pipes or other substantial guards. If guards are iron pipe or other magnetic material, conductors shall

be electrically connected to both ends of the guard. Connections shall be made as hereinbefore specified.

- N. Manholes shall be furnished with a grounding point. Cast-in-place manholes shall be furnished with a driven ground rod extending 8 inches above the finished floor.
- O. Precast manholes shall be furnished with a 6 inch by 1 inch by inch ground bus. The ground bus shall be connected to an external grounding electrode. The interconnecting cable shall be fitted with a cable water seal fitting to prevent water leakage.
- P. Do not allow water main connection to be painted. If the connections are painted, they shall be disassembled and remade with new fittings.
- Q. Bond and ground all conduit systems. Ground conduit system and neutral conductor of wiring system with a connection at the main electrical service switchboard.
- R. Furnish and install all main service grounding systems, building grounding systems and supplemental grounding systems as required by NEC and as shown on the drawings for a complete grounded system for the entire facility.
- S. Ground all motor frames (operating on Variable Frequency Drives) and VFD shielded cable per the recommendations of the manufacturer of the Variable Frequency Drive. Also, the contractor shall bond the motor, VFD cable, etc. per the recommendations of the VFD manufacturer to create a path back to the VFD drive.
- T. Equip and install all exposed "pigtailed" or grounding electrode conductors with an armored sheath.
- U. Group and bond ground wires to panel boxes, light fixtures, receptacles, etc., not to system neutral.
- V. Ground shield of a twisted-pair cable at one end only, at the power source for the device or instrument.
- W. Ground all lightning arresters and exterior conduit risers.
- X. Furnish and install a #4/0 bare copper ground conductor within the manhole systems and connect to the system ground grid. Connect and exothermic weld to ground rod and rack support mounting for proper grounding at each manhole as required by this contract.

3.2 TESTING

- A. Tests shall be performed before loaming and seeding or paving work has been performed. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16461ALOW VOLTAGE DRY TYPE TRANSFORMERSPART 1 - GENERAL1.1 DESCRIPTION

- A. Furnish and install, single phase and three phase general purpose individually mounted dry-type transformers of the two-winding type, self-cooled, with ratings and voltages as shown on the contract drawings and indicated on the "Single Line Diagrams".

1.2 QUALITY ASSURANCE

- A. The equipment specified herein is based upon the facilities existing SqD(Schneider Electric) equipment. No equal will be accepted. Equipment types, device ratings, dimensions, etc. correspond to the nomenclature dictated by that manufacturer.
- B. All equipment shall be tested at the factory. Unless specified elsewhere, standard factory inspection and operational tests will be acceptable.
- C. Transformers shall be designed, manufactured, and tested in accordance with all the latest applicable ANSI, NEMA, DOE, and IEEE standards.
- D. The following tests shall be made on all transformers:
 - 1. Ratio tests on the rated voltage connection and on all tap connections.
 - 2. Polarity and phase-relation tests on the rated voltage connection.
 - 3. Applied potential tests
 - 4. Induced potential test
- E. Refer to equipment manufacture requirements under 16010, Section 1.2.

1.3 SUBMITTALS TO THE ENGINEER

- A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.

1.4 REFERENCE TO OTHER SECTIONS

- A. Refer to Section 16010 for identification nameplates requirements.

PART 2 - PRODUCTS2.1 MATERIALS

- A. Dry Type Distribution Transformers (150 kVA and Below)
 - 1. General
 - a. Transformers shall be designed, manufactured, and tested in accordance with all the latest applicable ANSI, NEMA, DOE (Department of Energy), and IEEE standards.
 - b. All 600 volt class transformers shall be UL listed and bear the UL label.
 - c. Transformers shall be designed for continuous operation at rated kVA, for 24 hours a day, 365 days a year operation, with normal life expectancy as defined in ANSI C57.96.

- d. Transformer efficiency shall meet or exceed the latest DOE 2016 Efficiency Standard requirements.
2. Insulation Systems
- a. Transformers shall be insulated as follows:

KVA	Insulation Class	Average Winding Temperature Rise (°C)	Maximum Ambient Temp. (°C)	Hot Spot Differential (°C)	Total Temperature Rise (°C)
≤ 2 KVA	F	80	40	15	150
3 KVA - 29 KVA	H	125	40	20	185
≥ 30 KVA	R	150	40	30	220

- b. Required performance shall be obtained without exceeding the above indicated temperature rise in a 40 degree C maximum ambient, with a 30 degree C average ambient over 24 hours.
 - c. All insulation material shall be flame-retardant and shall not support combustion as defined in ASTM Standard Test Method D635.
3. Core and Coil Assemblies
- a. Transformer core shall be constructed with high grade, non-aging, grain-oriented silicon steel with high magnetic permeability, and low hysteresis and eddy current losses. Maximum magnetic flux densities shall be substantially below the saturation point. The transformer core volume shall allow efficient transformer operation at 10% above the highest tap voltage. The core laminations shall be tightly clamped and compressed. Coils shall be wound of electrical grade copper with continuous wound construction.
 - b. On units rated below 30 kVA, the core and coil assembly shall be completely encapsulated in a proportioned mixture of resin and aggregate to provide a moisture-proof, shock resistant seal.
 - c. On units rated 30 kVA and above, the core and coil assembly shall be impregnated with a non-hydroscopic, thermo-setting varnish and cured to reduce hot spots and seal out moisture.
4. Enclosures
- a. The enclosure shall be made of heavy gauge steel and shall be degreased, cleaned, primed, and finished with ANSI 61 color weather-resistant enamel. All transformers shall be equipped with a wiring compartment suitable for conduit entry and large enough to allow convenient wiring. The maximum temperature of the enclosure shall not exceed 90 degrees C.
 - b. On units rated below 15 kVA, the enclosure construction shall be totally enclosed, non-ventilated, NEMA 3R, with lifting eyes.
 - c. On units rated 15 kVA and above, the enclosure construction shall be ventilated, NEMA 2, drip-proof, with lifting holes. All ventilation openings shall be protected against falling dirt. On outdoor units, provide suitable weather shields over ventilation openings.

5. Transformer sound levels shall not exceed the following ANSI and NEMA levels for self cooled ratings:

KVA Rating	Maximum Sound Ratings
Up to 9 KVA	40 dB
10 to 50 KVA	45 dB
51 to 150 KVA	50 dB

6. Nameplates: Provide 1 inch high x 3 inches engraved lamocoid nameplates for each transformer. Furnish white letters on a black background. Identify primary and secondary voltages and feeder source designation on the nameplate.
7. Terminations: All lugs shall be UL Listed to accept solid and/or stranded copper and aluminum conductor. Lugs shall be suitable for 90° C rated wire, sized according to the 75° C temperature rating in the NEC. Provide required number of lugs/phase as indicated by the contract drawings and cabling requirements.
8. Manufacturers
9. Transformers shall be manufactured by Square D, Cutler-Hammer, General Electric, Hevi-Duty, Acme or equivalent.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. The Contractors shall install all equipment per the manufacturer's instructions, contract drawings and the latest edition of the National Electrical Code accepted by the Authority Having Jurisdiction.
- B. Ground all transformers in accordance with the National Electric Code and Section 16450.
- C. Floor mounted dry-type transformers shall be mounted on 4" high concrete pads which shall extend 2" on exposed sides.
- D. Install dry-type transformers with adequate clearances for proper ventilation.
- E. Bolt floor mounted transformer to concrete pad utilizing neoprene vibration damping pads. Securely bolt each unit to its pad for proper horizontal and vertical alignment. Use shims where necessary.
- F. Disconnecting Means:
 - Transformers, other than class 1 and class 2, shall have a disconnecting means located on the primary side either in sight of the transformer or in a remote location. Where remotely located, the disconnecting means shall be lockable and the location shall be field marked on the transformer via a lamacoid nameplate.
- G. Install Safety Labels in compliance with NEMA 260.

3.2 TESTS

- A. Refer to Section 16950 for testing requirements.

END OF SECTION

SECTION 16900CONTROLSPART 1 - GENERAL1.1 DESCRIPTION

- A. Provide and install all panel and enclosure components and appurtenances as shown on the Drawings as Local Control Stations as specified herein. All components shall meet NEMA ratings as indicated on drawing E-1 for the specific area where they are to be installed.

1.2 SUBMITTALS TO THE ENGINEER

- A. Shop drawings are required for all items provided under this Section. Submittals shall be in accordance with Sections 01340 and 16010.

PART 2 - PRODUCT2.1 MATERIALS

A. Control Station Enclosures:

1. General:

- a. Control stations shall be heavy duty oil-tight/watertight type stainless steel enclosure and shall consist of operators with contact blocks and indicator lights as indicated on the contract drawings. Enclosures shall have sufficient depth to accommodate mounting four Class 9001 KA-1 contact blocks side-by-side and in tandem behind a single operator for a maximum of eight circuits, four normally open and four normally closed.
- b. Enclosures shall have the required number of holes for the number of operators pre-manufactured as shown on the contract drawings.

2. NEMA 12 and NEMA 4X

- a. Enclosures shall be 16-gauge Type 316 stainless steel gasketed enclosures.
- b. Acceptable manufacturers are Allen Bradley, General Electric, Square D, or equivalent.

3. Class I, Division I and Class 1, Division 2 Enclosures

- a. Enclosures and covers shall be iron or aluminum and gasketed with premanufactured devices installed by manufacturer.
- b. Acceptable manufactures are Cooper Crouse-Hinds Flex Station Control Stations, Allen-Bradley, Square D, or equivalent.

B. Operators:

1. General:

- a. All operators used in control stations shall be Square D type K or Allen Bradley and shall be suitable for cover mounting in a 1-7/32-inch diameter notch type cover hole and shall be held in place by the locking thrust washer. All operators shall be heavy duty oil/water tight, be 30mm in size, and maintain the NEMA rating of the enclosure.

- b. Push buttons shall have removable inserts in eight different colors for function color coding. Push-button inserts shall be removable from the front of the control station without disturbing the wiring or mounting of the control units.
 - c. Selector switches shall have removable knobs in eight different colors for function color coding. Selector switch knobs shall be removable from the front of the control station without disturbing the wiring or mounting of the control units. Operators for selector switches shall be bat wing type.
 - d. Emergency stop pushbutton operators shall be large operator head type, red mushroom-head, maintained type switch with push to open and pull to re-engage control circuit. Provide multiple output contact type as shown on the drawings.
 - e. Indicator lights shall be heavy duty, oiltight and have the following requirements:
 - i. Designed to operate at 120 volts, 60 Hz AC.
 - ii. Provided with a chrome-plated metal or anodized-aluminum mounting rings, engraved as indicated on the Drawings.
 - iii. Lens color shall be as indicated on drawings.
 - iv. Shall be 30 mm LED lamp type, with "Push to Test" requirements.
 - f. Provide legend plates which describe function of each device on control station.
2. Contact blocks used in heavy duty oil-tight control stations shall be of Square D Type K, Allen Bradley single-pole, single-throw (SPST), single-pole, double-throw (SPDT). Contact blocks shall be suitable for mounting side by side and/or in tandem to the base of the operator with these following requirements:
 - a. mounting screws shall be captive with a drilled and tapped head to permit easy tandem mounting of contact blocks.
 - b. Terminals shall be pressure wire type with a self-lifting pressure clamp that will compensate for wire of different size ranging from #12-#18 solid or stranded.
 - c. Contacts shall be double break, and silver plated.
 3. Class 1 Division 2 operators shall meet all requirements of section 2.1.B.1 with the addition of devices being hermetically sealed by the factory.
- C. Control Circuit Fuses
1. Fuses shall be 3AB ceramic body fuses rated for at least 125 volts at the current ratings shown on the Drawings. Fuse size shall be ¼" x 1¼".
 2. Blow time shall be:
 - a. 110%, 4 hours minimum;
 - b. 135%, 1 hour maximum;
 - c. 200%, 15 seconds maximum for 1/8-12 amp fuses
 - d. 200%, 60 seconds maximum for 15-30 amp fuses.
 3. Fuses shall be Littlefuse, Bussmann, or approved equal.
- D. Relays
1. Industrial Control Relays - Industrial control relays shall be utilized where specifically called for on the Drawings or within the Specifications. Industrial

control relays with 10 ampere contact rating shall be Square D, Class 8501 Type X, Allen-Bradley or approved equal. Relays with 30 ampere contact rating shall be Square D, Class 8501, Type C or equal.

2. Pilot Duty Relays - Unless specifically noted otherwise, relays shall be general purpose relays. General purpose relays shall be IDEC RH Series, 10A contact rating, 4 Form "C" contacts, Allen-Bradley or approved equal, provided with internal indicating light. Pilot duty control isolating relays for PLC inputs and outputs shall be suitable for the application, and shall be submitted for approval by Engineer.
 3. Relays shall be electrically held, electrically operated with 120 volt coils except as noted otherwise on the Drawings. Contacts shall be rated 600 volt, 10 ampere and shall be convertible from Normally Open to Normally Closed. Where relays are used to control single-phase, fractional horsepower motors, contacts shall be rated in accordance with the N.E.C. for the motor to be controlled. Where relays are not installed within system control panels, provide a suitable enclosure as specified in Section 16160, with NEMA ratings as indicated on the Drawings.
 4. Dry contacts used for instrumentation and SCADA inputs or other low current inputs, shall be bifurcated cross bar gold overlay silver and rated dry circuit. These contacts will be provided through dedicated interposing relays as shown on the schematic diagrams of the Drawings or as specified herein. Relays shall be provided with plug-in type sockets with screw terminal wiring connections to facilitate relay change out and wiring. Relays shall be Potter and Brumfield type KHAU-17A16 - 120 or 12V, IDEC, or approved equal as shown on Drawing.
- E. On-Delay & Off-Delay Timing Relays
1. Solid State - Unless specifically noted otherwise, time delay relays shall be general purpose time delay relays. General purpose time delay relays shall be IDEC RTE, Potter-Brumfield, or approved equal.
 2. Delay timing relays shall be solid state type rated for use at 120 volts. Contacts shall be normally open (NO) or normally closed (NC) as detailed shown on the Drawings or within the Specifications, and shall be rated 5 amperes (minimum). Minimum time range shall be adjustable from 1 second to 1 minute. Other ranges as required by function and as indicated on the Drawings or within the Specifications. Where mounted external to control panels, delay timing relays shall be provided with enclosures as specified in Section 16160, with NEMA ratings as indicated on the Drawings.
- F. Fuse Blocks
1. Fuse blocks shall be rated for at least 30 amps and 300 volts. The clips shall be high tensile spring brass, electro-tin plated. The base shall be polyester, glass reinforced with a UL-94VO flammability rating.
 2. At least four spare sets of clips shall be provided on each fuse block and shall be labeled "SPARE".
 3. Fuse block switches shall be din rail mounted.
 4. Fuse blocks shall be Littlefuse Omni-block, Bussmann, or considered equal.
- G. Terminal Strips

1. Terminal strips with box type connectors shall be supplied to make all power and control connections. All terminals shall be clearly marked for easy identification. A ground terminal strip shall also be provided. At least 20 percent of terminals supplied shall be spare. All wiring shall be terminated on field terminal blocks.
- H. Control Power Transformers
1. Supply all control power transformers necessary to make panel functional. All transformers shall have both primary legs and all "hot" secondary legs fused. One secondary leg shall be grounded. Fuse sizing shall be as recommended by the equipment manufacturer for the particular installation.
 2. Final sizing of the control power transformer shall be based on the application and control equipment to be operated on this equipment. The supplier/contractor shall review all system schematics and provide the appropriate size CPT for each application. Oversized CPT will be required where necessary for the installation.
- I. Emergency Stop Pushbuttons (E-Stops)
1. Pushbutton control station shall be red, large mushroom-head maintained switch with pull-on and push-off type. Provide multiple output contact type as shown on the drawings. Device shall maintain the NEMA rating for area in which it is being installed.

PART 3 - EXECUTION

3.1 INSTALLATION

- A. All items incorporated into the work shall be installed in accordance with the Drawings and Specifications. Where detailed drawings or technical specifications are not provided, the items shall be installed in accordance with the manufacturer's preferred recommendations and conforming to the best practice of the trade involved.
- B. All installations shall be in accordance with the applicable sections of Division 11, 13, 14, 15 and 16 (where applicable).

3.2 TESTS

- A. All items shall be factory tested.
- B. Refer to section 16950 for additional testing requirements.

END OF SECTION

SECTION 16950START-UP AND TESTING OF ELECTRICAL SYSTEMSPART 1 - GENERAL1.1 DESCRIPTION

- A. Test and demonstrate, to the satisfaction of the Engineer, all electrical devices in accordance with Division 13, Specification 01800 and the following requirements. All testing and checkout of equipment specified under this Section shall be performed by an independent testing agency. The testing agency shall be an independent and qualified field services company regularly engaged in the testing of electrical equipment and apparatus. The following company has been listed:

Electrical Engineering & Service Co., Inc.
289 Center Street
Holbrook, MA 02343
Tel: 781-767-9988
Contact: Mr. Joseph Cipolla

CE Power
40 Washington Street
Westborough, MA 01581
Tel: 855-881-3911

The testing agency's noted are a qualified entity. Additional or equally qualified companies shall be considered as or equal.

- B. During the checkout and startup period, the electrical contractor shall provide sufficient personnel to aid with the start-up of all electrical equipment, to remove any faults, and to make the necessary adjustments for the proper operation of electrical equipment and installation.
- C. A 1000 volt "megger" insulation test shall be available at all times during the testing of power feeders and motor wiring and 2500 volt "megger" test for heat trace cable.
- D. All electrical equipment, wiring, switches and insulators found to be defective or to have failed due to poor workmanship shall be replaced promptly at no additional cost to the Owner.
- E. The testing agency shall be responsible for setting and adjusting all required setting to all electrical equipment based upon the final coordination, short circuit and arc flash study for the entire facility and associated building structures for the electrical distribution system. Signoff and certification sheets shall be submitted and documented for final acceptance.
- F. The contractor will not be allowed to perform any testing, set any equipment parameters or perform any megohm cable testing as this is the responsibility of a third party testing agency as specified herein.
- G. Provide NETA Acceptance testing of feeder breakers in switchboards, main

distribution panels and motor control centers.

- H. Provide certificates for all testing equipment that shows calibration has been completed within the past 12 months

1.2 SUBMITTALS TO THE ENGINEER

- A. Shop Drawings are required for all items provided under this section. Submittals shall be provided in accordance with Sections 01340, 16010 and as specified in this section.
- B. It should be the Contractors responsibility to provide all required forms/direction as to submittal procedures for this contract and to verify compliance prior to submitting to the Engineer for review.
- C. A record of all insulation values shall be properly recorded as listed in worksheet attached to the back of the section. All time intervals shown shall be recorded for each conductor being tested.
- D. Ground testing results shall be properly recorded, witnessed, and reported to the Engineer.
- E. All circuit breaker settings and testing shall be provided in order to check for proper cable connections, impedance testing and infra-red testing of all connections of all electrical equipment, cables, devices and distribution system equipment for the entire project at all locations.

1.3 TESTING REQUIREMENTS

- A. Prior to the start of check out and testing, ensure that all equipment is properly and permanently identified according to Section 16010.
- B. Before energizing any electrical equipment or apparatus, thoroughly check all equipment for the following:
 - 1. All equipment and materials shall be clean, dry and free of foreign materials.
 - 2. Vacuum clean to make free from filings, foreign matter or other materials left inside equipment or enclosures. Particular attention shall be given to bus conductors, conductors, terminal blocks, and windings.
 - 3. Check for tools inside equipment or enclosures. All screw, bolt, and terminal connections shall be checked for tightness as specified by the equipment manufacturer.
 - 4. Check the bearings of all rotating electrical apparatus and, if required, have supplier fill with the grease or oil as recommended by the manufacturers.
 - 5. All motors, contacts, relays, bus, insulators and other electrical apparatus shall be cleaned and dried out if required and/or needed. Drying out methods will be such that the insulation temperature of the apparatus does not exceed 90°C.
- C. Prior to applying voltage to any apparatus or circuit, make insulation resistance tests and, if necessary, dry the apparatus until resistance values conform to the standards of IEEE.
- D. In case of a low resistance circuit insulation, eliminate the problem before the circuit is energized.
- E. Provide 1000 volt "Megger" insulation testing on all 600 volt feeder conductors and motor power conductors. This shall include any and all of the existing electrical feeder cables at the facility which shall remain and shall be reconnected. Motors shall be meggered from the starters.
- F. Provide 2500 volt "Megger" insulation testing for all heat trace cabling to be installed

- at all locations as shown on the Drawings.
- G. "Megger" test all required service feeder cables and circuit wiring at the existing facility in their entirety and submit a complete test report. Test voltage shall be applied until readings reach a constant value, and until three (3) equal readings, each one (1) minute apart, are obtained. Minimum megger reading shall be 45 megohms for feeder conductors.
 - H. Panelboard's line currents shall be balance to within 10% of each other.
 - I. Three phase motors shall be checked for rotation and, if necessary, reverse the connections at the starter. Single phase and DC motors at motor connection box.
 - J. All main plant building loops and major equipment grounds shall be tested to remote earth or directly referenced to an extremely low resistance (approximately 1 ohm) reference ground bench mark. Tests shall be made with ground testing ohm meter or "megger" approved by the Engineer for the purpose.
 - K. The ground resistance of the individual networks shall be measured at two points with the cables at all the test points disconnected.
 - L. Test the grounding system to assure continuity and to assure that resistance to ground does not exceed specified limits or form any ground loops.
 - M. The entire grounding network resistance shall be meggered. Resistance shall not exceed 25 ohms. Drive additional ground rods if necessary.
 - N. The Contractor shall provide load readings for all equipment, switchgear, motor control centers and panelboards.
 - O. Set all coordination, short circuit and arc fault settings to study provided for this facility for final set up of the electrical system.
 - P. Test and set all motor circuit protectors, motor overload heaters to the nameplate horsepower of the equipment; and all circuit breaker settings in all electrical equipment shall be tested and verified operational.
 - Q. Adjust all settings on protective equipment and verify, check and establish with the power company that the secondary voltage is within 2% of rated voltage.
 - R. Provide and check all overload relays settings and sizing for all motors and submit this data to the Engineer for final approval. This shall include settings and adjustments to MCP devices for each motor starter.
 - S. The contractor shall maintain a complete marked up drawing set and all written documentation of all changes at the job site. These documents shall be made available to the Engineer at all times.

1.4 DEMONSTRATION AND START UP

- A. All equipment shall be properly identified as indicated in SECTION 16010.
- B. When directed by the Engineer, demonstrate the total system operation and make final adjustments to the system. If any system or piece of equipment within a system fails to function properly, rectify such defects or inadequacies and make a final demonstration as directed by the Engineer.
- C. Provide the services of authorized manufacturers' representatives to instruct the Owner's representatives in the proper operation of each partial or complete system installed under this Contract.
- D. Pay all charges or fees, including the cost of any special test equipment, factory engineers, etc. necessary for the proper performance of the specified tests, demonstrations, and instructions.

START-UP AND TESTING OF ELECTRICAL SYSTEMS

- E. All demonstrations and instructions shall be scheduled at the convenience of the Engineer and the Owner and shall be scheduled with at least seventy-two (72) hours written notice.
- F. Set all circuit breaker and overcurrent devices based on overall system coordination and short circuit study. Final acceptance will not be allowed until all settings and protective devices are set, checked, tested, and verified in the field in the presence of the Engineer.
- G. All control circuits shall be functionally checked to see that their operation and sequence are correct. Any adjustable switches such as float switches, limit switches and timers shall be adjusted for proper operation.
- H. System Integrator to provide all revised drawings prior to startup. Drawings to incorporate all red-lined drawings received from electrical contractor
- I. Just prior to acceptance of the lighting facilities, clean all lighting fixtures and re-lamp where required at no additional cost to the Owner.
- J. All local control stations and control panels for equipment specified in DIVISIONS 11, 13, 14, 15 and 16 shall be demonstrated to function properly of all items under simulated operating conditions unless otherwise specified elsewhere.

MEGGER TEST RESULTS

Project: _____ **Temperature:** _____
Date: _____ **Weather:** _____
Location: _____ **Test Equipment:** _____

Equipment/feeder Under Test: _____ **Start Time:** _____ **End Time:** _____
Test Equipment: Make: _____ **Serial No.:** _____ **Test Voltage:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
Phase A-Gnd.												
Phase B-Gnd.												
Phase C-Gnd.												
Phase A-PhaseB												
Phase A-PhaseC												
Phase B-PhaseC												

Equipment/feeder Under Test: _____ **Start Time:** _____ **End Time:** _____

	0.5 min	1 min	2 min	3 min	4 min	5 min	6 min	7 min	8 min	9 min	10 min	P.I.
Phase A-Gnd.												
Phase B-Gnd.												
Phase C-Gnd.												
Phase A-PhaseB												
Phase A-PhaseC												
Phase B-PhaseC												

*Notes: Megger test only should record 5 minutes value...
Polarization Index (P.I.) is 10 min reading divided by 1 min reading
Note: If a neutral is provided, this will also need to be tested*

END OF SECTION

APPENDIX A
NIC Systems Incorporation – Cromwell, CT
Proposal



SYSTEMS CORPORATION

Control Systems Integrators

40 Commerce Drive – Cromwell, CT 06416-1167

Ph: (860) 529-0110 Fax: (860) 529-0105

E-Mail: cmarchi@nicssystems.com

April 27, 2022

Prashanth Emmanuel, PE
Project Manager
Wright-Pierce

Phone: 860.852.1907
Fax:
Cell: 203.606.9747
prashanth.emmanuel@wright-pierce.com

RE: The Mattabassett District Primary Sedimentation Basin No 1 Primary Scum Skimmer System Upgrade. NIC Quote No. Q-2204271301.

Emmanuel,

We are pleased to provide the following proposal for a bid item allowance for the Scum Skimmer Upgrade Project.

Hardware Scope of Supply

- One (1) **GBCP** – PLC control panel – NEMA-4X (also contains the Flushing Water components)
 - 10.4" OIT
 - PLC
 - Unmanaged Ethernet switch
 - UPS
 - UPS bypass switch (with Outlet)
 - Fiber Optic Patch Panel
 - Control Relays
 - Operator Devices
 - Pilot Lights
 - On-Delay timers
 - Off-Delay timers
 - Field terminals
- 400 ft. of OM1, 6-fiber, multi-mode, fiber optic cable (spur connection between GBCP and the existing PE-COMM-CP panel).
- Twelve (12) – SC connectors and termination services for the new fiber cable
- One (1) - Media converter – for the PE-COMM-CP new fiber to Cat5e

SPARES

- One (1) PLC Processor
- One (1) PLC Power Supply
- One (1) Analog Input Module
- One (1) Digital Input Module
- One (1) Digital Output Module
- One unmanaged Ethernet switch
- One media converter
- Three-6ft CAT 6 patch cables with connectors installed
- Three-10ft CAT 6 patch cables with connectors installed
- Three fiber optic patch cables of each type used
- No Fiber Optic connector spares provided
- No SFP spares are provided

Services Scope of Supply

- Engineering Design, Panel Assembly Drawings, Electrical Schematics, Network Drawing
- Procurement of specified hardware
- Fabrication of control panels
- Factory Testing
- PLC programming
- OIT programming
- SCADA programming
- Installation supervision
- Start-up and Field Testing
- On-site Training - One (1) 4-hour session first shift - overview of new equipment
- Manuals
- Documentation
- Warranty

Clarifications and Exceptions

- Sheet I-2 calls for single mode fiber optic cable, the cable will be provided multi-mode OM1 type OFNP as described in specifications.
- Sheet I-2 calls for managed Ethernet Switch. The Mattabasset plant network is managed by others. NIC plans to provide an unmanaged network switch similar to others currently in use at the plant.
- A fiber optic media converter will be provided for installation into the Primary Electrical Room Communications panel to convert the new fiber communication line to Gigabit Ethernet and plug in to the managed Cisco switch in that location.
- The contractor shall retain the services of Decian, Inc. to configure the existing network switch ports, if necessary. NIC will connect all physical media.
- Training session provided only as described above in services.

Not Included

- Installation
- Mounting hardware
- Field wiring, conduit, wireway, or associated appurtenances
- Installation of Conduit and Field Wiring
- I/O terminations or field wiring
- Misc. bolts and concrete fasteners required for mounting equipment
- Concrete work of any kind – including coring and sleeves
- No Network Management Software is included (specified in 13445-1.1.A.9)
- No Managed switch configuration is included (this is by others)

Total price \$61,500.
(Sixty-One Thousand, Five Hundred Dollars)

Terms:

- SOV Invoicing based on percentage of completion

Please note our prices do not include any applicable state or local taxes, permits, bonding, or shipping costs. Shipping FOB Cromwell, CT.

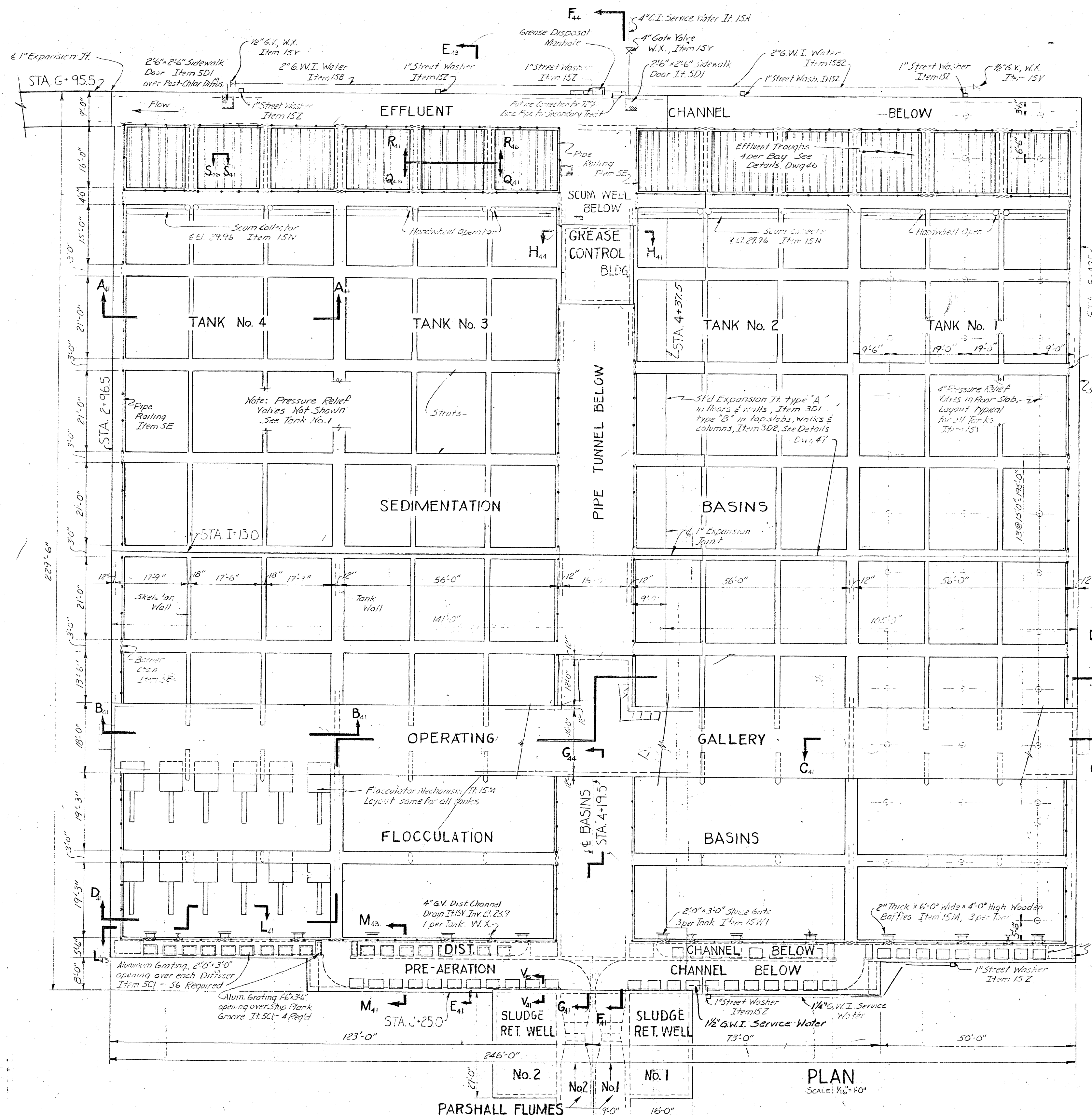
Please feel free to contact me to discuss any questions or concerns you may have once you've had a chance to review this proposal.

Sincerely,

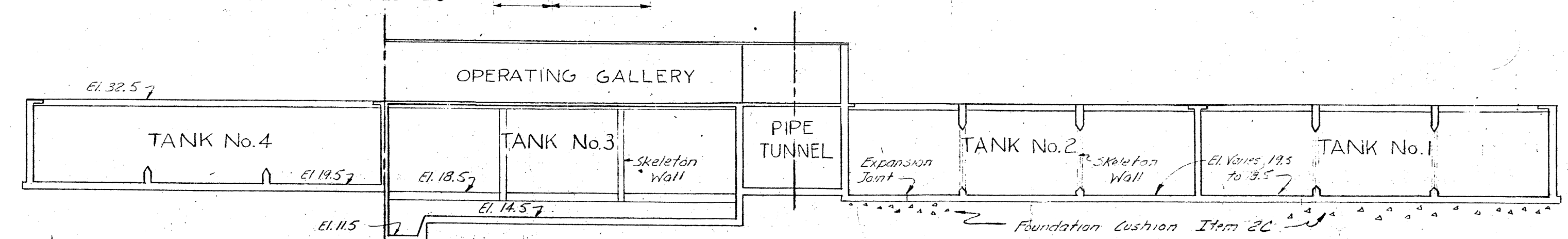
C. P. Marchi

Carlo P. Marchi
Sr. Sales Engineer

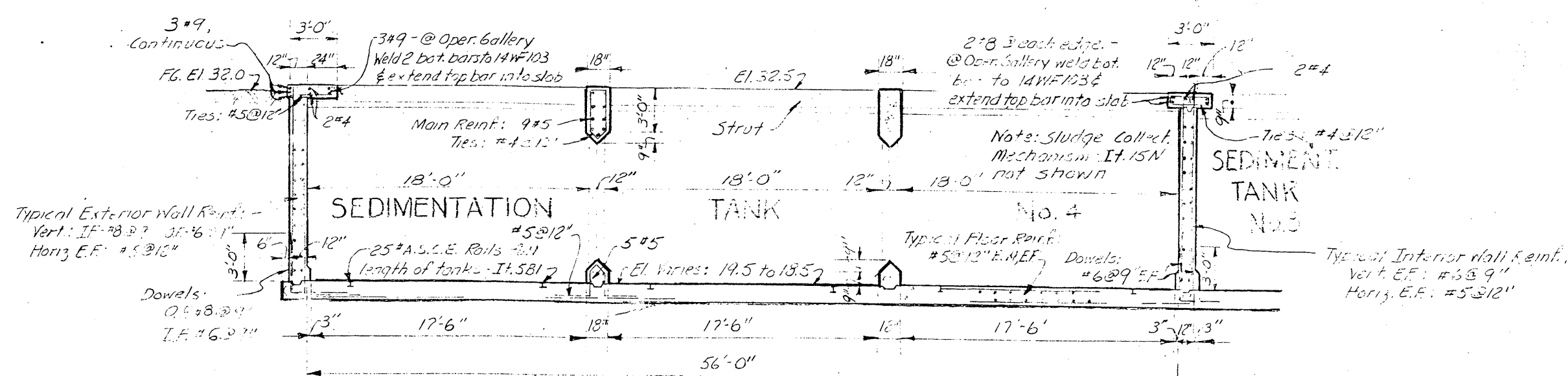
APPENDIX B
1965 Primary Clarifier Sedimentation Basin Drawings



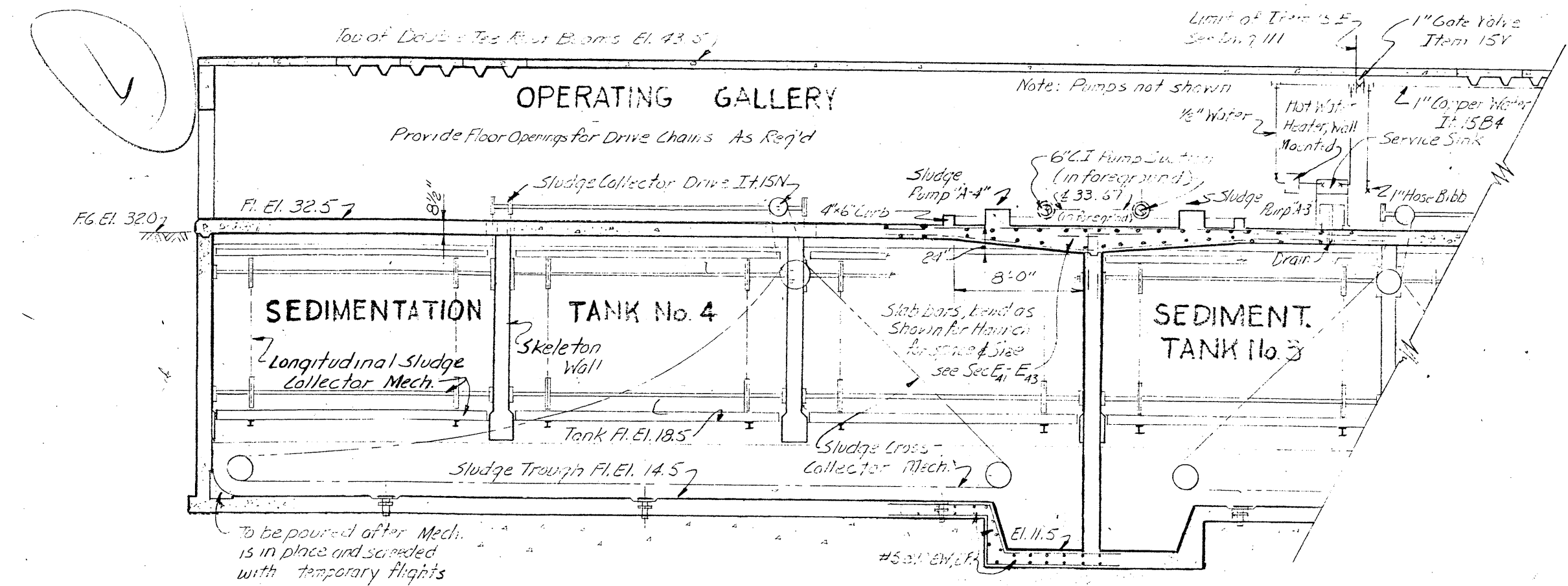
PLAN SCALE: 1/8"=1'-0"



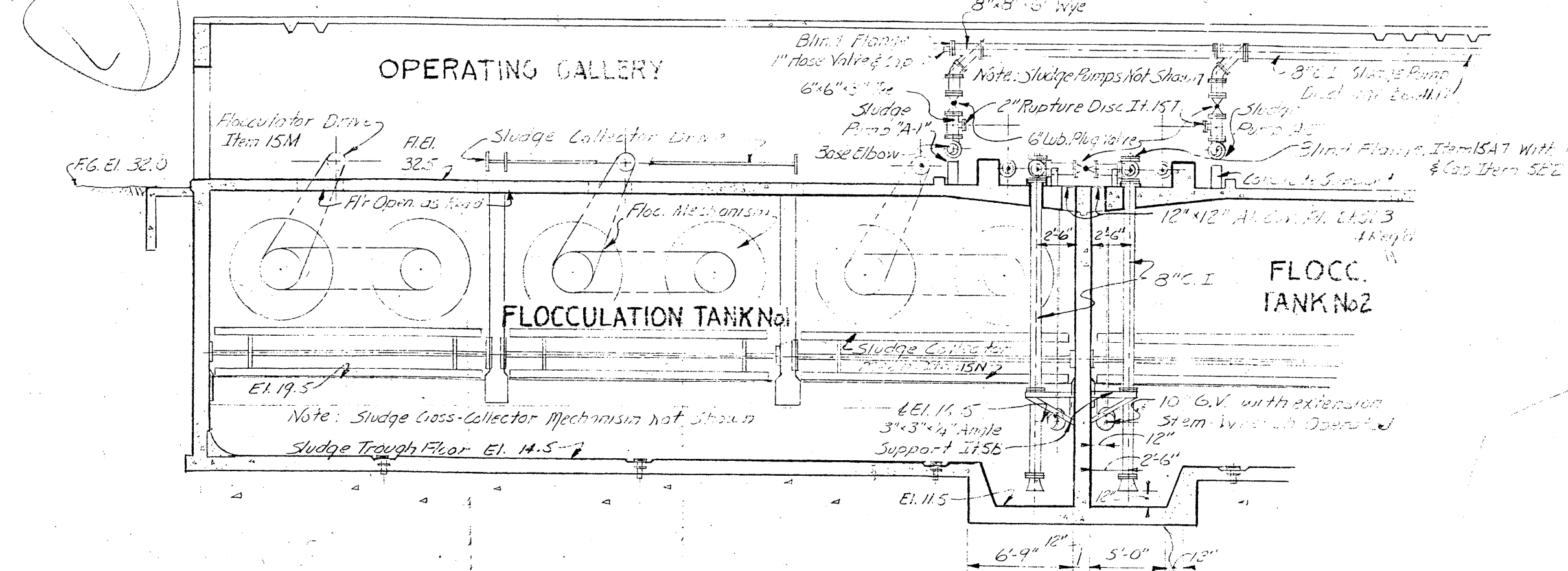
SECTION D1-D4 SCALE: 1/4"=1'-0"



SECTION A1-A4 SCALE: 1/8"=1'-0"



SECTION B1-B4 SCALE: 1/8"=1'-0"



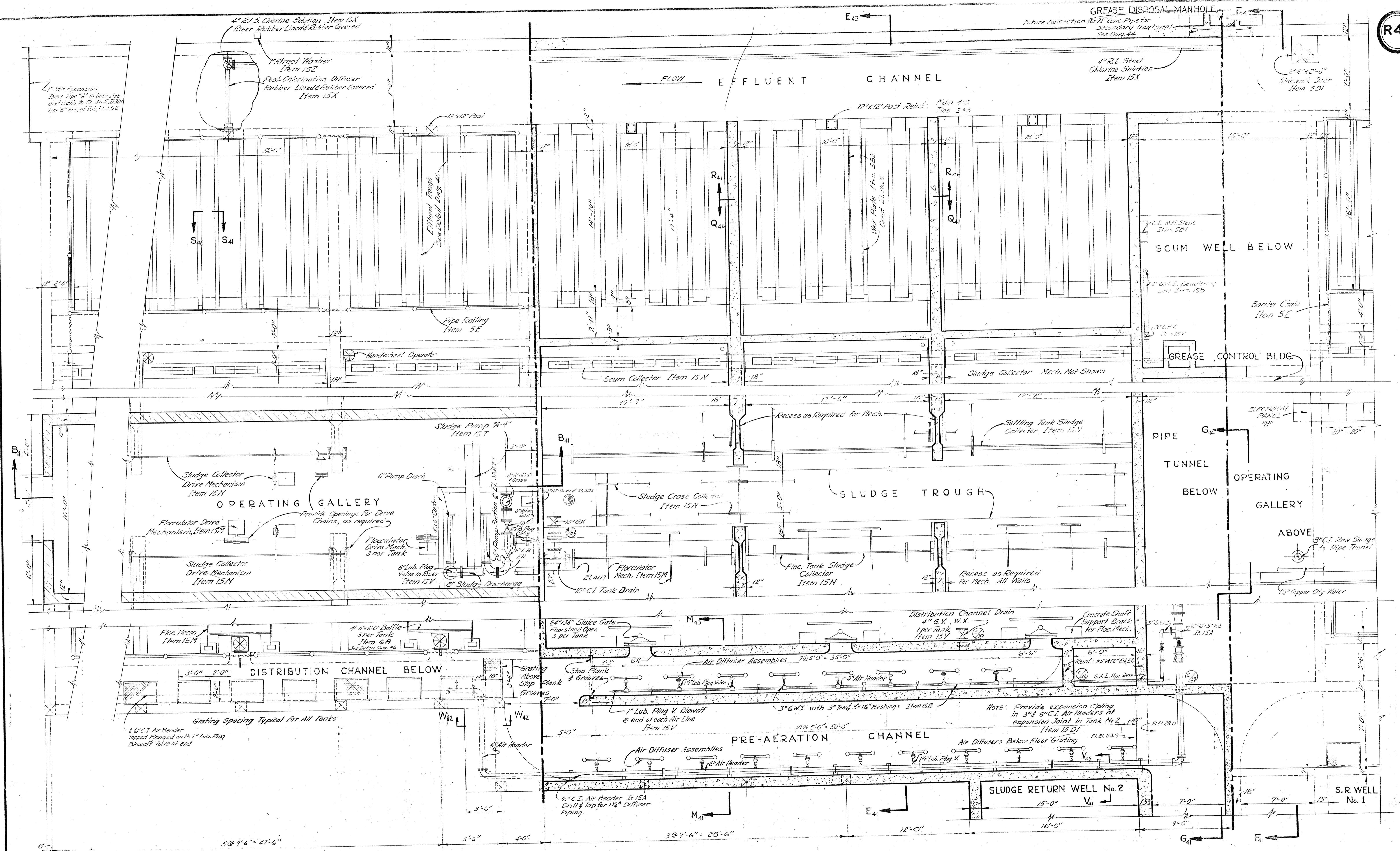
SECTION C1-C4 SCALE: 1/8"=1'-0"

Note: See Dwg. #52 for Valve and Pipe Leg and

NO.	DATE	ITEM	MADE BY
REVISIONS			
DRAWN BY: M.J.H.		933-2-41	
CHECKED BY: J.W.S.		12 SHEETS	
APPROVED BY: John S. Hartman			
HAVENS & EMERSON		CLEVELAND	

RECORD DWG. NO. 933-2-R41

THE MATTABASSETT DISTRICT
 CROMWELL, CONNECTICUT
 WATER POLLUTION CONTROL PLANT
 CONTRACT 2
 FLOCCULATION & SETTLING TANKS
 GENERAL PLAN & SECTIONS
 SCALE: AS SHOWN
 OCTOBER, 1965



THE MATTABASSETT DISTRICT
 CROMWELL, CONNECTICUT
WATER POLLUTION CONTROL PLANT
 CONTRACT 2

FLOCCULATION & SETTLING TANKS
 SECTIONAL PLAN

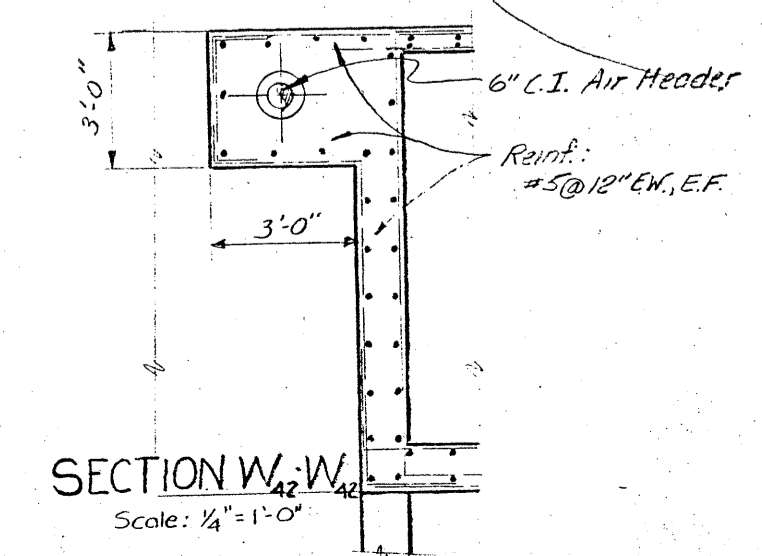
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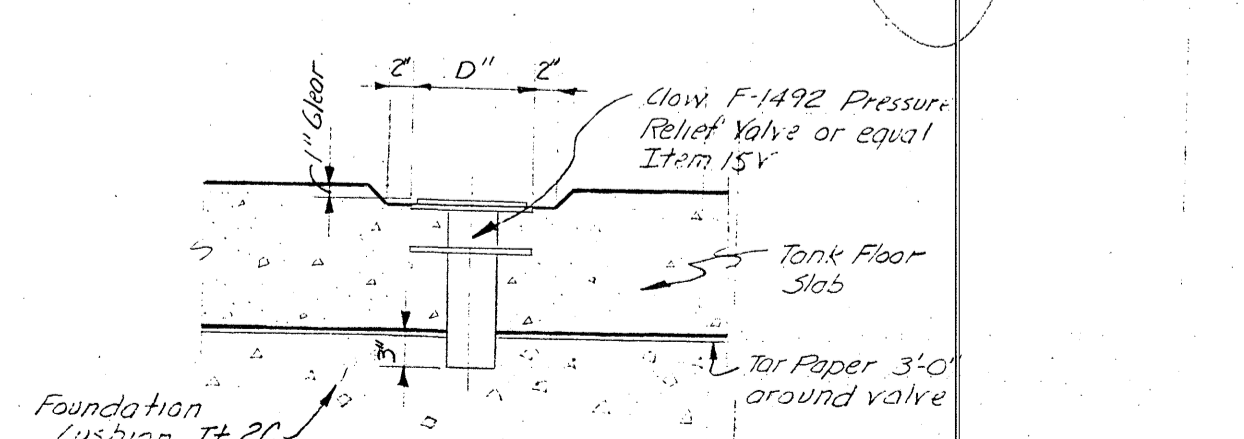
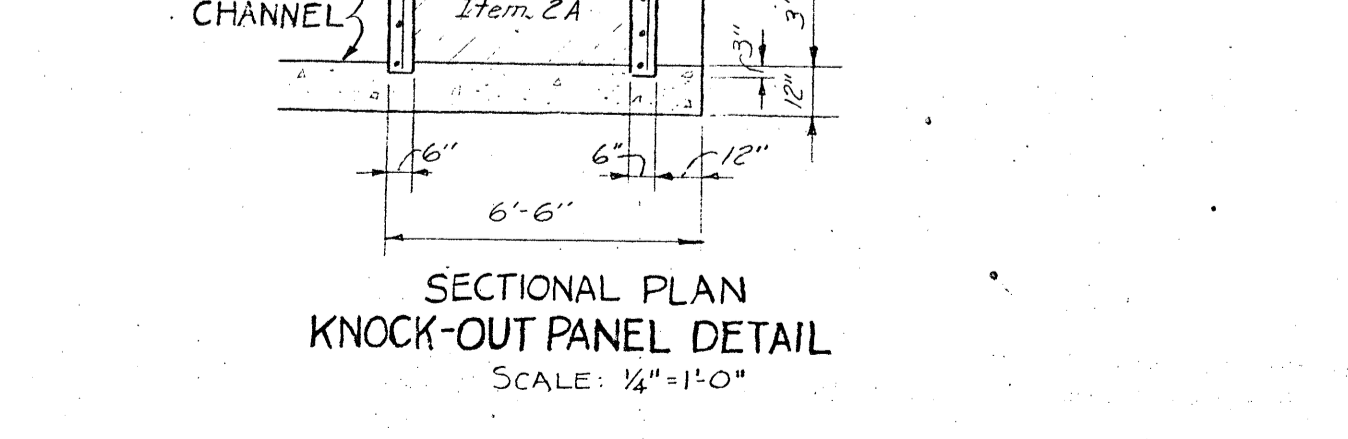
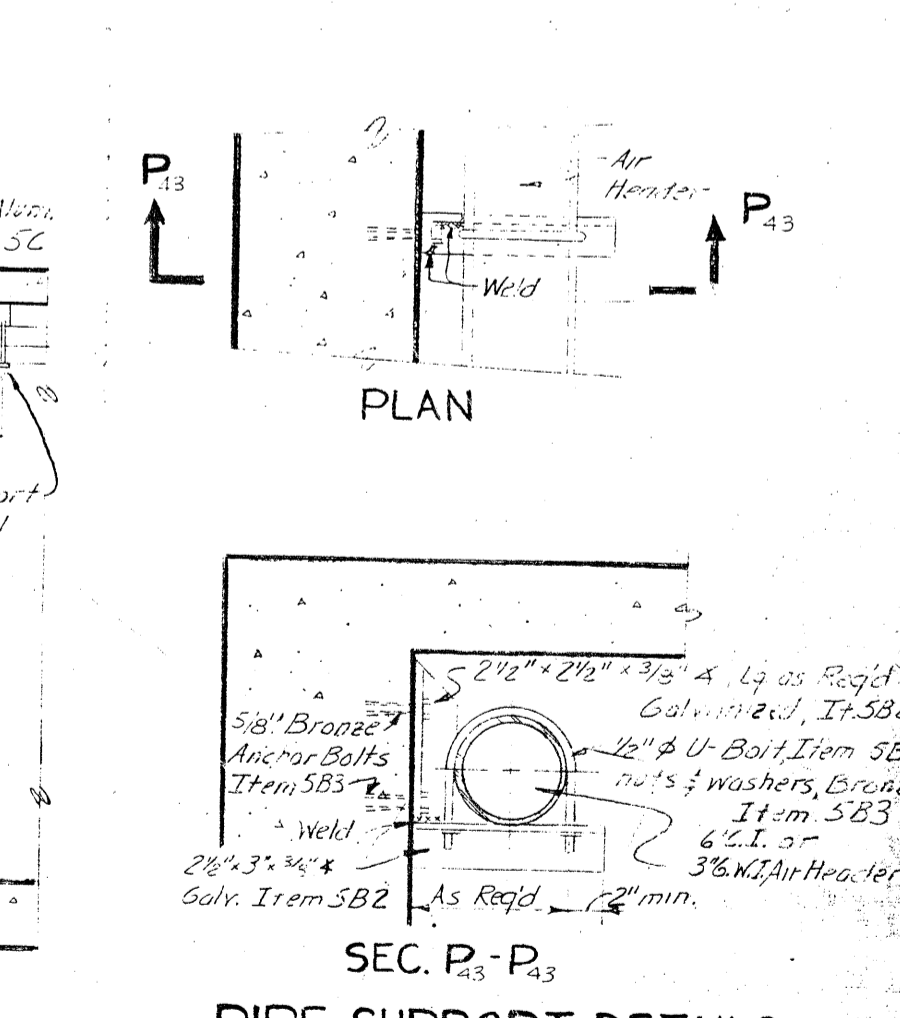
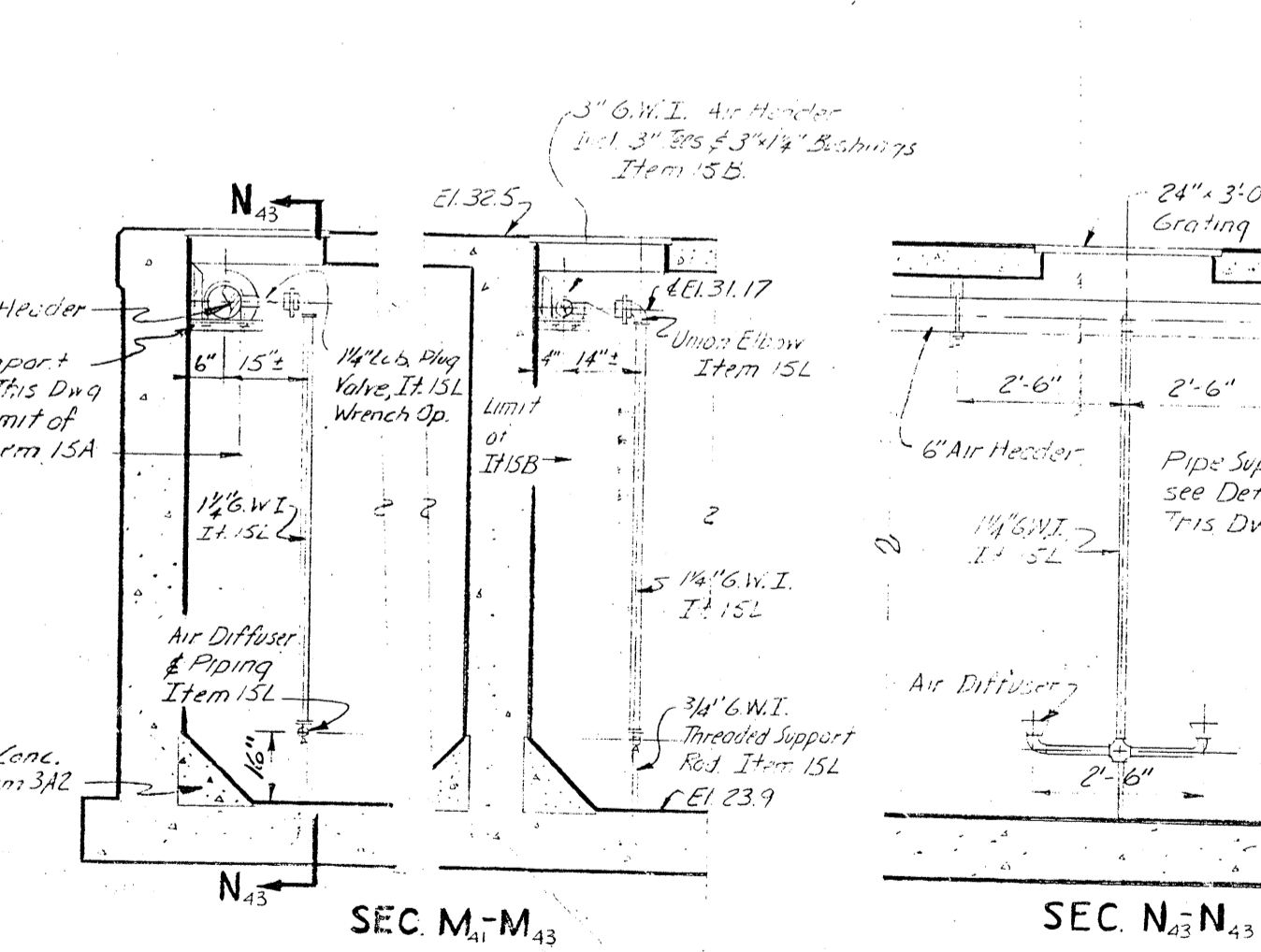
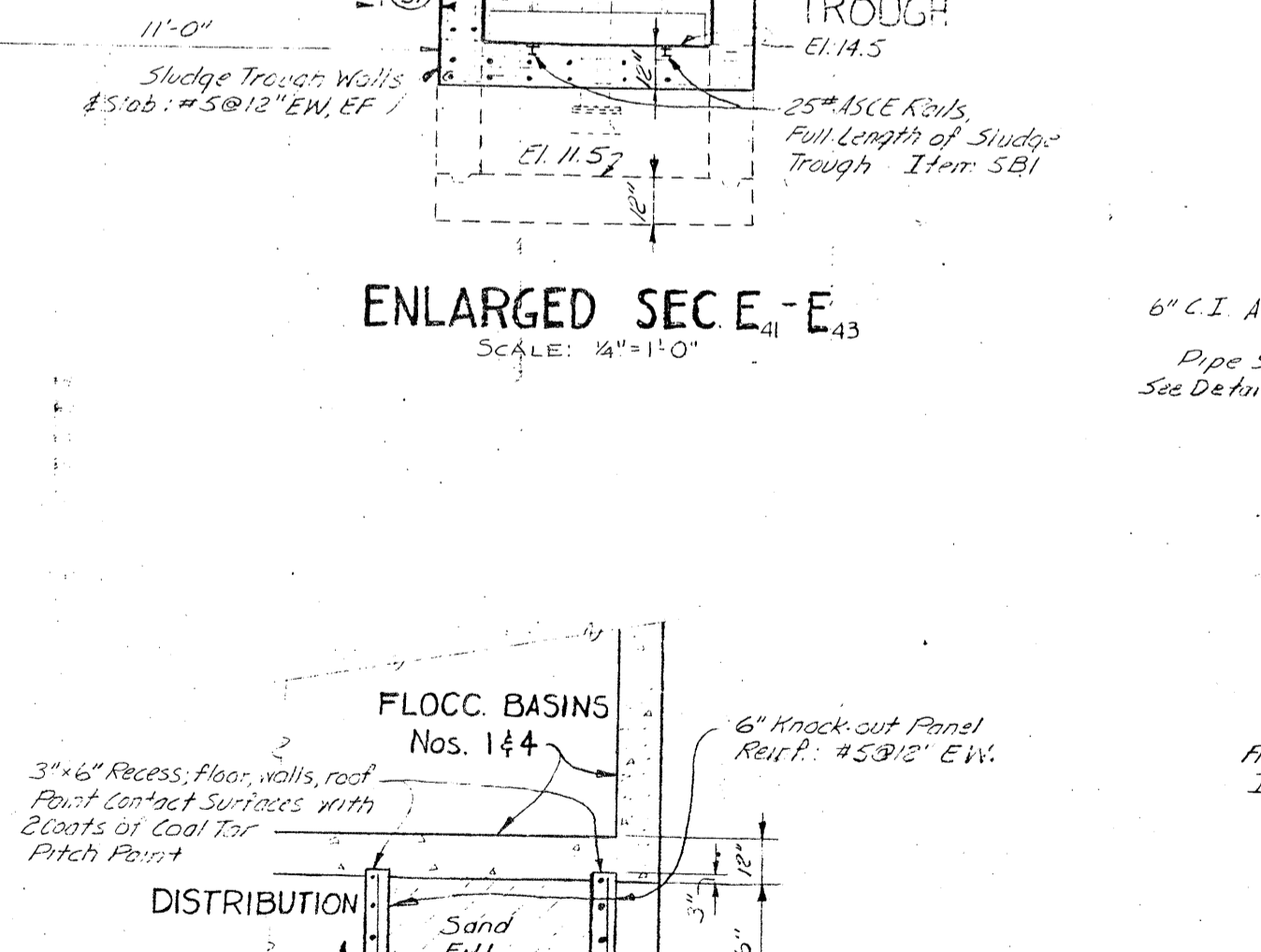
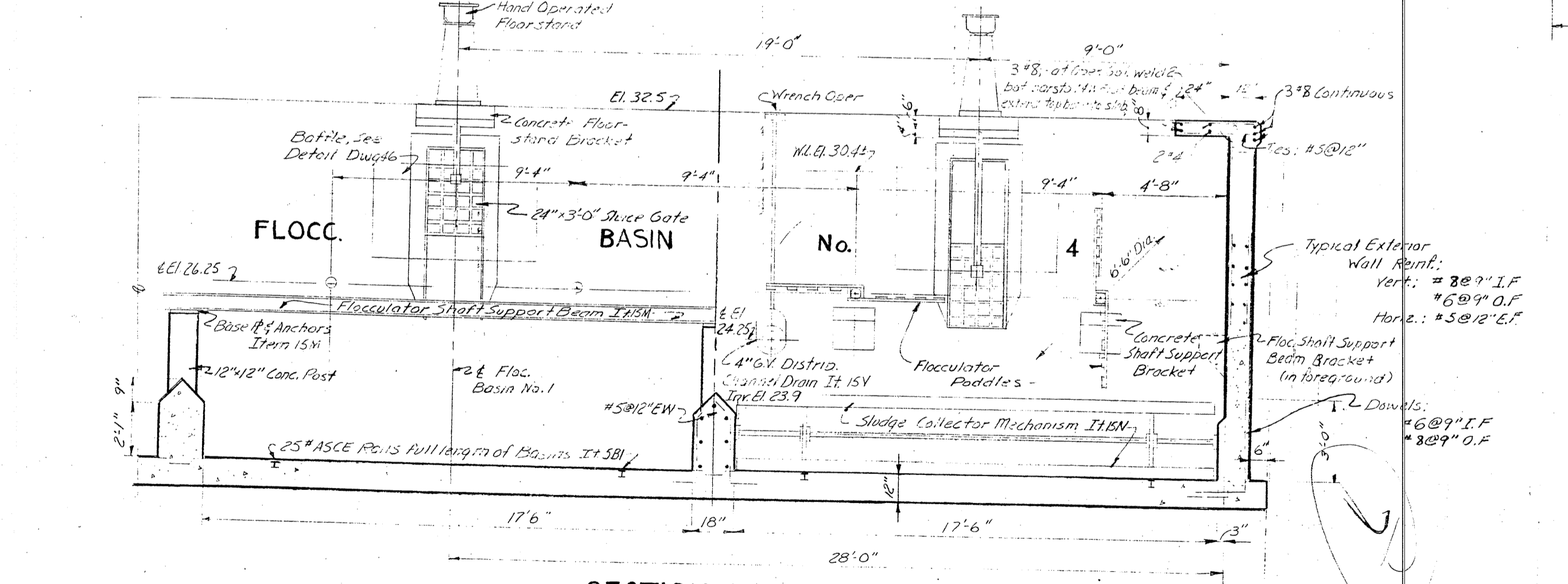
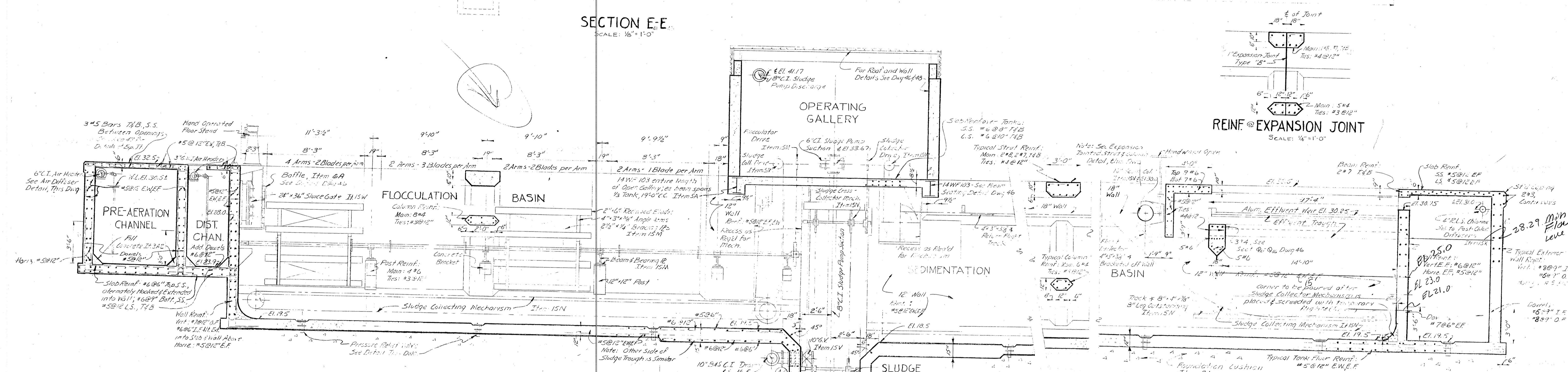
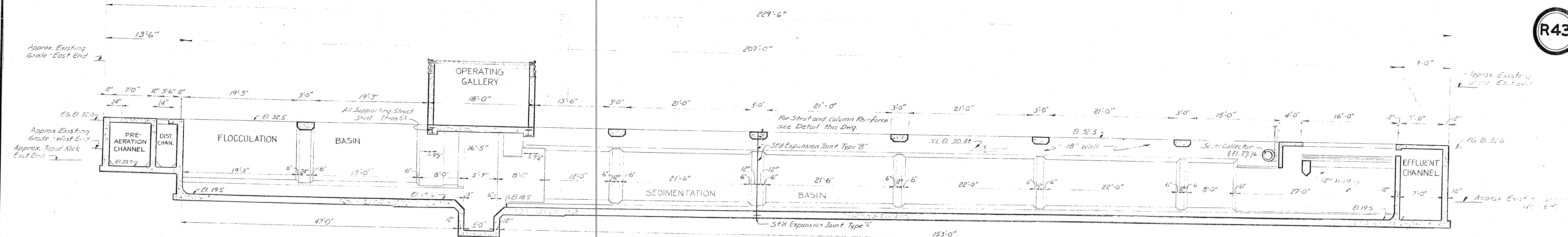
OCTOBER, 1965

RECORD DWG. NO. 933-2-R42

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2		CHECKED BY: J. W. S.	
APPROVED BY:		<i>[Signature]</i>	
HAVENS & EMERSON		CLEVELAND	

933-2-42
 121 SHEETS





NO.	DATE	ITEM	MADE BY
REVISIONS			
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DR. W. BY: M.F.H.
 TR. CD. BY: M.J.H.
 CH. CK. BY: J.W.S.
 933-2-43
 120 SHEETS
 APPROVED BY: *John D. ...*
 HAVENS & EMERSON
 NEW YORK CLEVELAND

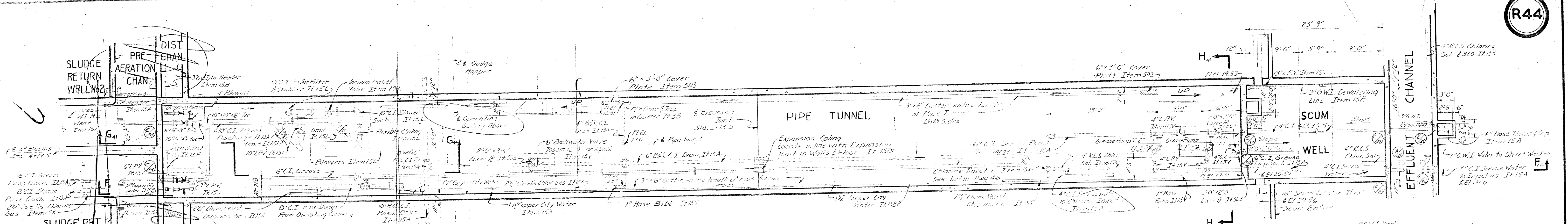
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THE MATTABASSETT DISTRICT
 CROMWELL, CONNECTICUT
 WATER POLLUTION CONTROL PLANT
 CONTRACT 2

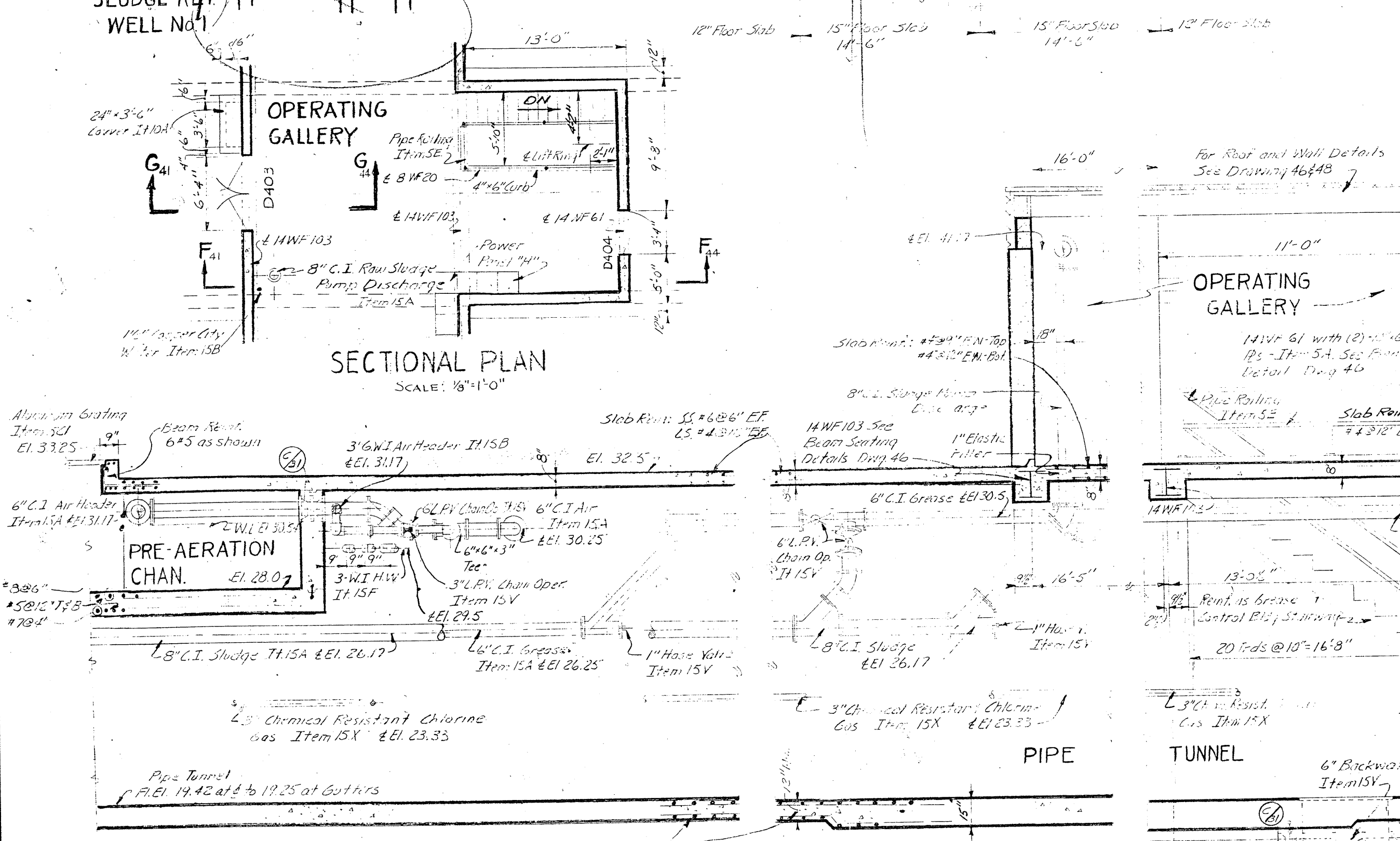
FLOCCULATION & SETTLING TANKS
 SECTIONS & DETAILS

SCALE: AS SHOWN

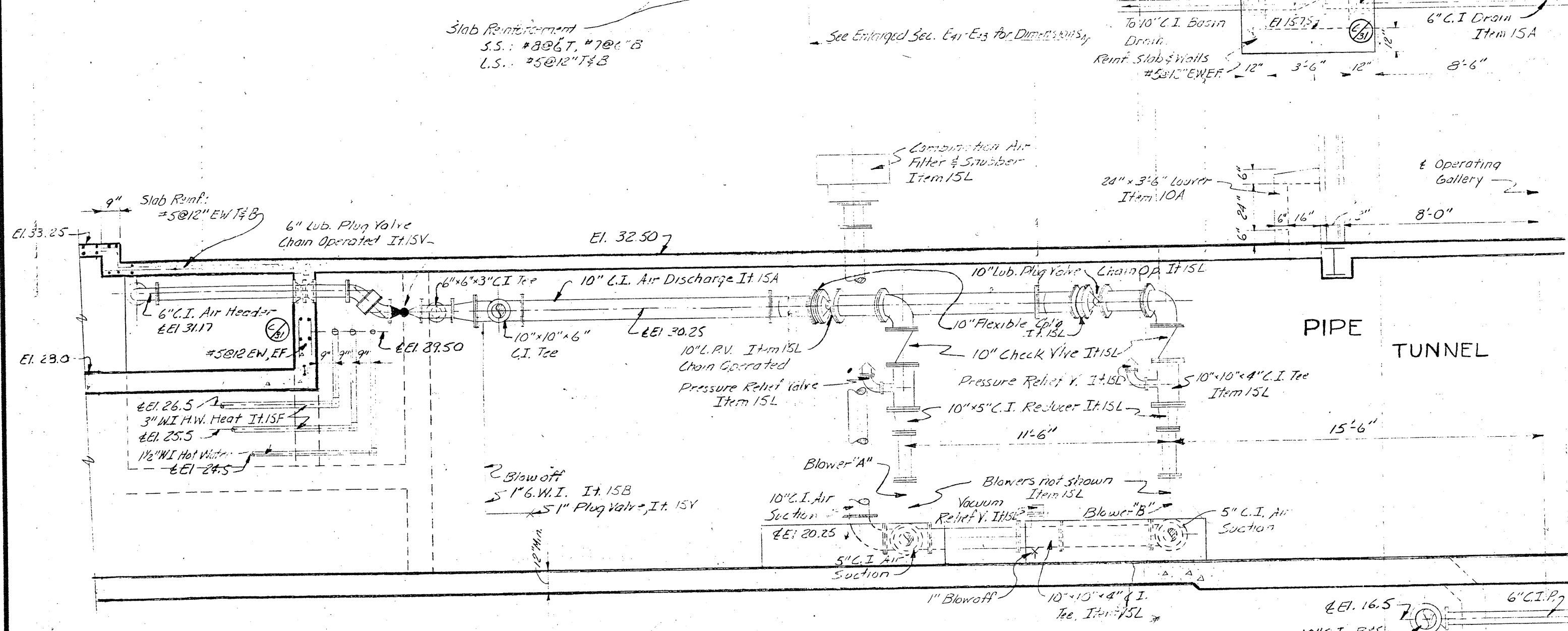
OCTOBER, 1965



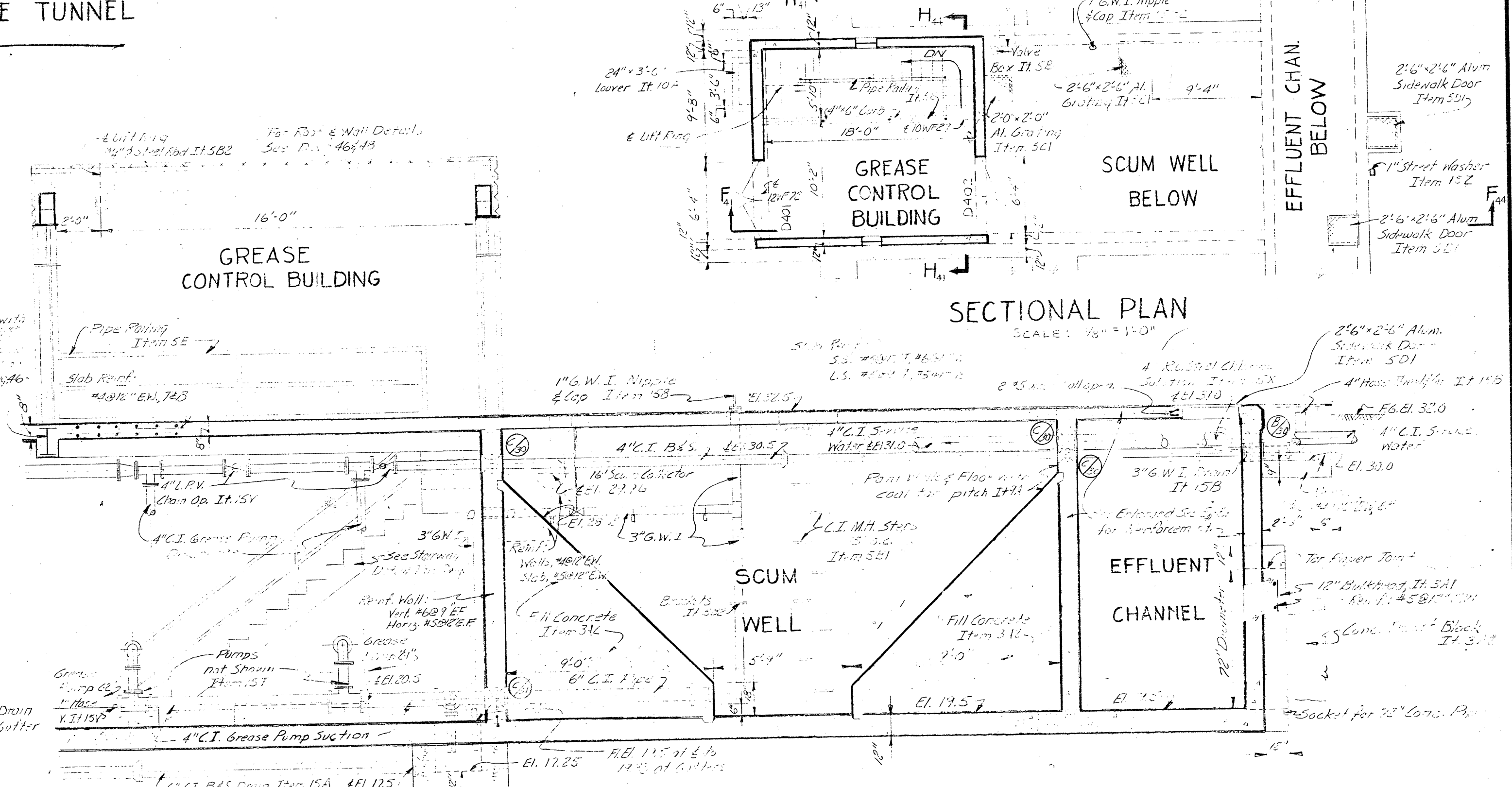
SECTIONAL PLAN - PIPE TUNNEL
SCALE: 1/8" = 1'-0"



SECTIONAL PLAN
SCALE: 1/8" = 1'-0"

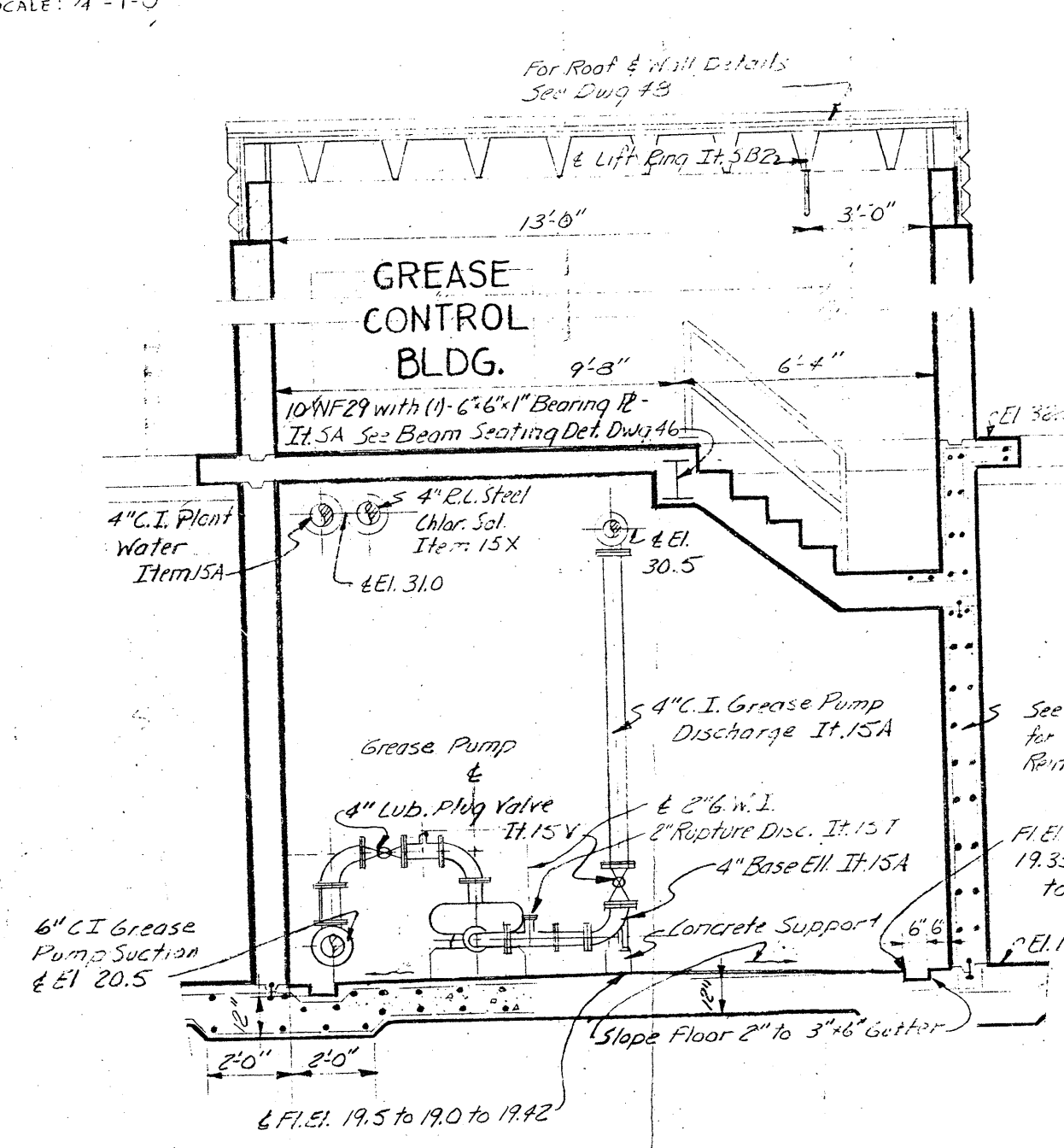


SECTION G-G
SCALE: 1/4" = 1'-0"

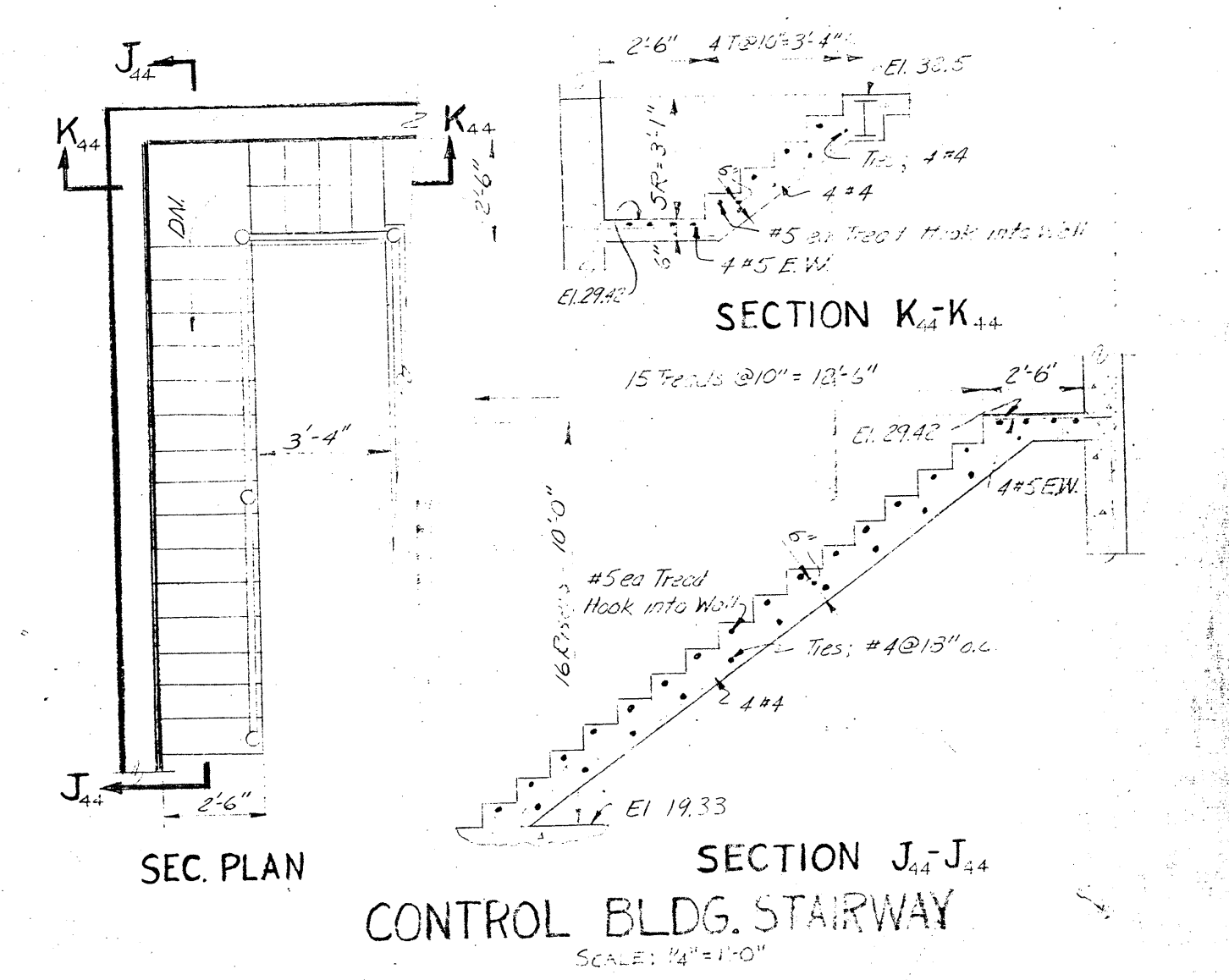


SECTIONAL PLAN
SCALE: 1/8" = 1'-0"

SECTION F-F
SCALE: 1/4" = 1'-0"



SECTION H-H
SCALE: 1/4" = 1'-0"



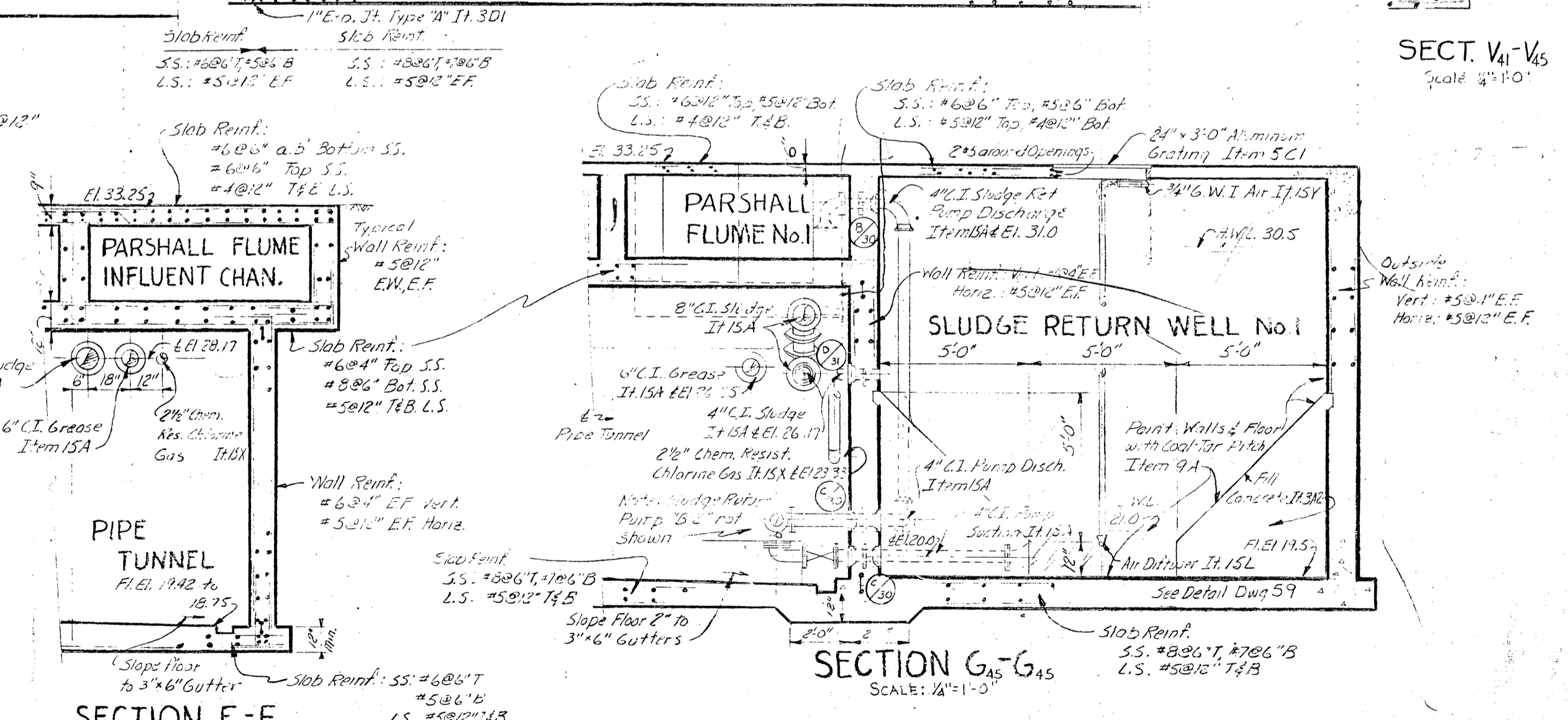
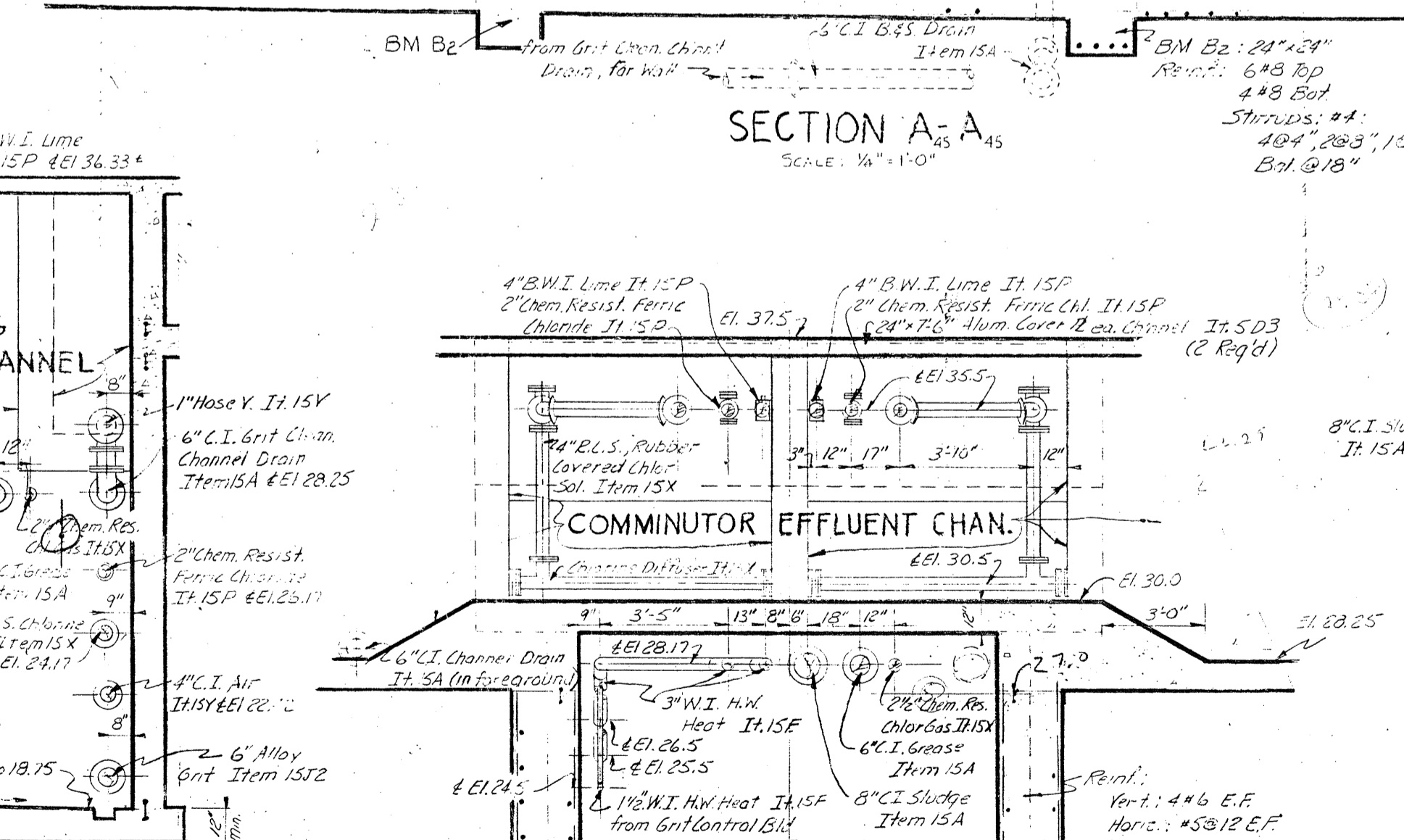
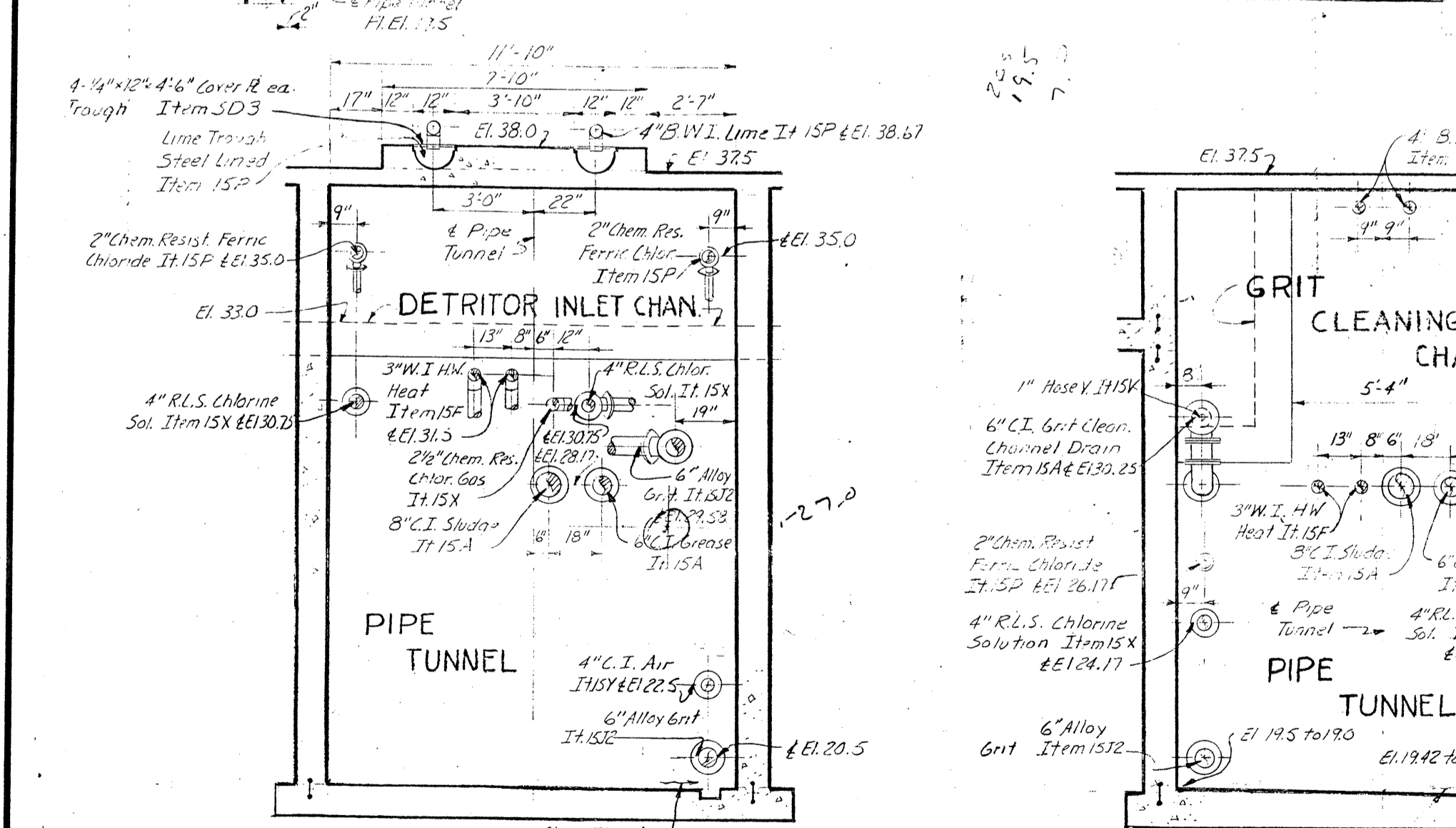
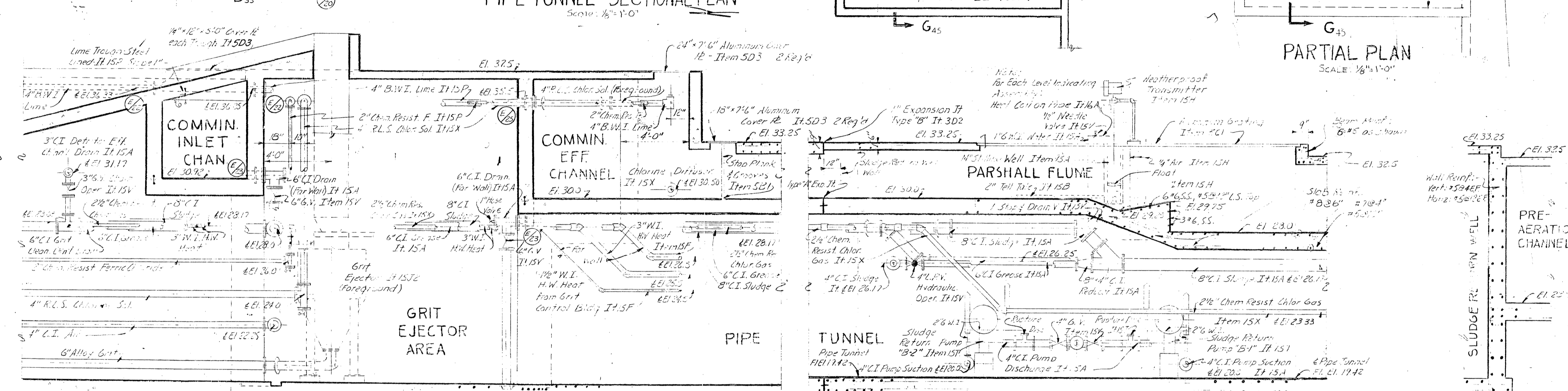
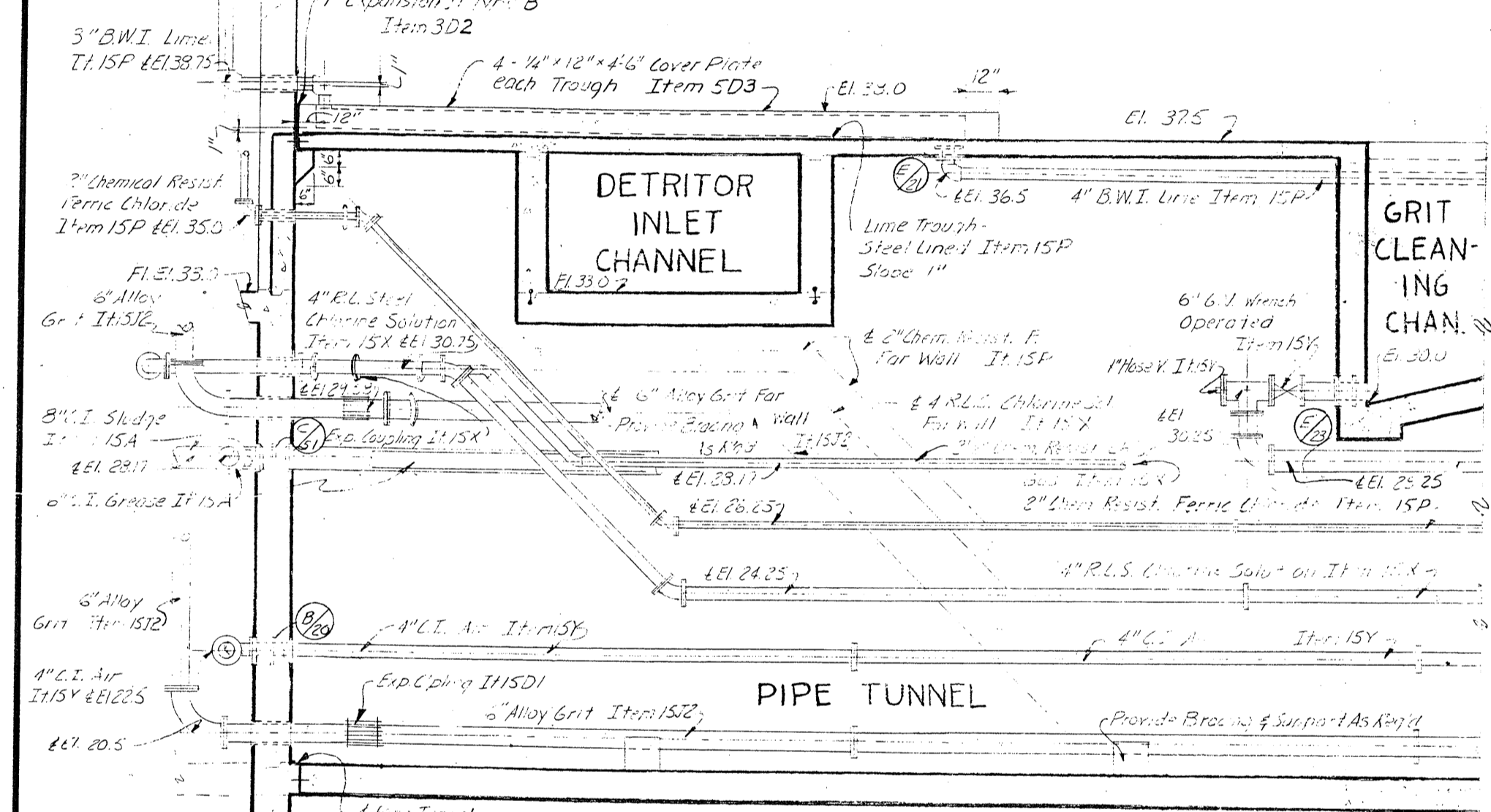
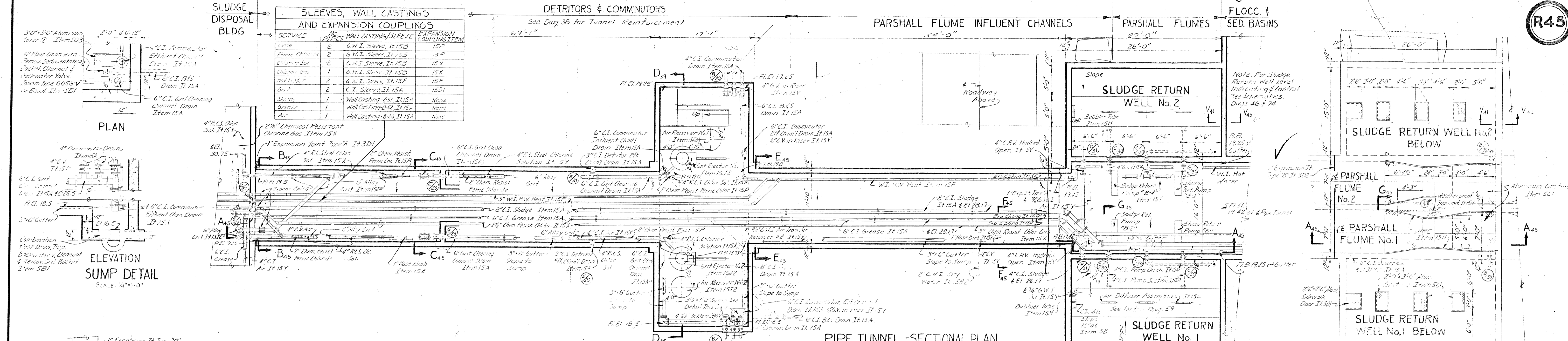
SECTION J-J
SCALE: 1/4" = 1'-0"

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REVISIONS			
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DRAWN BY: M.T.H. 933-2-44			
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APPROVED BY: <i>[Signature]</i>			
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RECORD DWG. NO. 933-2-R44

THE MATTABASSETT DISTRICT
CROMWELL, CONNECTICUT
WATER POLLUTION CONTROL PLANT
CONTRACT 2

FLOCCULATION & SETTLING TANKS
PIPE TUNNEL & GREASE CONTROL BUILDING
SCALE: AS SHOWN
OCTOBER, 1965



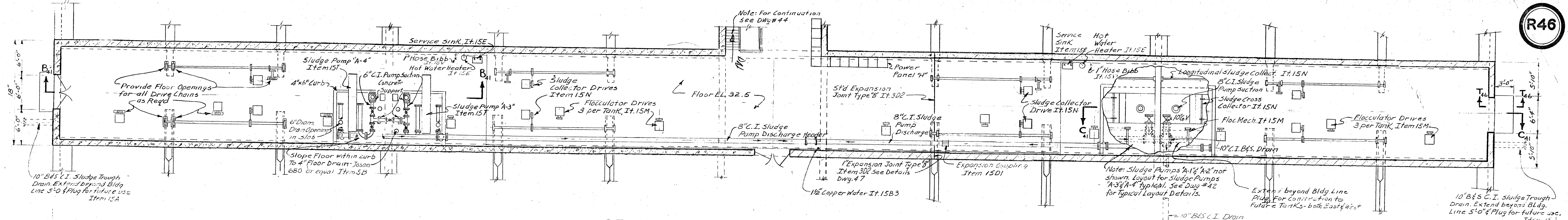
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REVISIONS			
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DRAWN BY: M.J.H.
 TRACED BY: M.J.H.
 CHECKED BY: J.W.S.
 APPROVED BY: *[Signature]*
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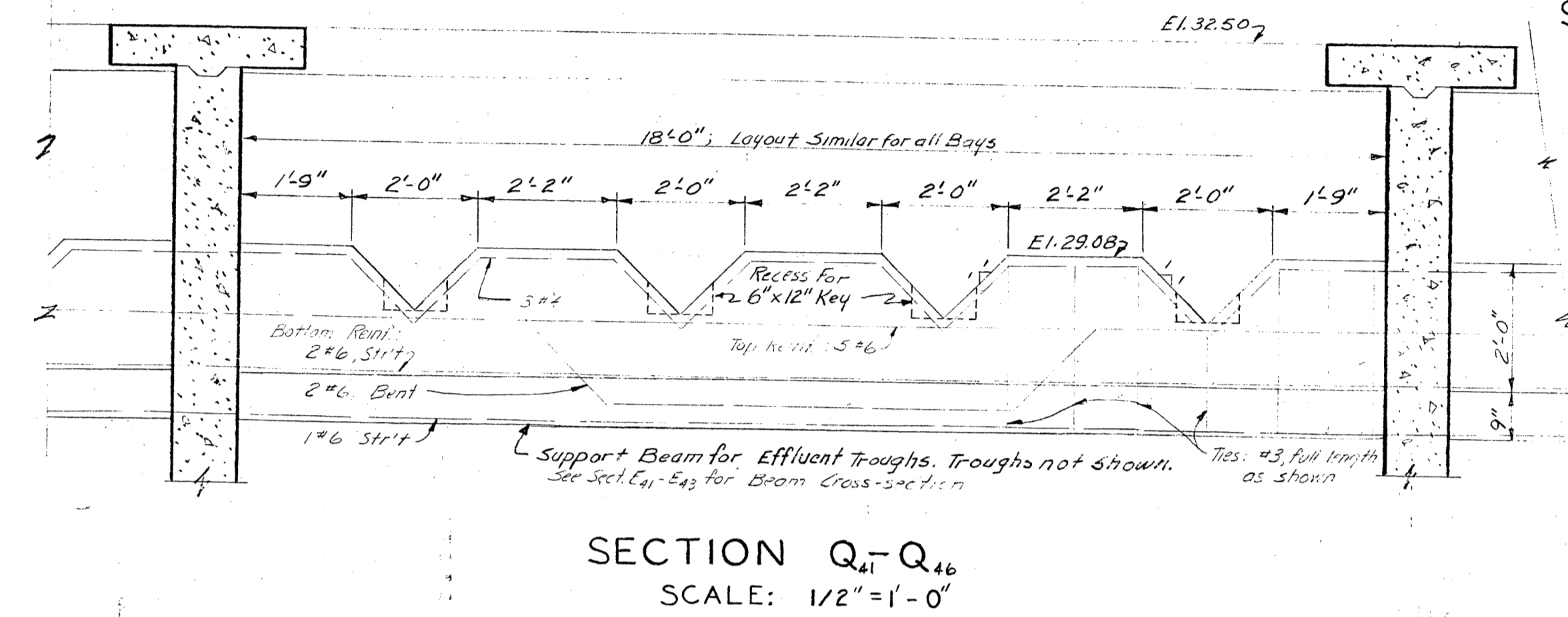
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**THE MATTABASSETT DISTRICT
CROMWELL, CONNECTICUT
WATER POLLUTION CONTROL PLANT
CONTRACT 2
FLOCCULATION & SETTLING TANKS
PIPE TUNNEL - PIPING DETAILS**

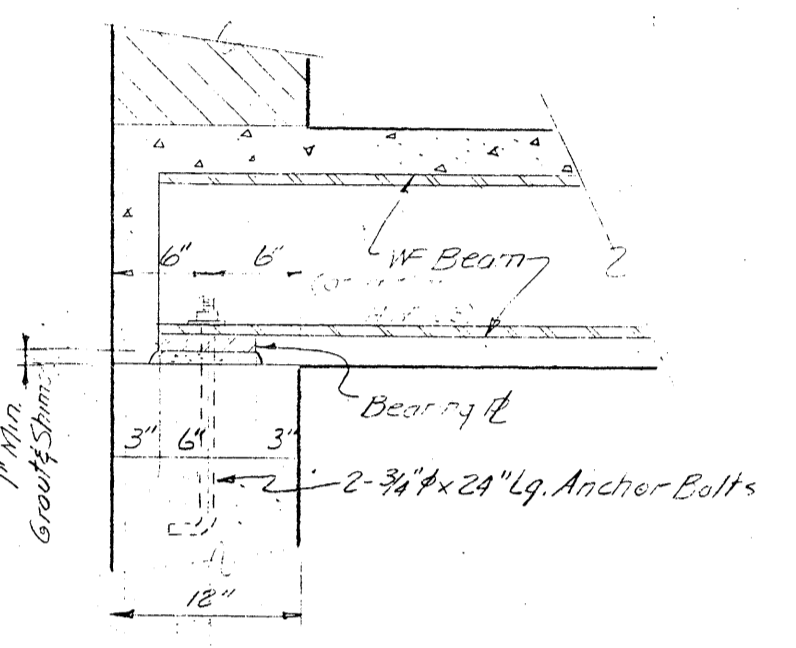
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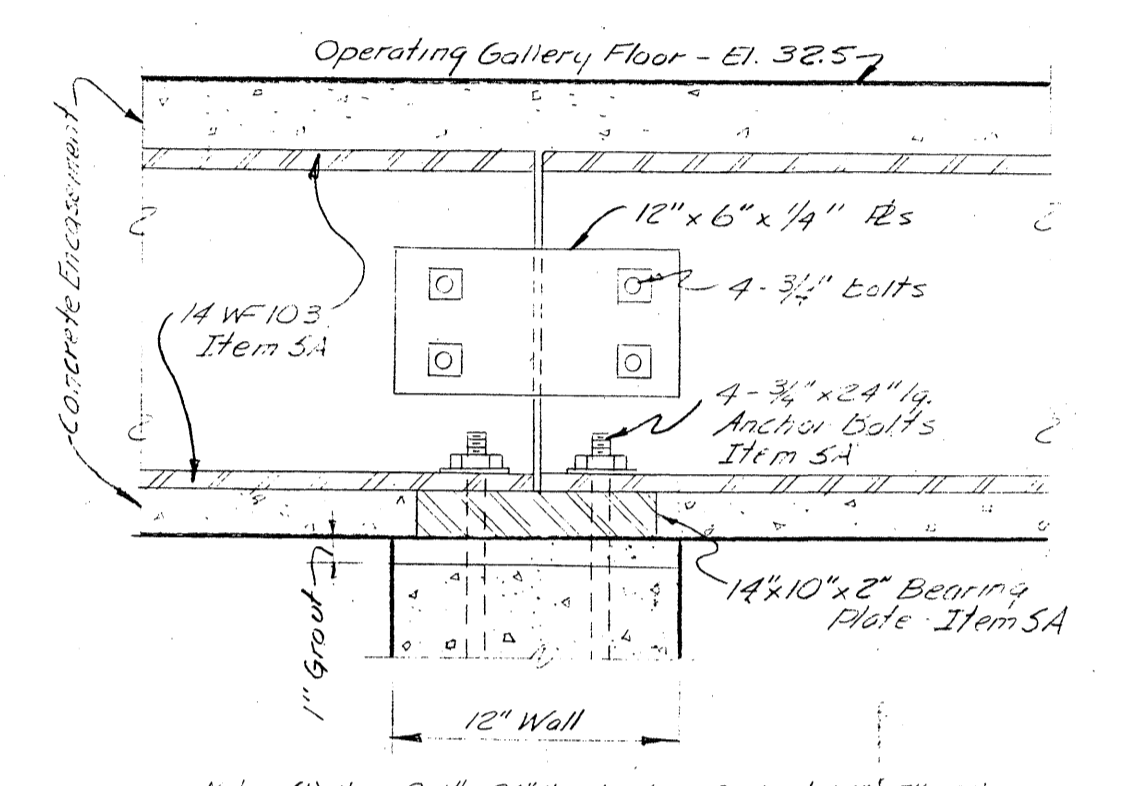
SECTIONAL PLAN - OPERATING GALLERY
SCALE: 1/8" = 1'-0"



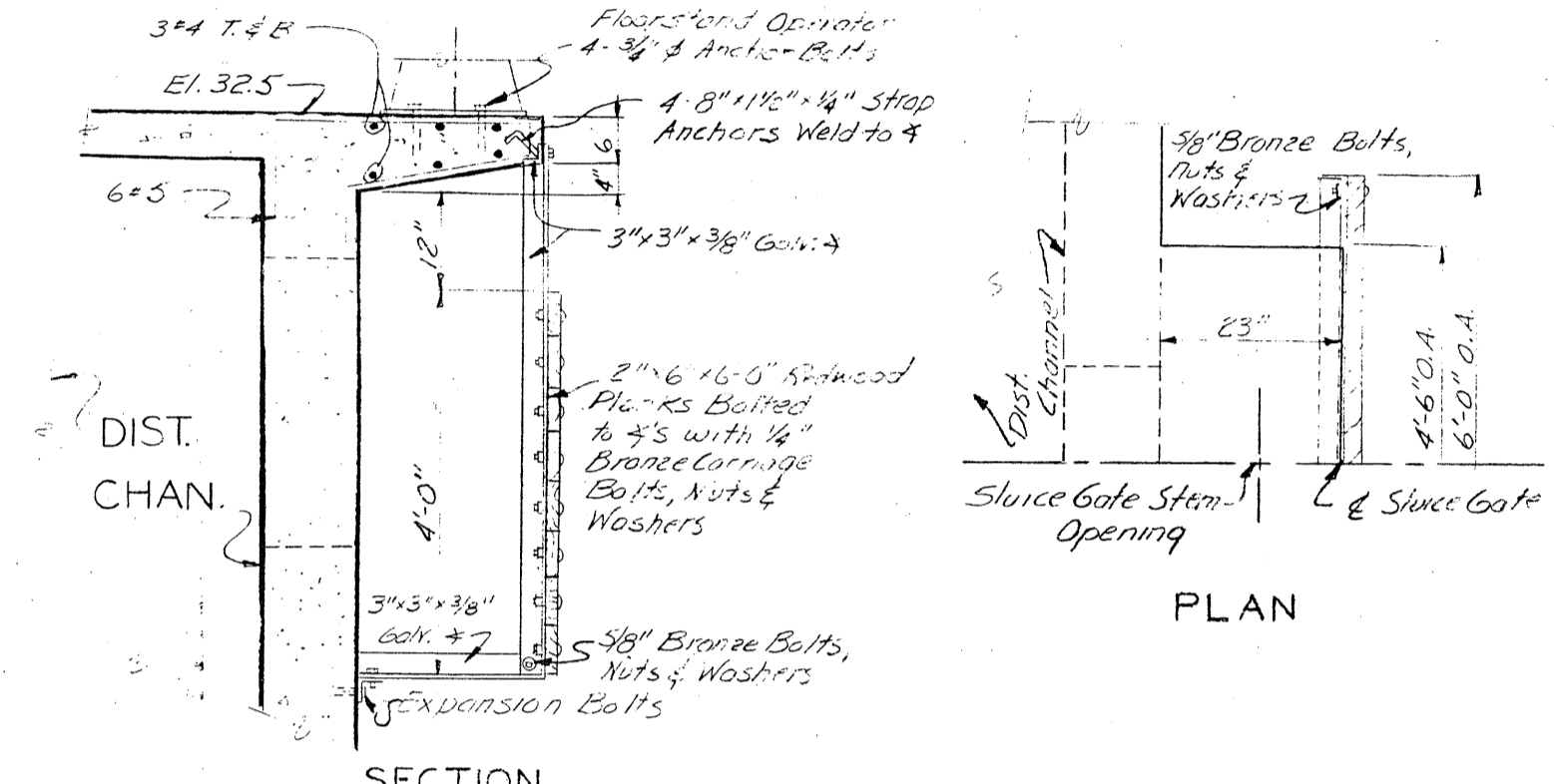
SECTION Q1-Q46
SCALE: 1/2" = 1'-0"



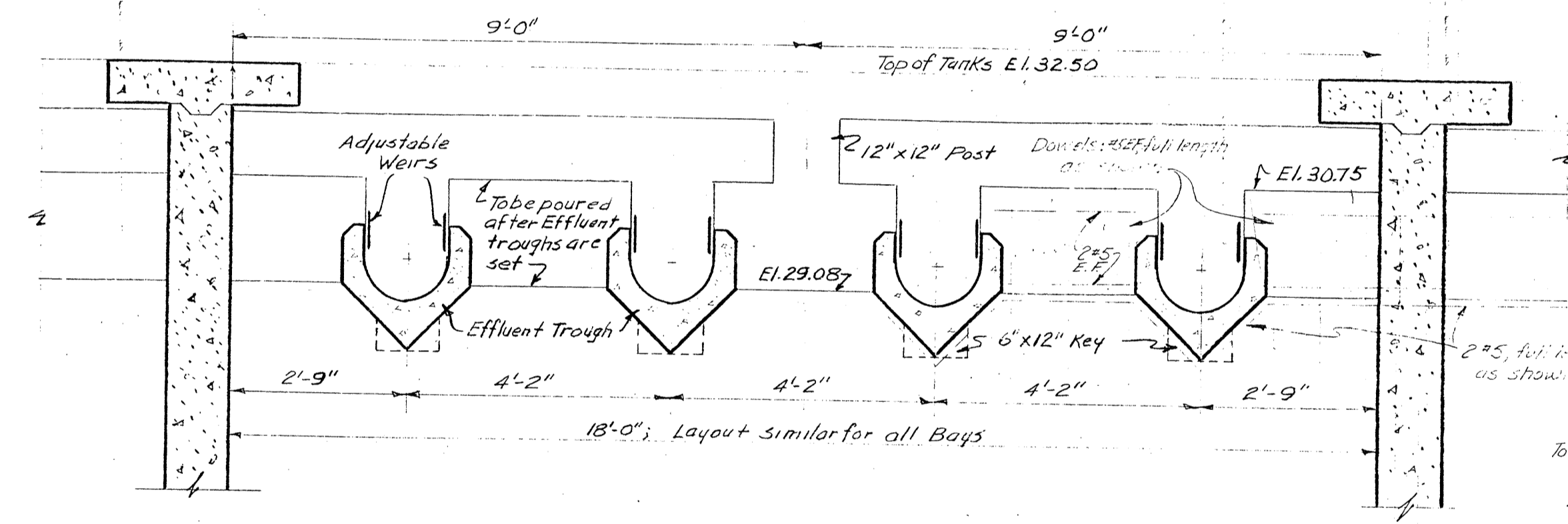
BEAM SEATING
DETAIL
NO SCALE



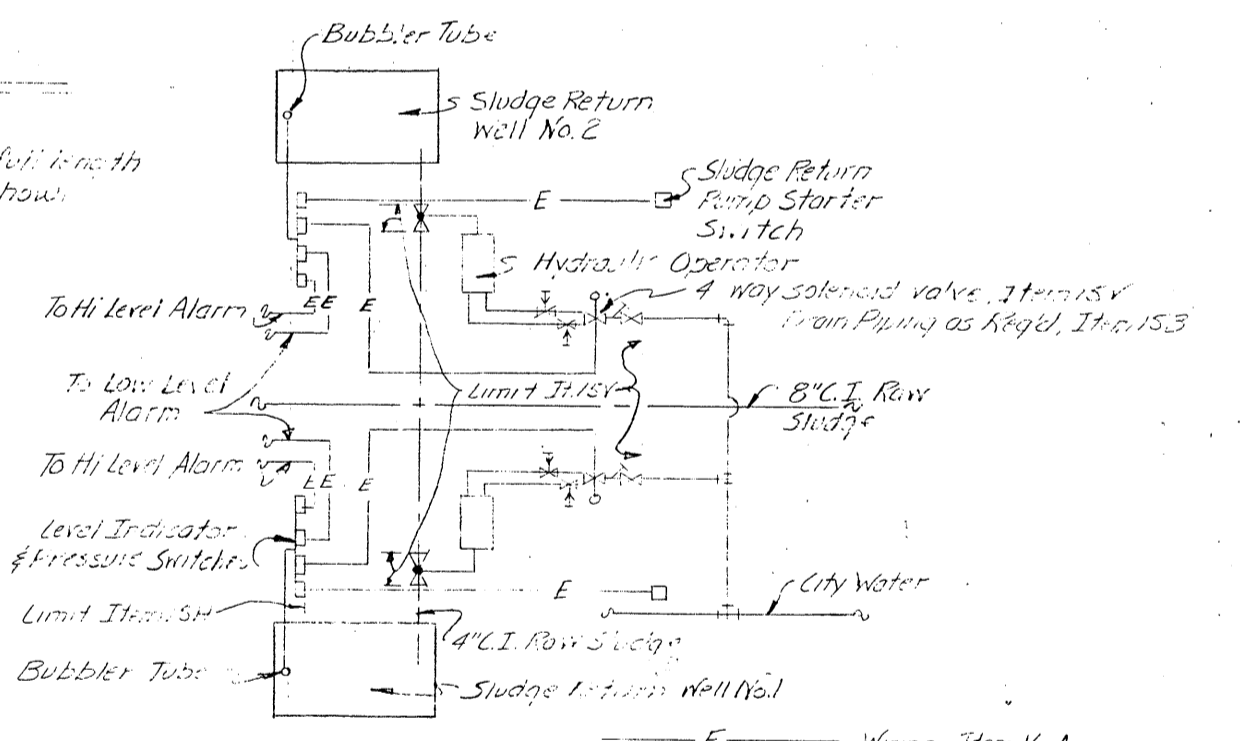
BEAM SEATING DETAIL
SCALE: 1/4" = 1'-0"



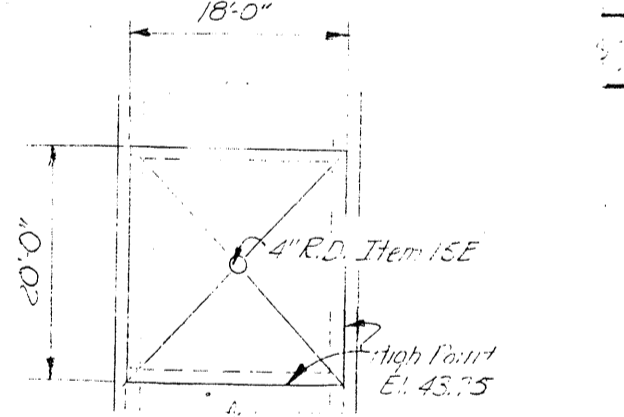
BAFFLE DETAIL
ITEM 6A
SCALE: 1/2" = 1'-0"



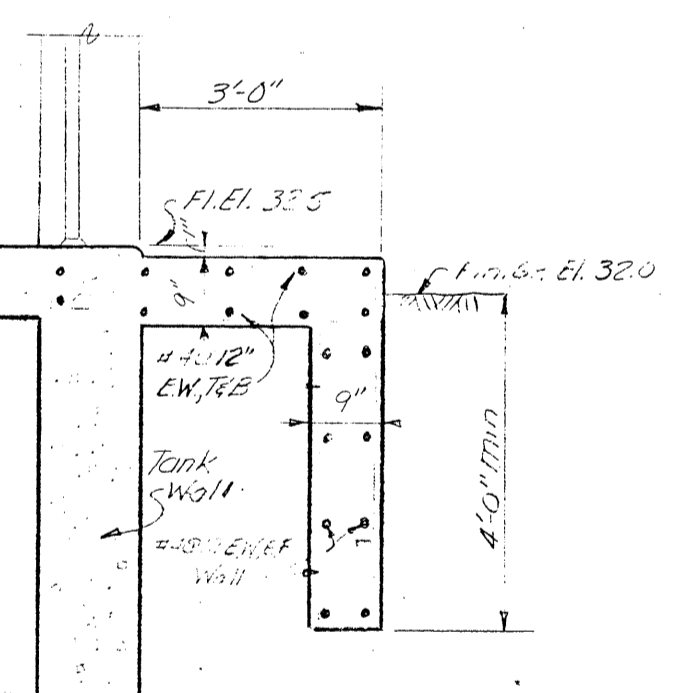
SECTION R1-R46
SCALE: 1/2" = 1'-0"



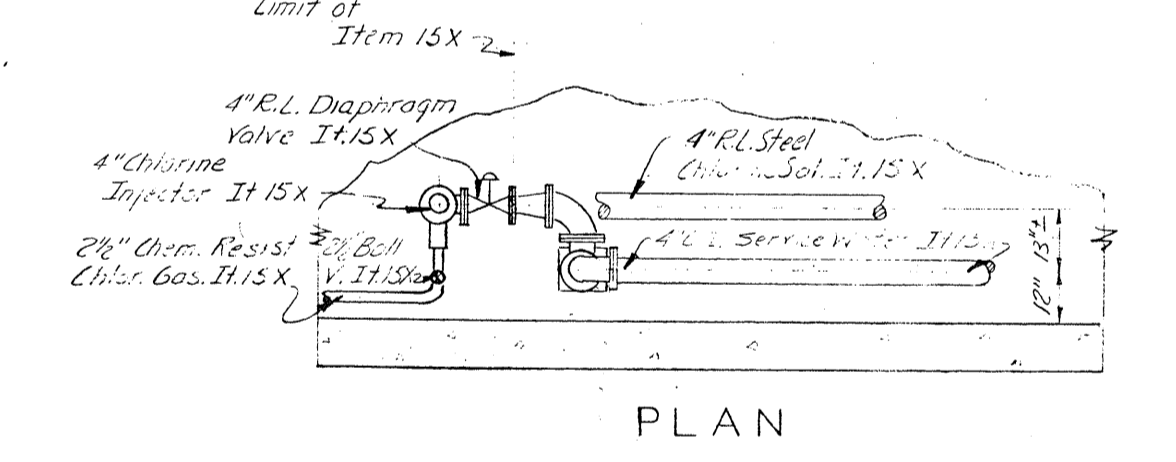
SCHEMATIC - SLUDGE
RETURN CONTROL
NO SCALE



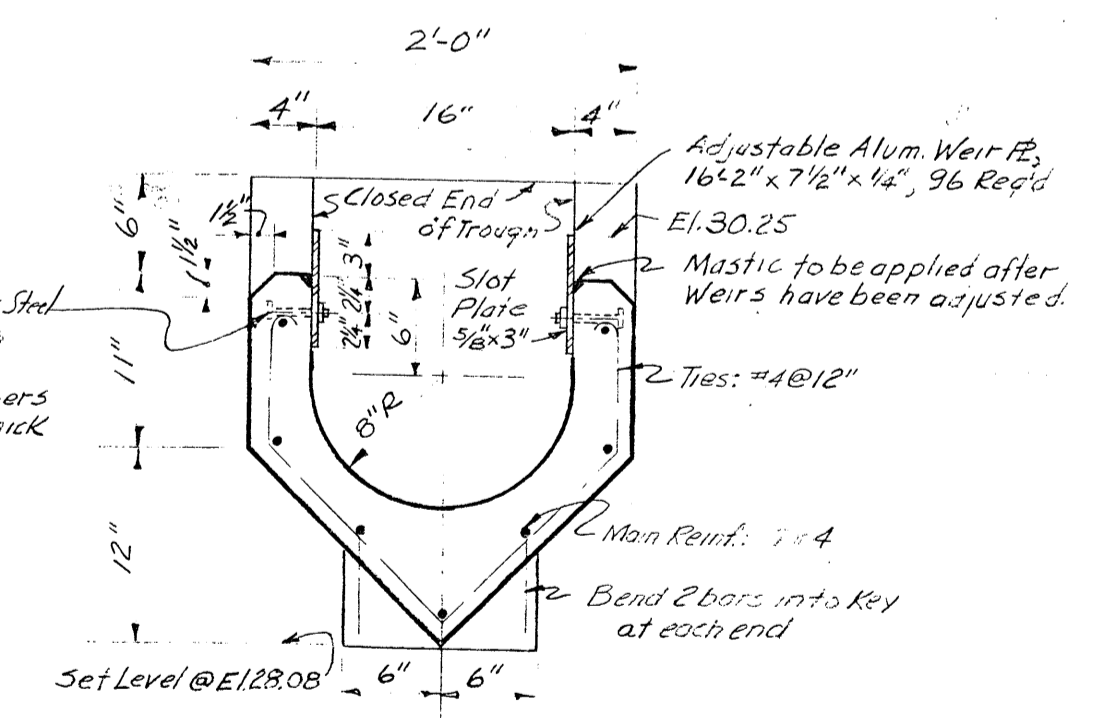
ROOF PLAN
GREASE CONTROL
BLDG
SCALE: 1/16" = 1'-0"



SECTION T1-T46
NO SCALE

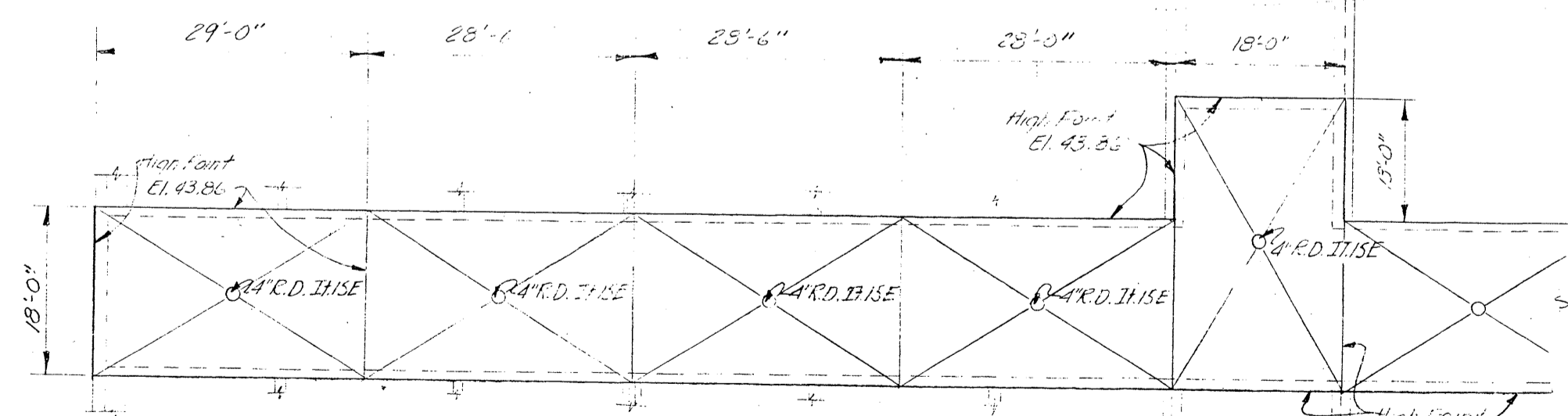


PIPE TUNNEL
NO SCALE

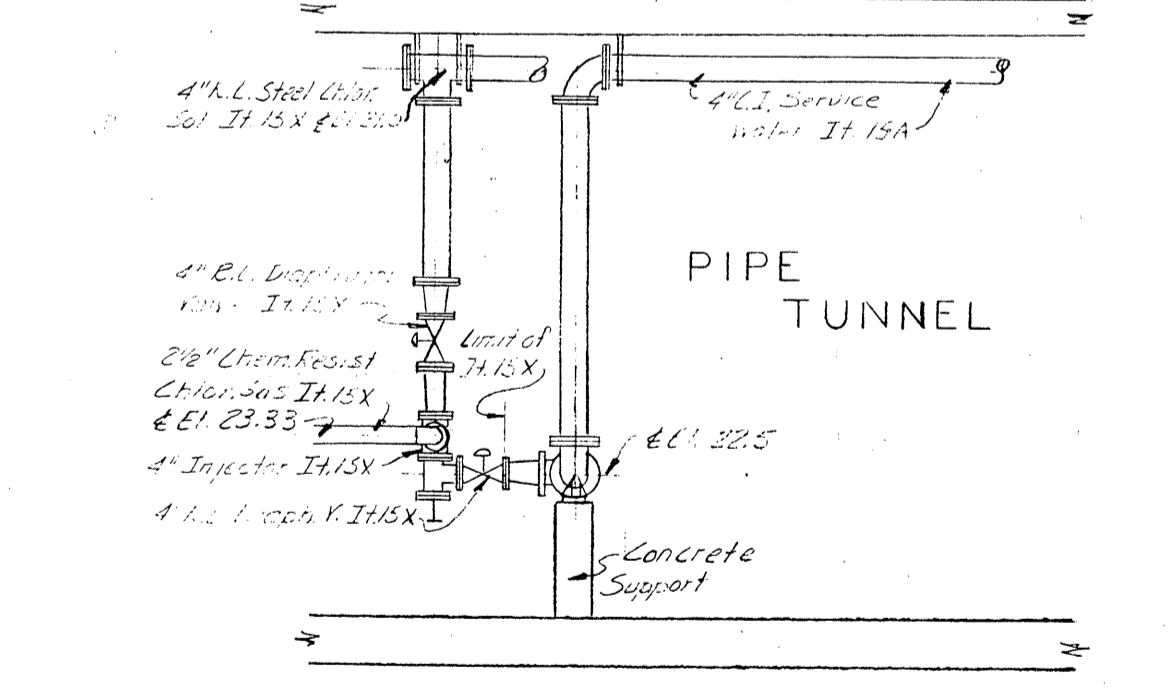


SECTION S1-S46 EFFLUENT WEIR TROUGH
48 REQUIRED
SCALE: 1" = 1'-0"

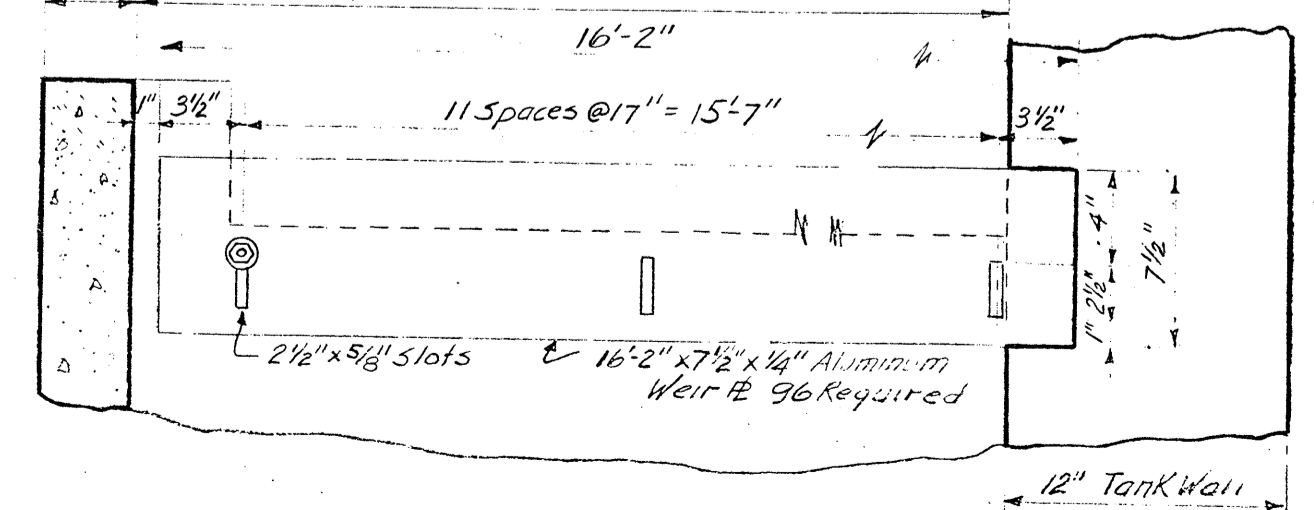
Note:
All washers shall be Stainless Steel
All Anchor Bolts and Nuts shall be Stainless Steel
After Trough is set level at the required elevation, it shall be grouted in position.
After Plates are set, saw opening between them and concrete with plastic. Troughs may be pre-cast or cast in place.
Material will be paid for under the respective items: Concrete, Item 3A1; Reinforcing Steel, Item 303; Alum. Weir Pl. & Stainless Steel Washers, Item 52; Stainless Steel Anchor Bolts and Nuts, Item 503.



PARTIAL ROOF PLAN
OPERATING GALLERY
SCALE: 1/16" = 1'-0"

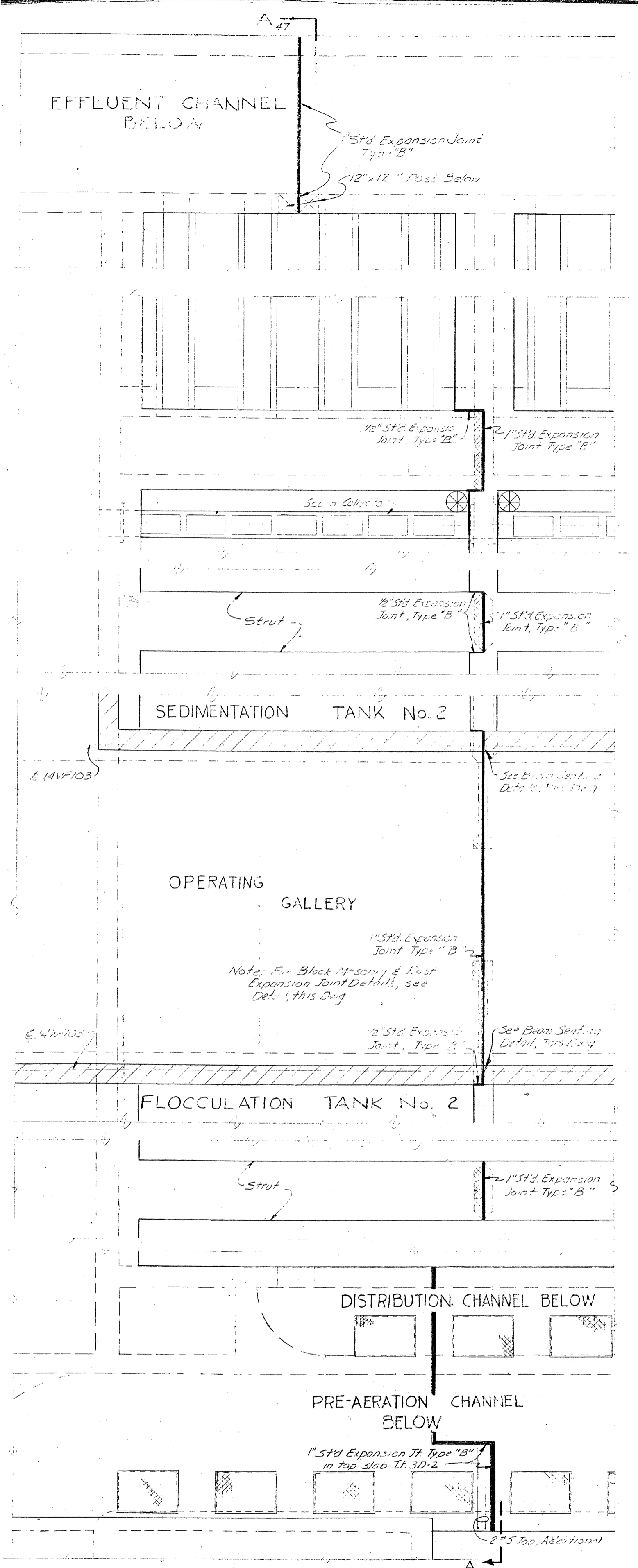


ELEVATION
CHLORINE INJECTOR
SCALE: 1/4" = 1'-0"

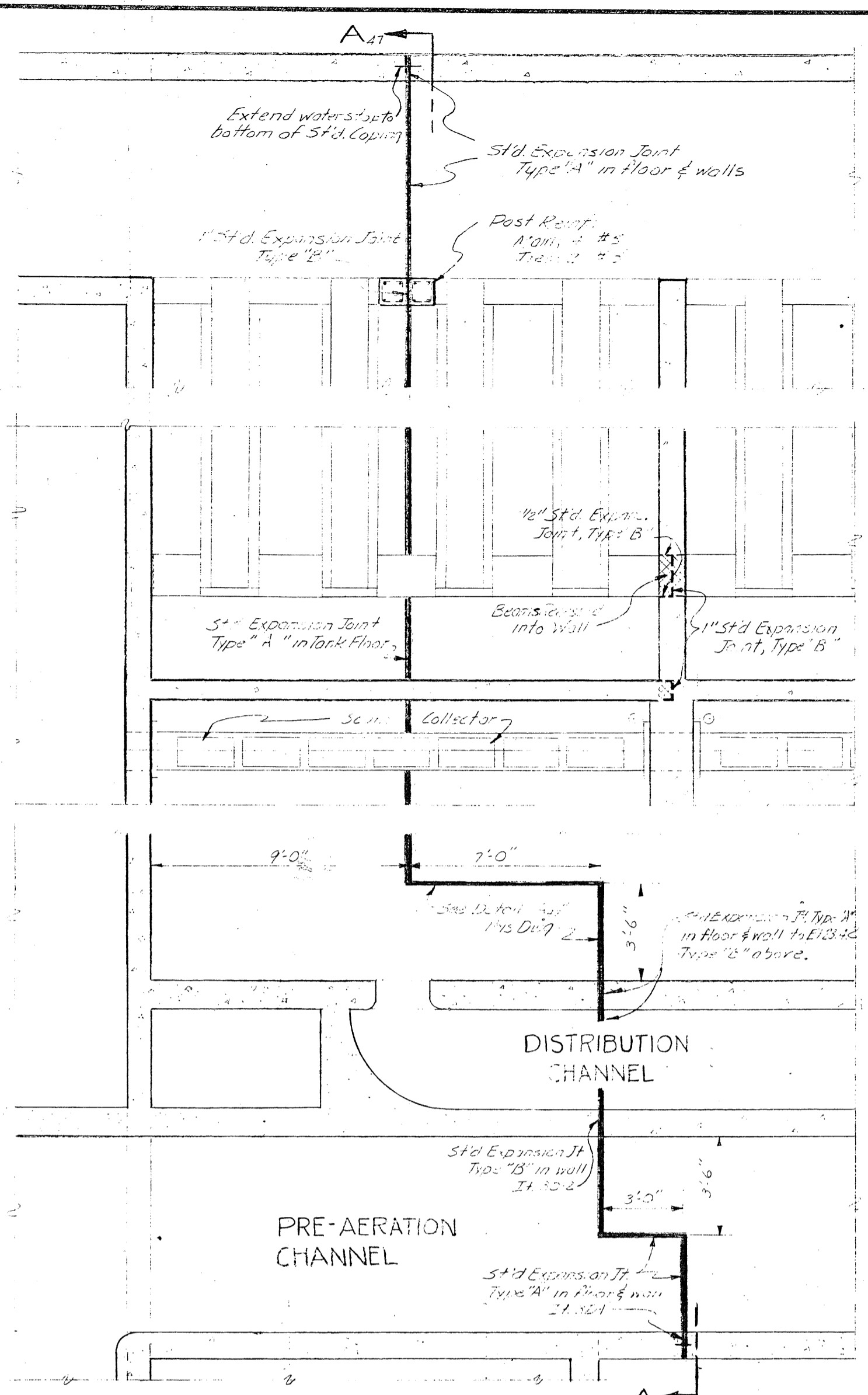


WEIR PLATE DETAIL
SCALE: 1/2" = 1'-0"

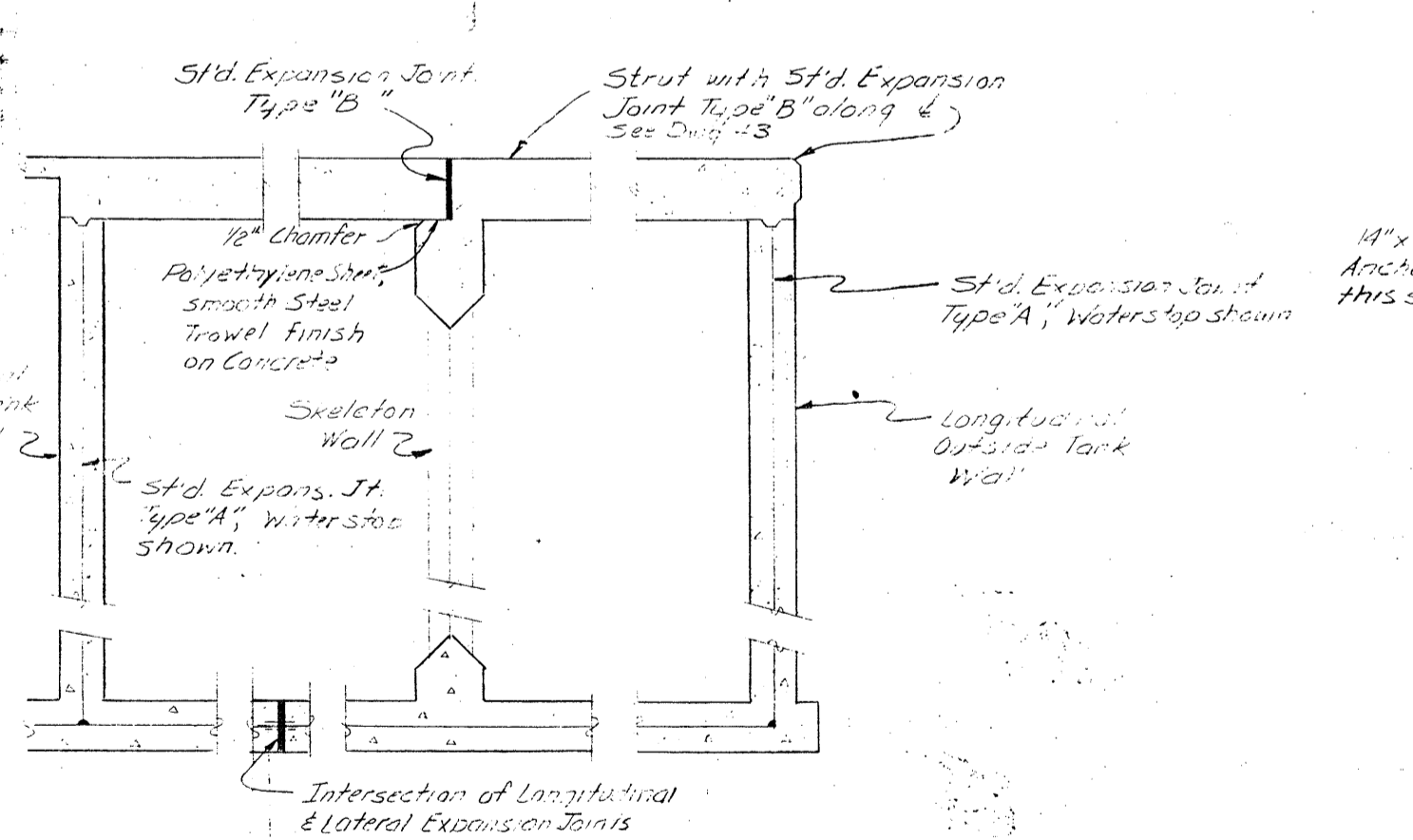
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REVISIONS			
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CHECKED BY: J.M.S. 121 SHEETS			
APPROVED BY: <i>[Signature]</i>			
HAVENS & EMERSON			
NEW YORK CLEVELAND			



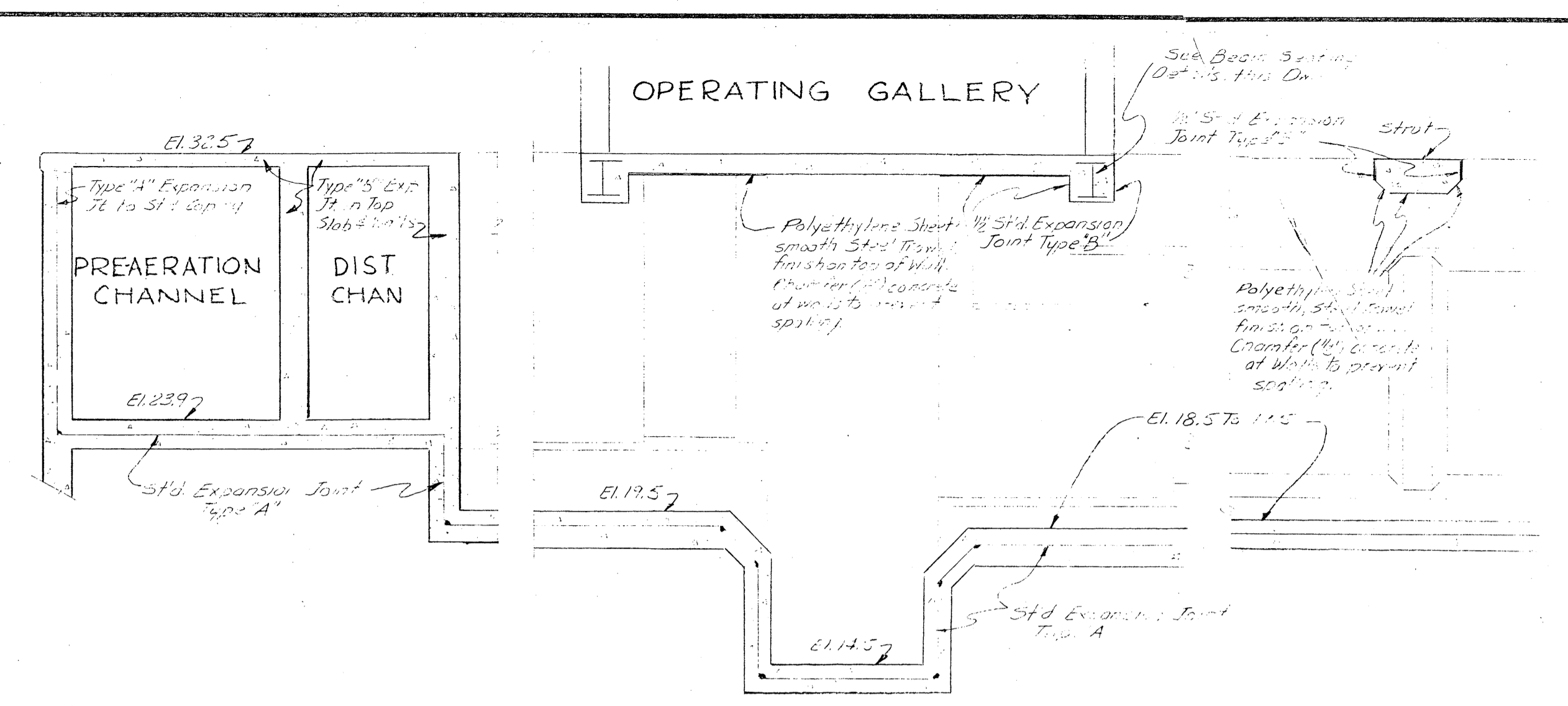
SECT. PLAN AT EL. 32.5
SCALE: 1/8"=1'-0"



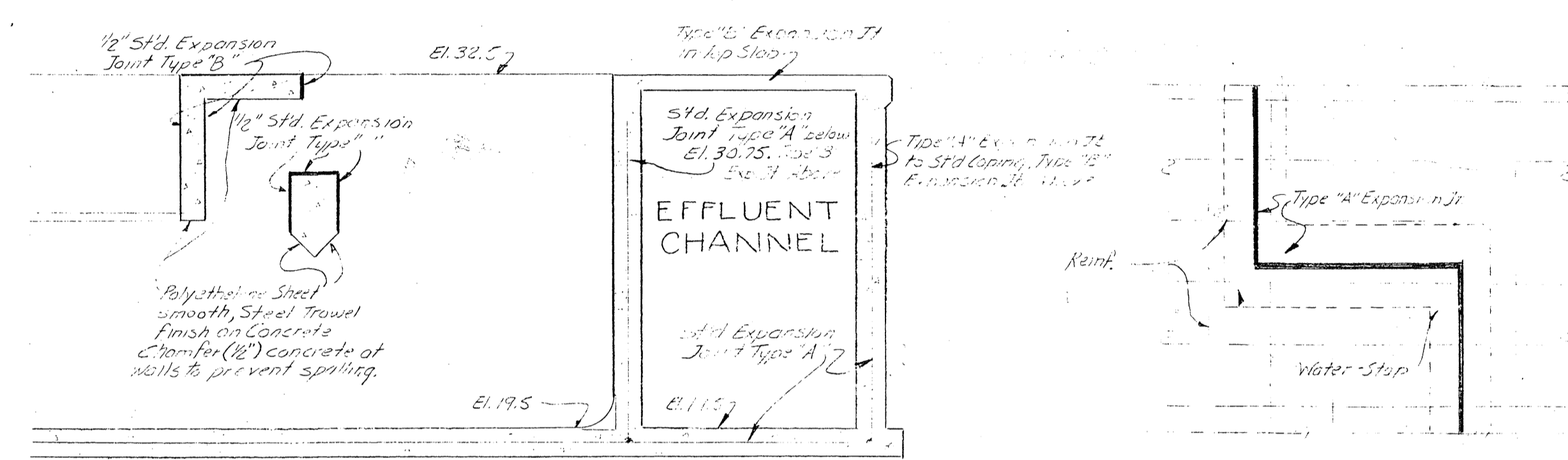
SECTIONAL PLAN AT EL. 31.5
SCALE: 1/8"=1'-0"



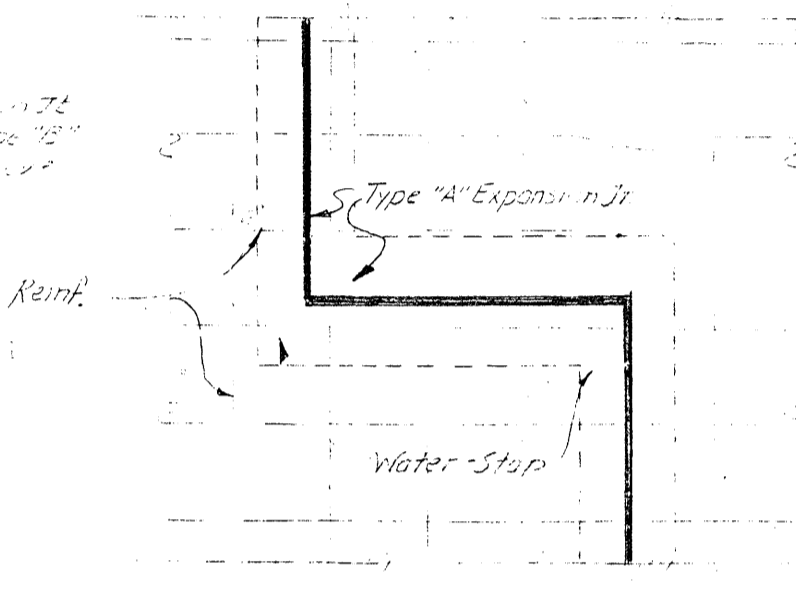
LATERAL JOINT DETAILS
SCALE: 1/4"=1'-0"



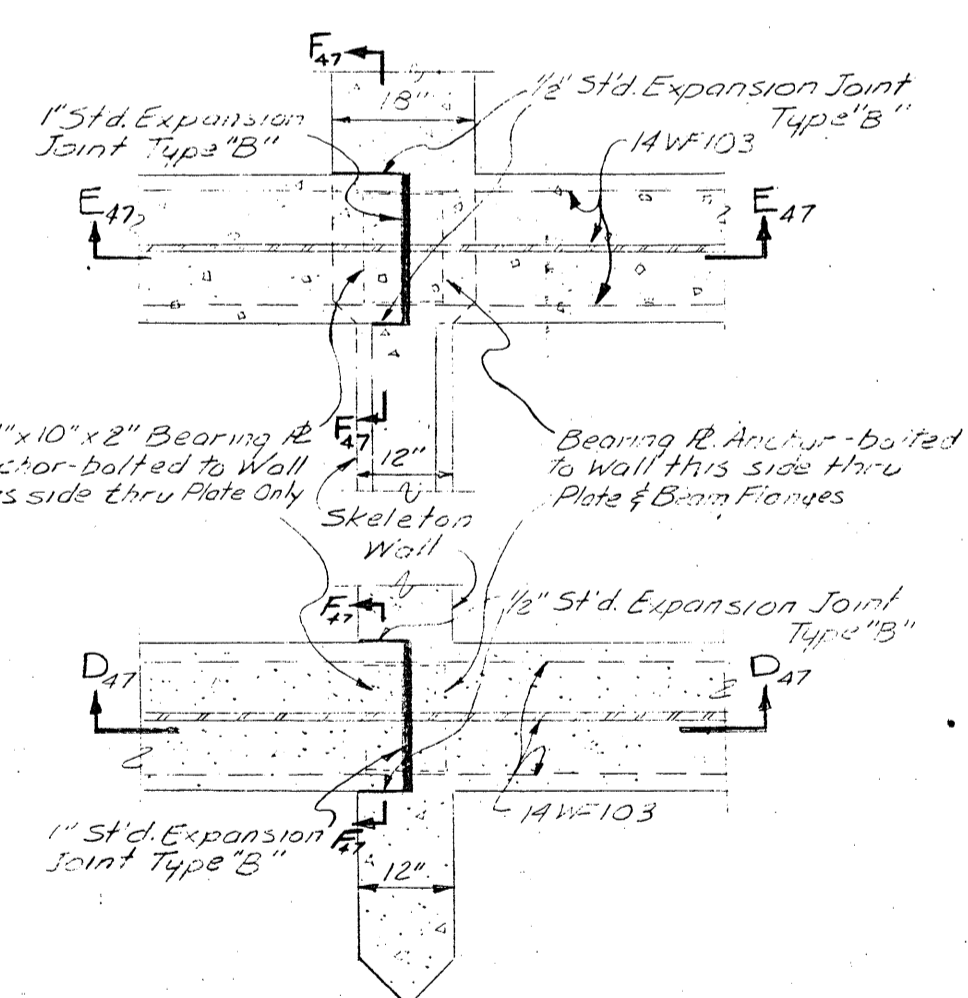
SECTION A-A
NO SCALE



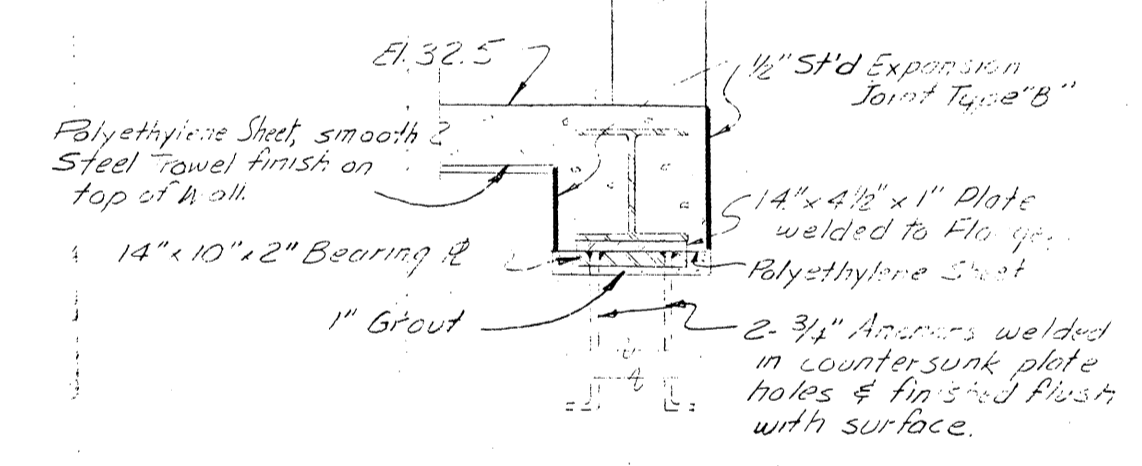
CONTINUATION SECTION A-A
NO SCALE



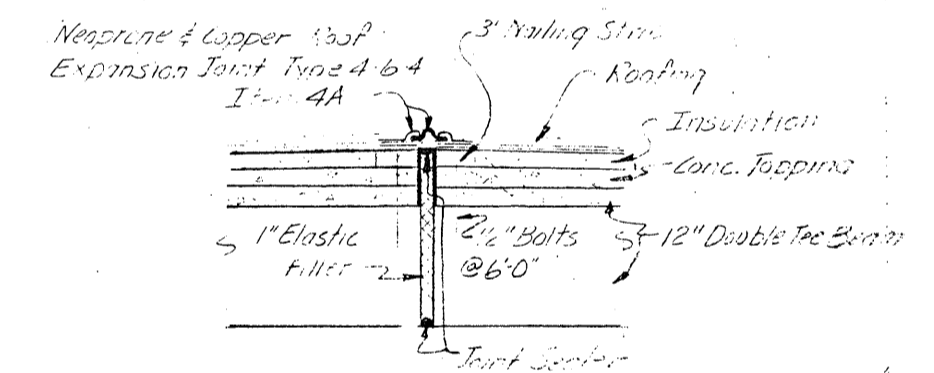
DETAIL "A"
NO SCALE



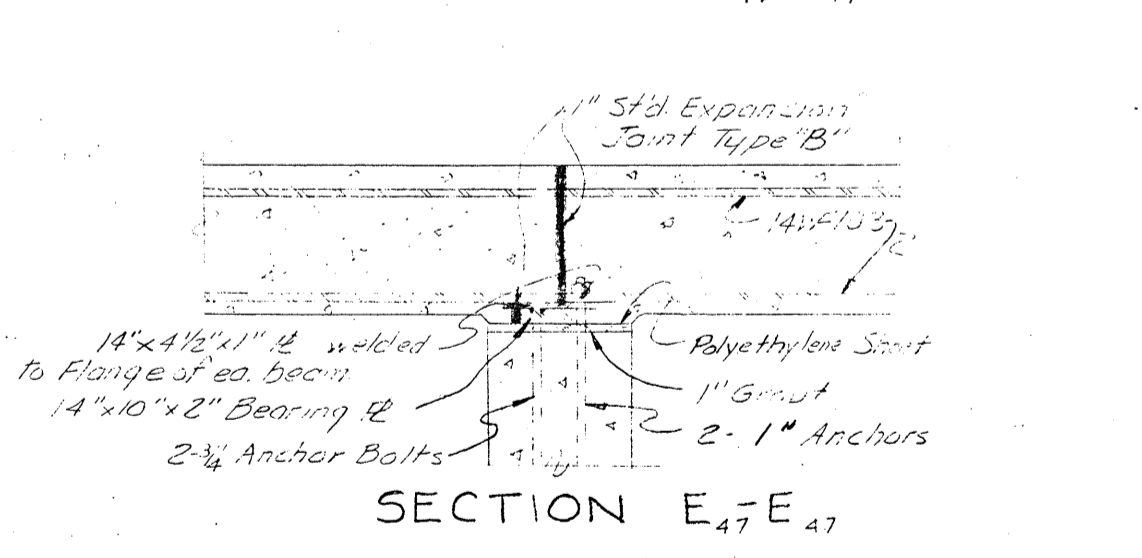
SECTIONAL PLAN @ EL. 31.5



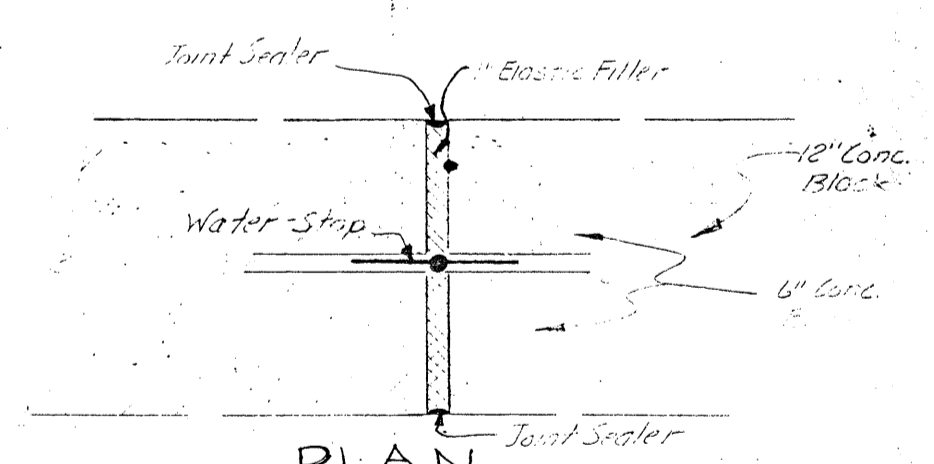
SECTION F-F



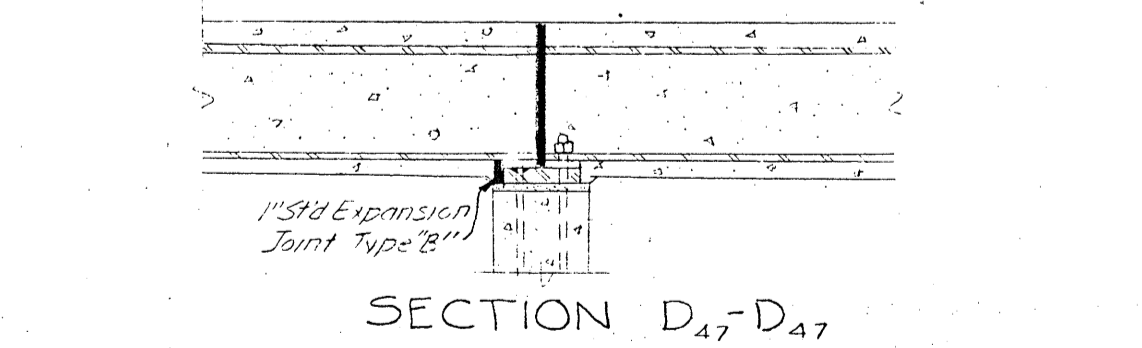
SECTION ROOF EXPANSION JOINT
ITEM 4A
NO SCALE



SECTION E-E



PLAN MASONRY EXPANSION JOINT
ITEM 4A
SCALE: 1/2"=1'-0"



SECTION D-D

BEAM SEATING DETAILS AT EXPANSION JOINTS

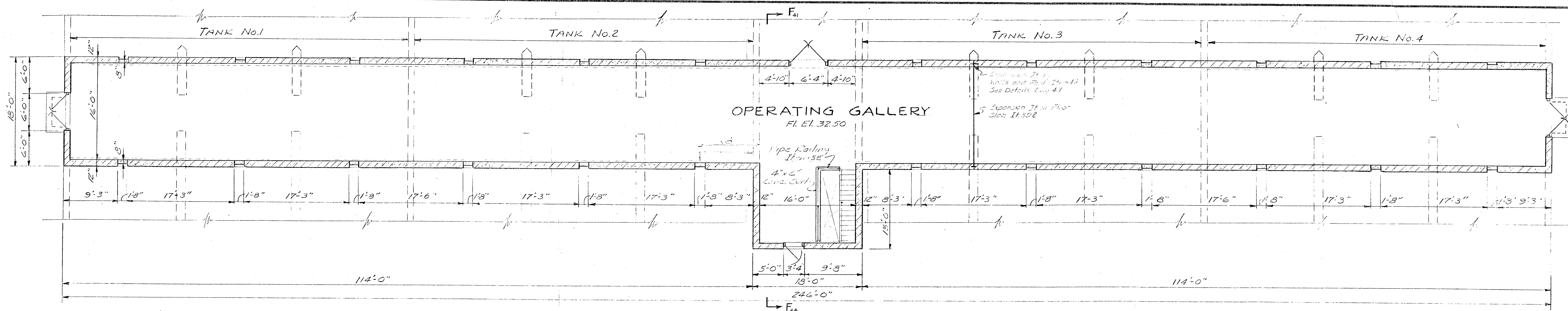
Note: See Dwg 43 for additional expansion joint details

NO.	DATE	ITEM	MADE BY
REVISIONS			
DRAWN BY: M.T.H.			
TRACED BY: M.T.H.			
CHECKED BY: J.H.H.			
APPROVED BY: <i>[Signature]</i>			
HAVENS & EMERSON NEW YORK CLEVELAND			

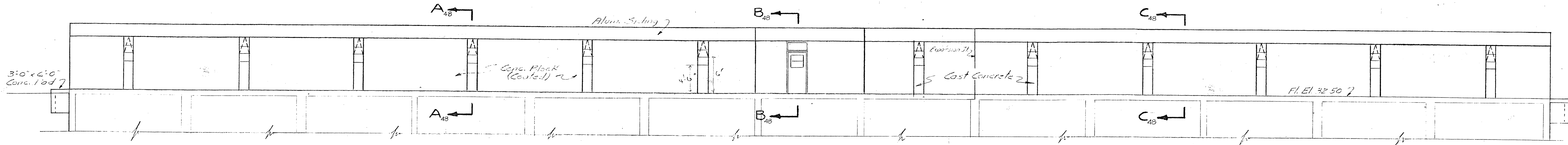
933-2-47
121 SHEETS

RECORD DWG. NO. 933-2-R47

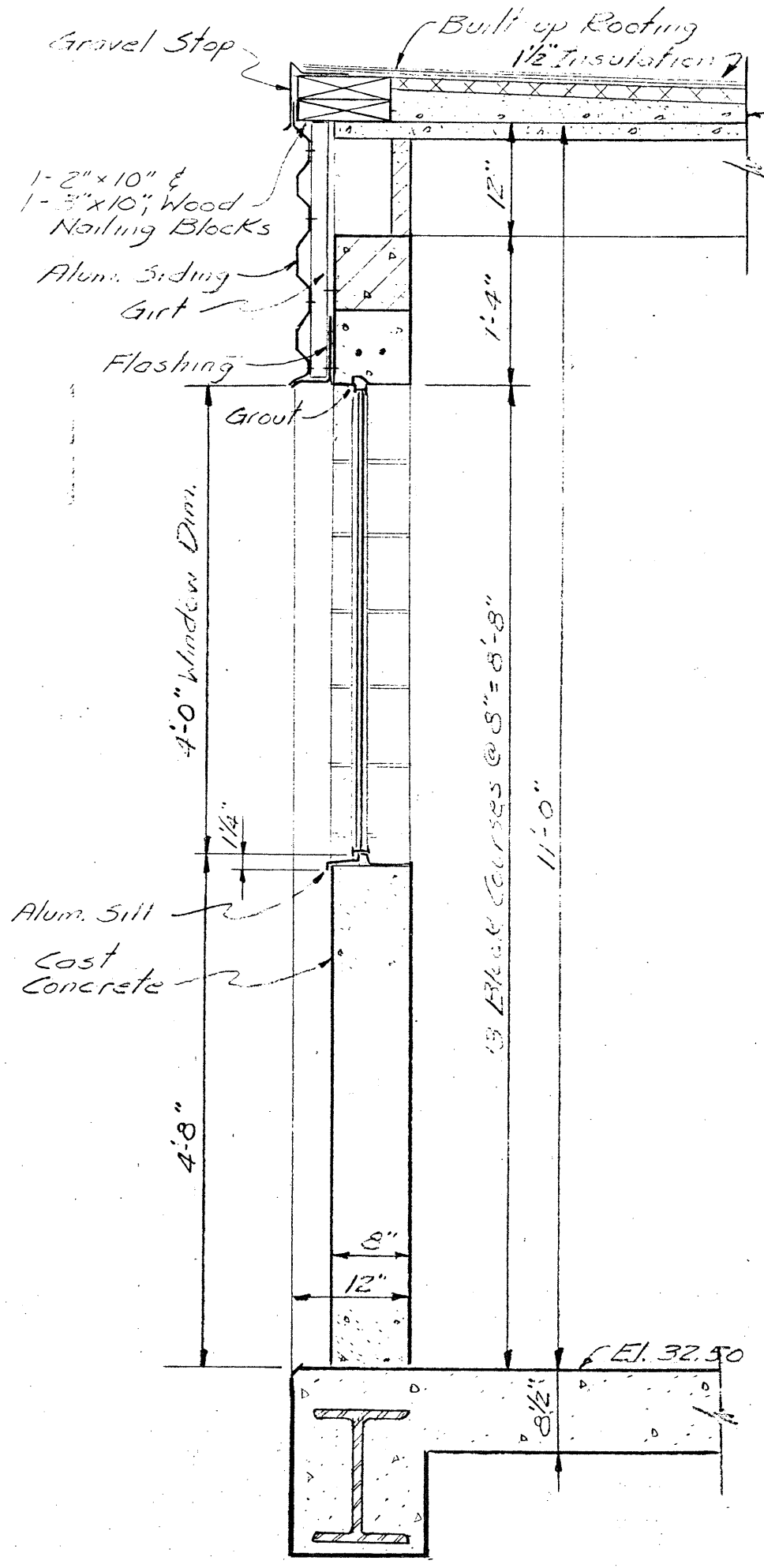
THE MATTABASSETT DISTRICT
CROMWELL, CONNECTICUT
WATER POLLUTION CONTROL PLANT
CONTRACT 2
FLOCCULATION & SETTLING TANKS
PLANS, SECTIONS AND DETAILS
SCALE: AS SHOWN
OCTOBER, 1965



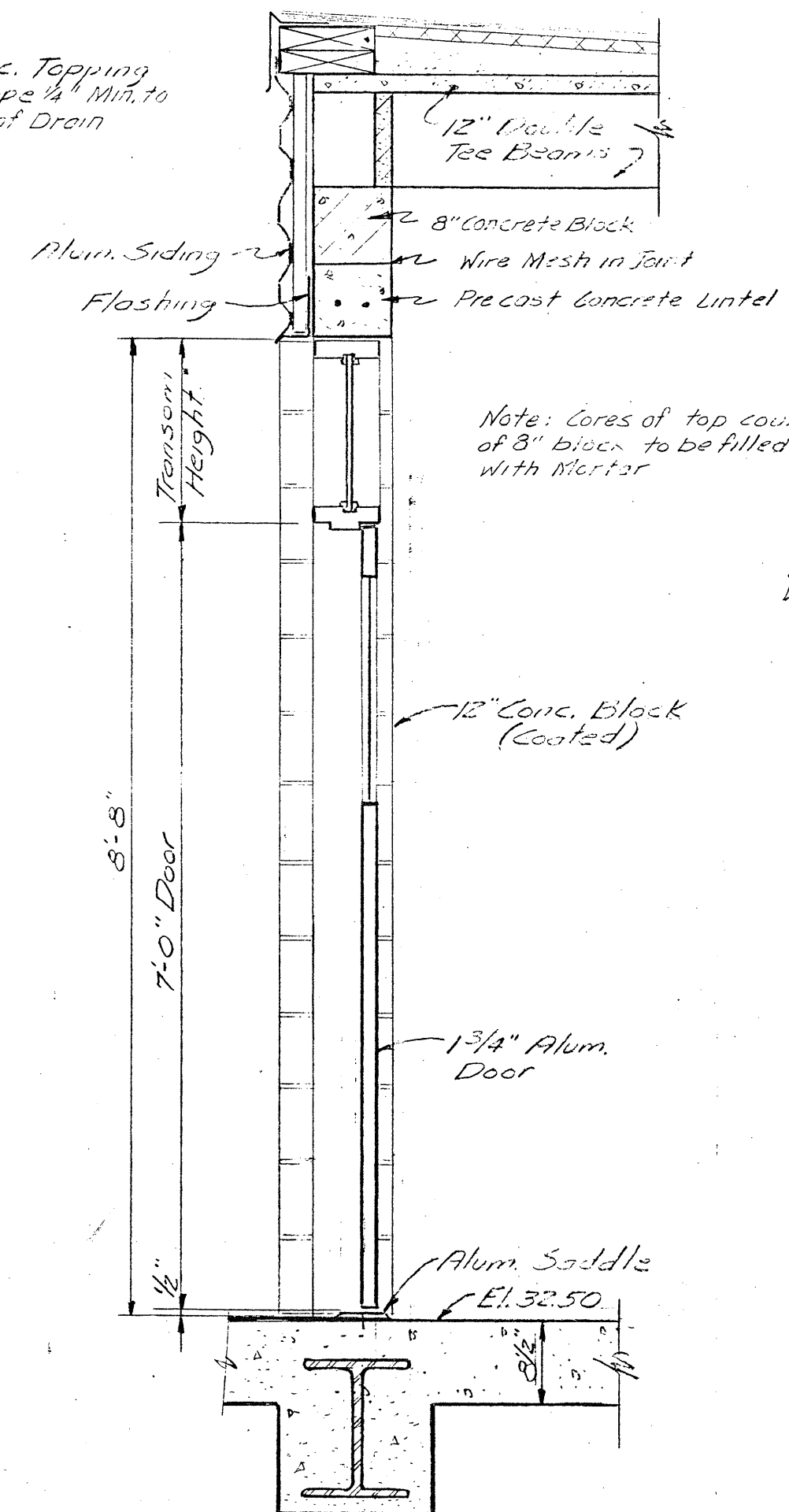
PLAN
Scale: 1/8" = 1'-0"



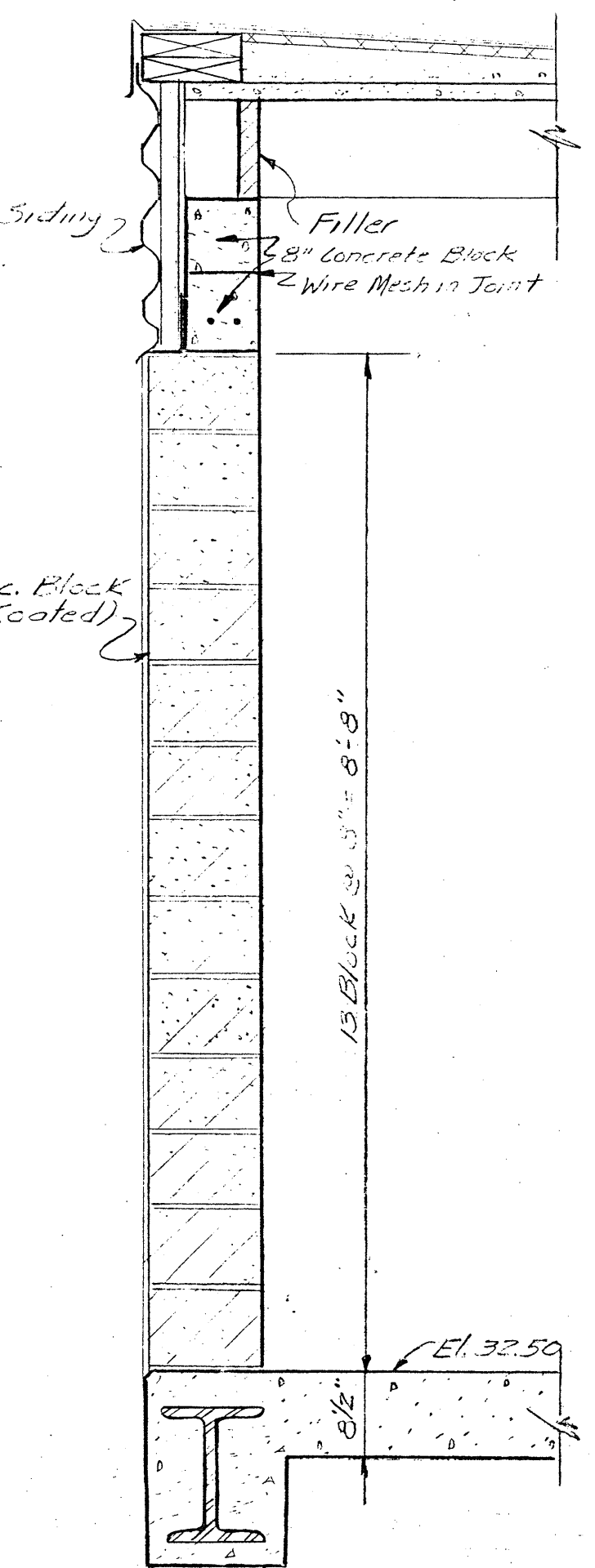
SOUTH ELEVATION
North Elevation Same Except Door Size and Location



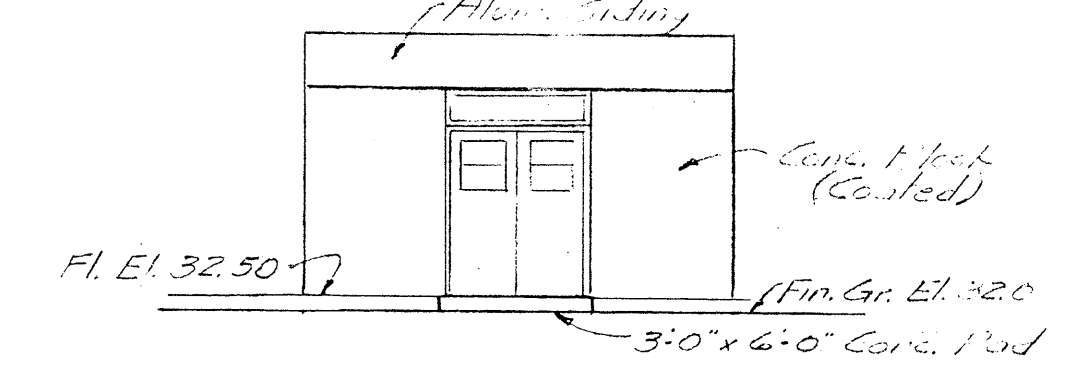
SECTION A-A
Scale: 3/4" = 1'-0"



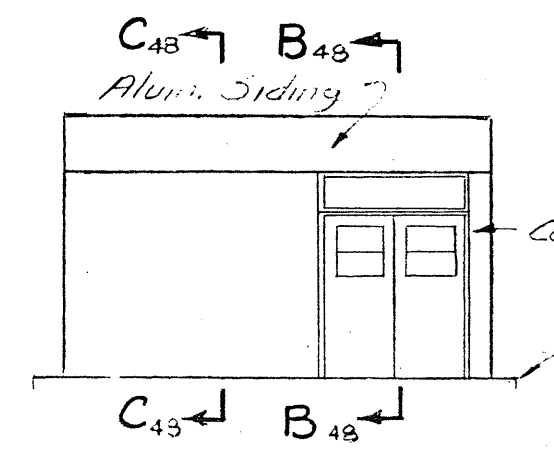
SECTION B-B
Scale: 3/4" = 1'-0"



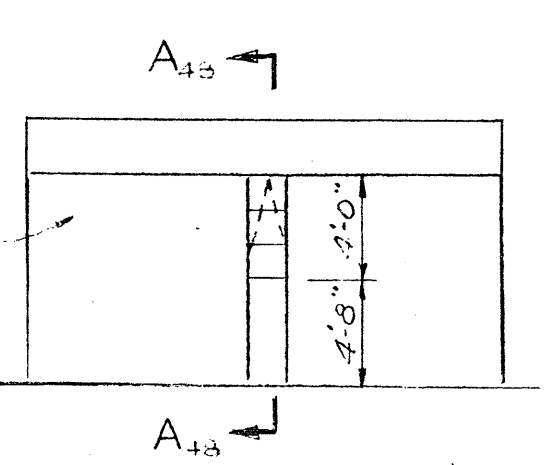
SECTION C-C
Scale: 3/4" = 1'-0"



EAST & WEST ELEVATION
OPERATING GALLERY
Scale: 1/8" = 1'-0"



NORTH ELEVATION
South Elevation Opposite Hand



EAST & WEST ELEVATION

GREASE CONTROL BUILDING
Scale: 1/8" = 1'-0"

RECORD DWG.
NO. 933-2-R48

NO.	DATE	ITEM	MADE BY
REVISIONS			
DRAWN BY: A.A.			
TRACED BY: G.A., M.T.H.			
CHECKED BY: J.W.S.			
APPROVED BY: <i>John S. Conway</i>			
HAVENS & EMERSON			
NEW YORK CLEVELAND			

933-2-48
121 SHEETS

THE MATTABASSETT DISTRICT
CROMWELL, CONNECTICUT
WATER POLLUTION CONTROL PLANT
CONTRACT 2

FLOCCULATION & SETTLING TANKS
ARCHITECTURAL ELEVATIONS & SECTIONS
SCALE: AS SHOWN
OCTOBER, 1965

32.50
1.67
30.83

R102

APPENDIX C
Tank Roll Up Door Shop Submittal

PLEASANT MOUNT WELDING, INC.

45 DUNDAFF STREET
CARBONDALE, PA 18407

(570) 282-6164 Phone
(570) 281-5931 DRAFTING FAX

LETTER OF TRANSMITTAL# 2

Submittal Date: 10/5/2017

Attn: Dan Tiso

RE: Mattabassett WPCF

PMWI Job: 17-3046

To: C.H. Nickerson and Co.
49 Haydon Hill Rd.

Torrington CT 06790

* NOTE:

MATERIAL WILL NOT BE RELEASED FOR FABRICATION WITHOUT WRITTEN AUTHORIZATION FROM THE CUSTOMER. PMWI drawings are per specs and contract drawings and will be detailed ONLY once. Changes will warrant a PMWI change order.

WE ARE SENDING YOU Attached Under separate cover via _____ the following items:

- Shop Drawings Prints Plans Samples Specifications
 Copy of Letter Change Order _____

Qty.	Dwg. Number	Content	Billing Code
	17-3046 0001	Primary Settling Tanks frames [A-1]	A
	17-3046 0001R	111 L/ft 2-line alum. guardrail w/gates	A-003
	17-3046 0002	10 Galv. steel bar frame braces	A-002
	17-3046 0002	8 Galv. steel tube roll up door frames	A-001
	17-3046 0002R	111 L/ft 2-line alum. guardrail w/gates	A-003
	17-3046 0003	10 Galv. steel bar frame braces	A-002
	17-3046 0003	8 Galv. steel tube roll up door frames	A-001
	17-3046 0004	10 Galv. steel bar frame braces	A-002
	17-3046 0004	8 Galv. steel tube roll up door frames	A-001
	17-3046 0005	10 Galv. steel bar frame braces	A-002
	17-3046 0005	8 Galv. steel tube roll up door frames	A-001
	17-3046 ASD2	Mount Details	SD

THESE ARE TRANSMITTED as checked below:

- For Approval For Your Use As Requested For Review and Comment
 Approved as Submitted Approved as Noted Resubmit _____ Copies for Approval

REMARKS:

Signature SP

Checker: VB

If Enclosures are not noted, kindly notify us at once.

PLEASANT MOUNT WELDING, INC.

45 DUNDAFF STREET
CARBONDALE, PA 18407

(570) 282-6164 Phone
(570) 281-5931 DRAFTING FAX

LETTER OF TRANSMITTAL# 2

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Attn: Dan Tiso

RE: Mattabassett WPCF

PMWI Job: 17-3046

To: C.H. Nickerson and Co.
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Torrington CT 06790

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WE ARE SENDING YOU Attached Under separate cover via _____ the following items:

- Shop Drawings Prints Plans Samples Specifications
 Copy of Letter Change Order _____

Qty.	Dwg. Number	Content	Billing Code
	17-3046 MA2SD1	Typical Detail Pages	SD

THESE ARE TRANSMITTED as checked below:

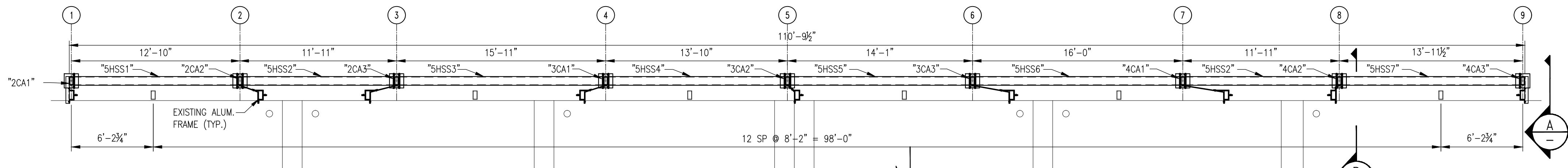
- For Approval For Your Use As Requested For Review and Comment
 Approved as Submitted Approved as Noted Resubmit _____ Copies for Approval

REMARKS:

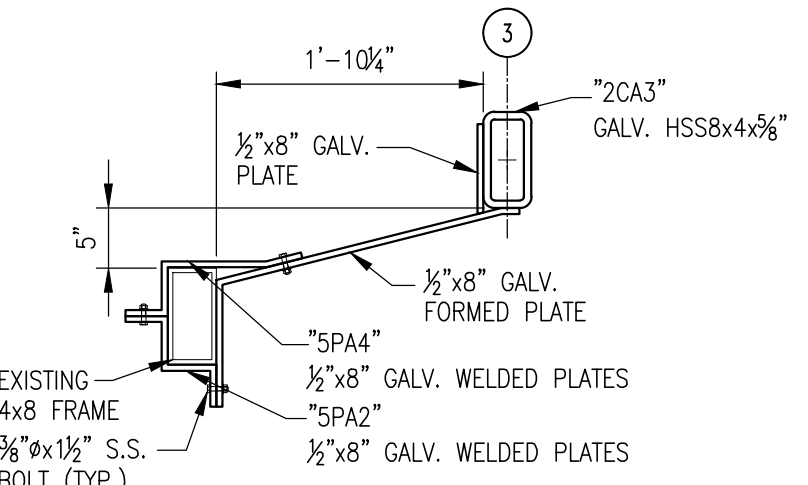
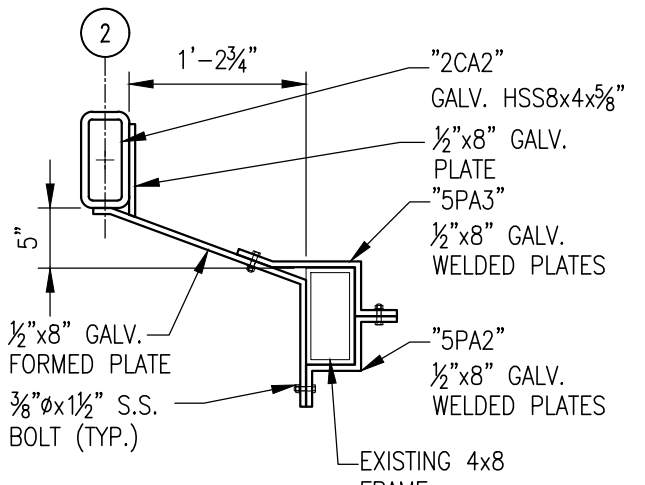
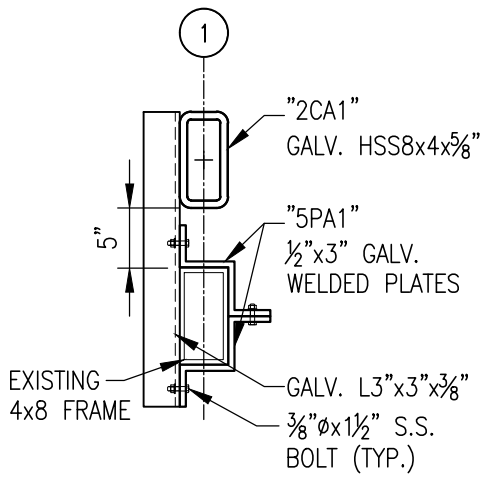
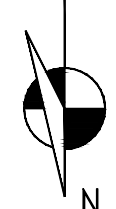
Signature SP

Checker: VB

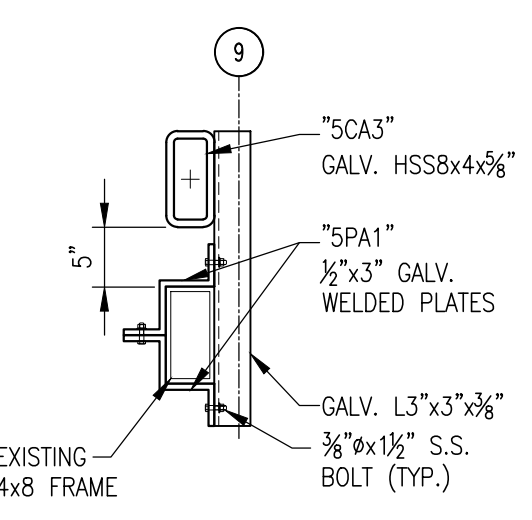
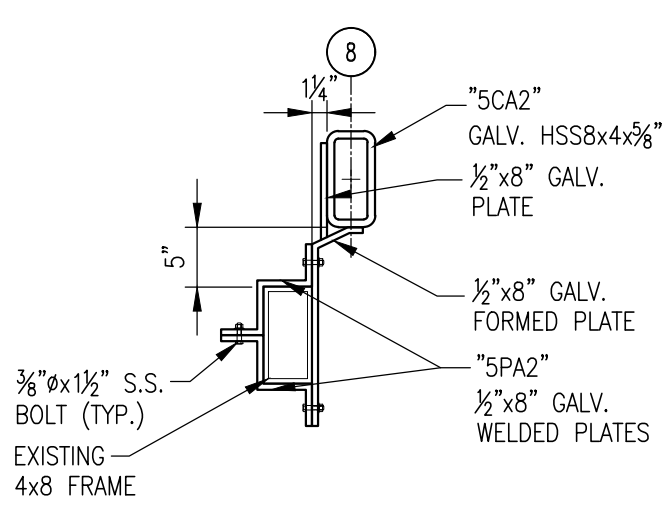
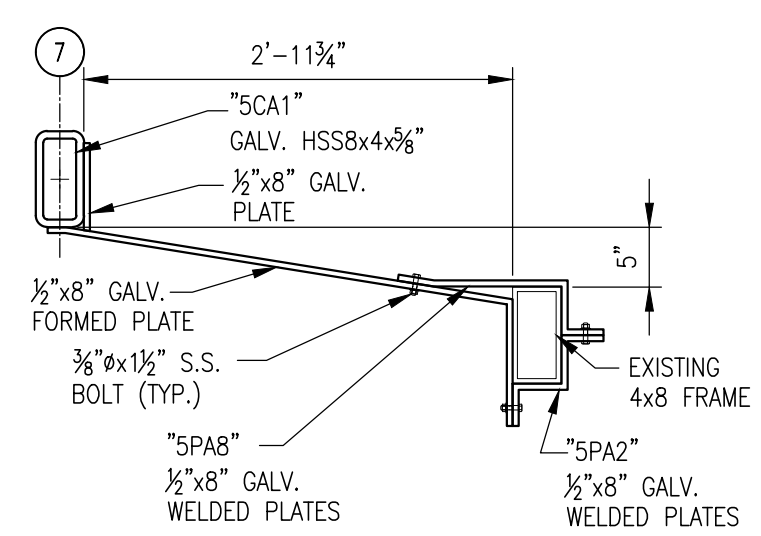
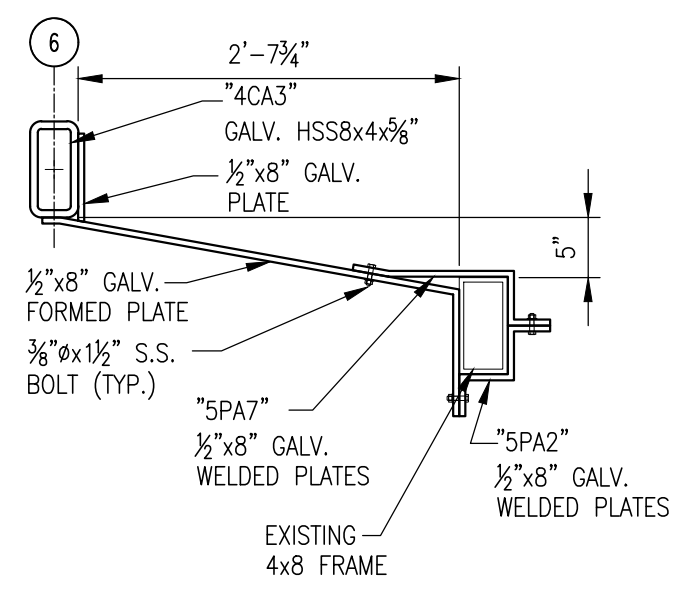
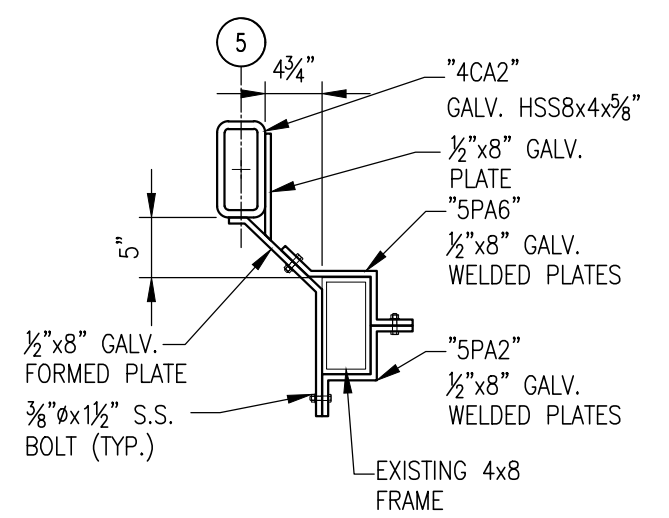
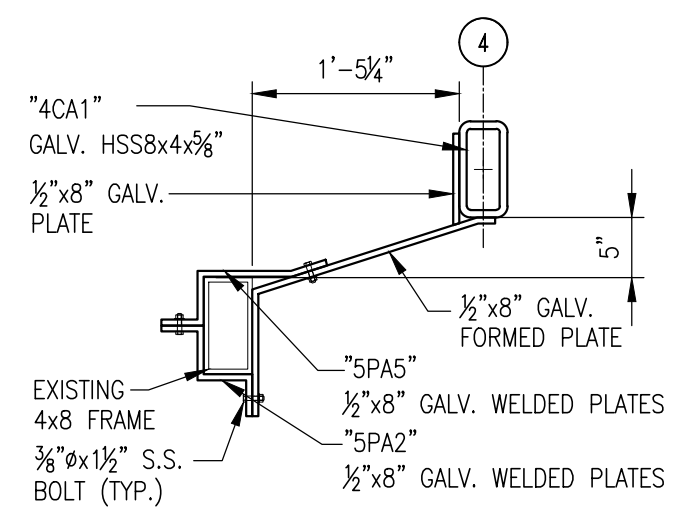
If Enclosures are not noted, kindly notify us at once.



DOOR LAYOUT PLAN
 NOTE: HANDRAIL NOT SHOWN FOR CLARITY.
 HANDRAIL DETAILED SEPARATELY. SEE P.M.W.I.
 SHEET 17-3046-0001R FOR HANDRAIL DETAILS.

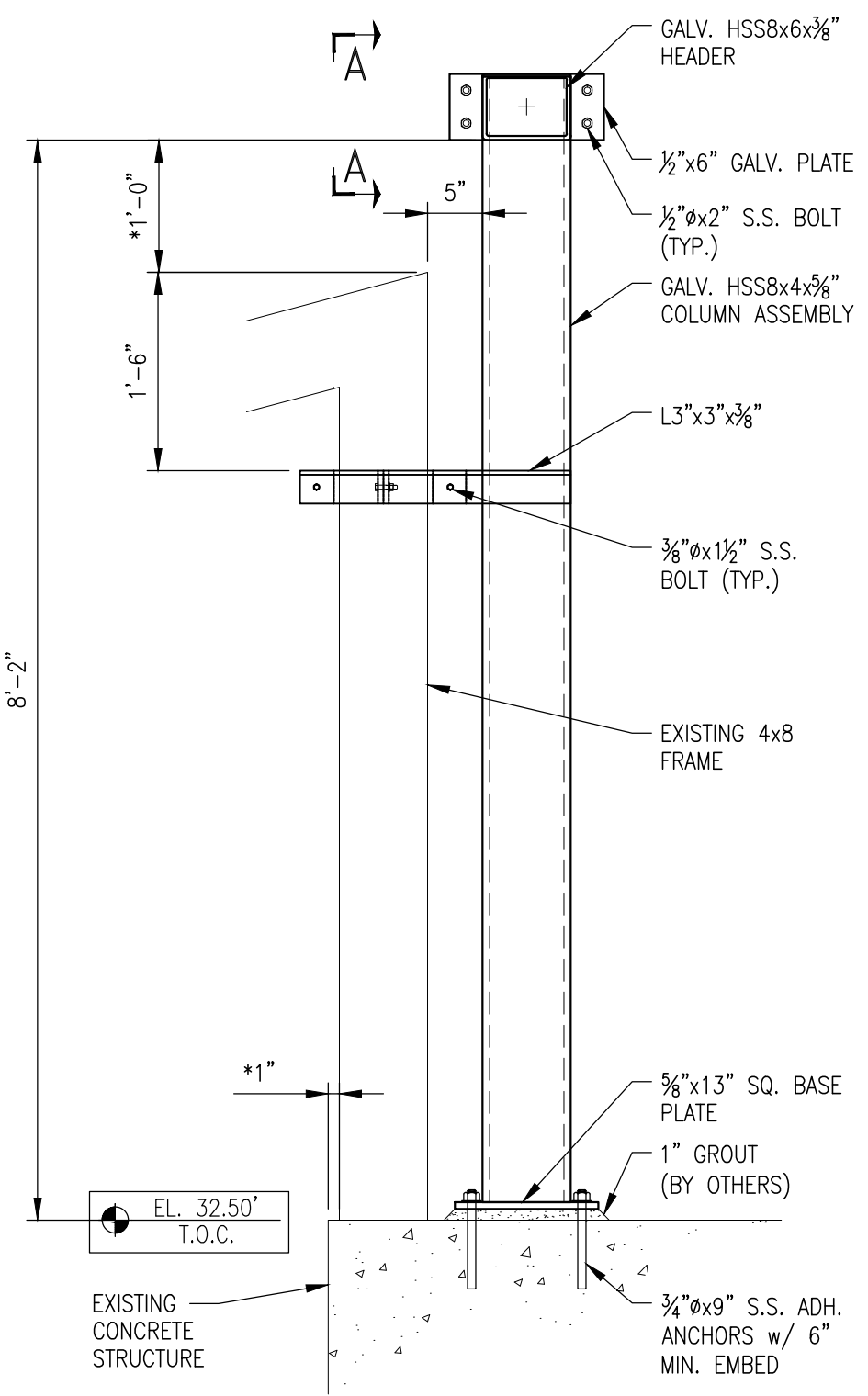


GC NOTE:
 CONFIRM ORIENTATION OF
 L3"x3"x3/8" BRACE AS SHOWN
 @ COLUMNS 1 & 9

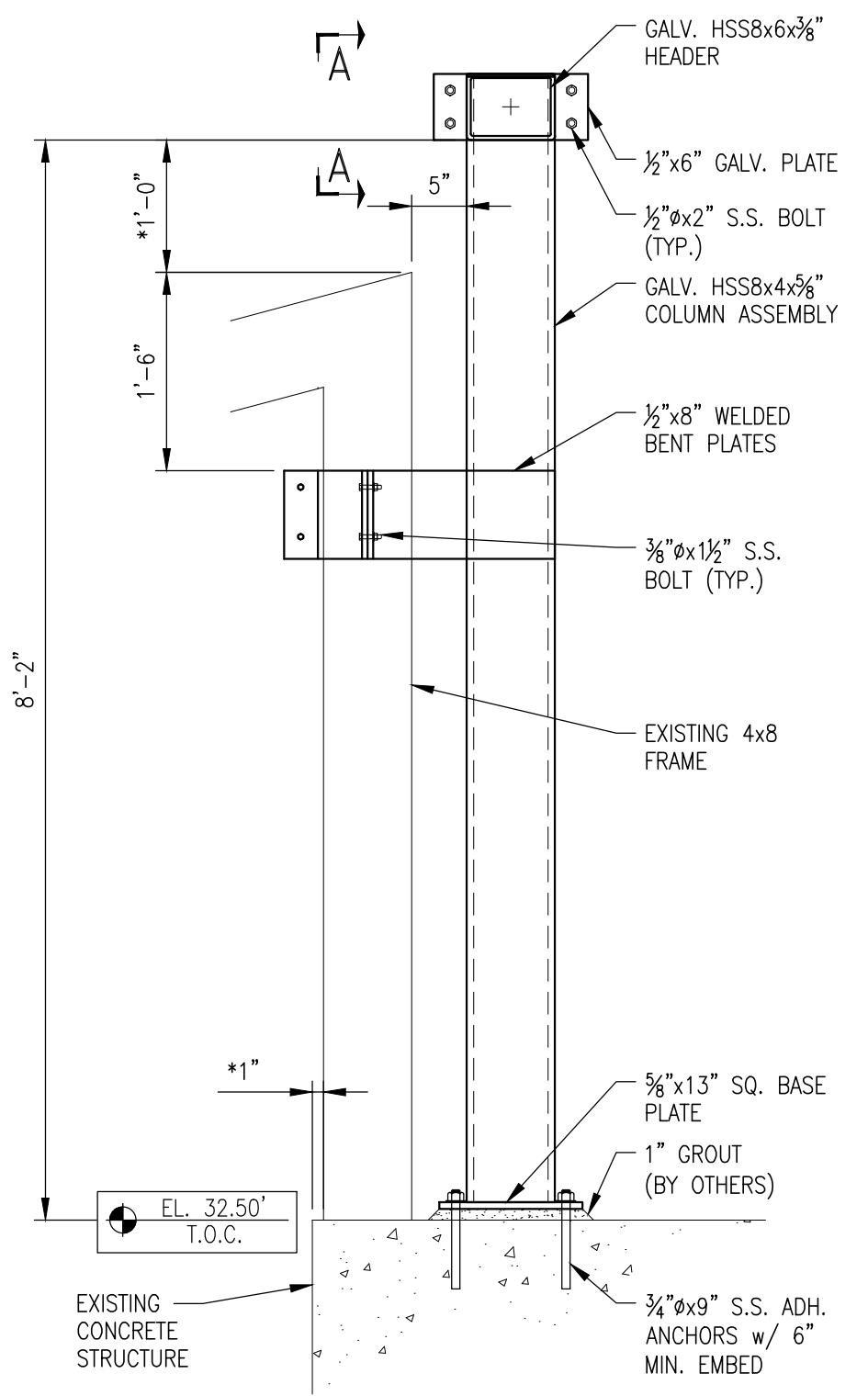


ENLARGED COLUMN ATTACHMENT PLANS

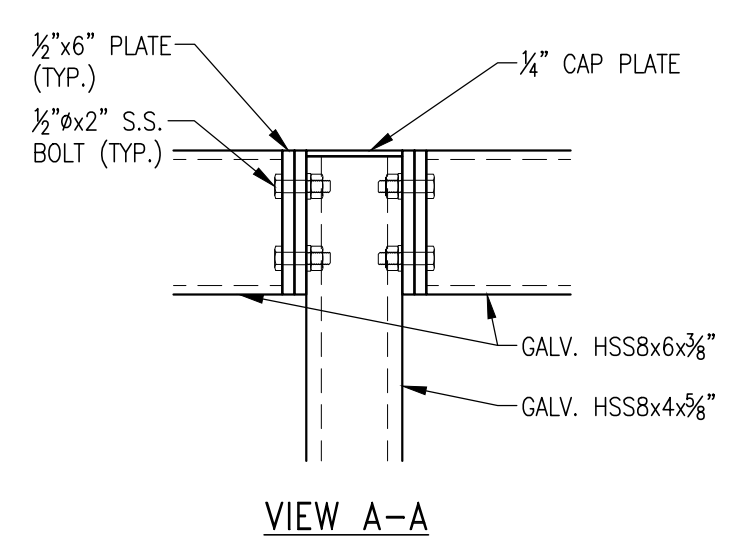
* GC TO FIELD VERIFY
 DIMENSIONS PRIOR TO
 FABRICATION



SECTION A



SECTION B



VIEW A-A

PHONE: (570) 282-6164 FAX: (570) 281-5931
PLEASANT MOUNT WELDING, INC.
 45 DUNDAFF STREET
 CARBONDALE, PA. 18407
 STATE OF N.J. CERT. OF AUTH.: 24GA28256200
 VISIT US ON THE WEB @ www.pmw.net

#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.
 TITLE: PRIMARY SETTLING TANKS REF. C'TRACT DWG.- A-1, S-1
GALV. STEEL DOOR FRAMES -PLAN & SECTIONS

TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	CO	9/29/17	BF	10/5/17	17-3046-0001	

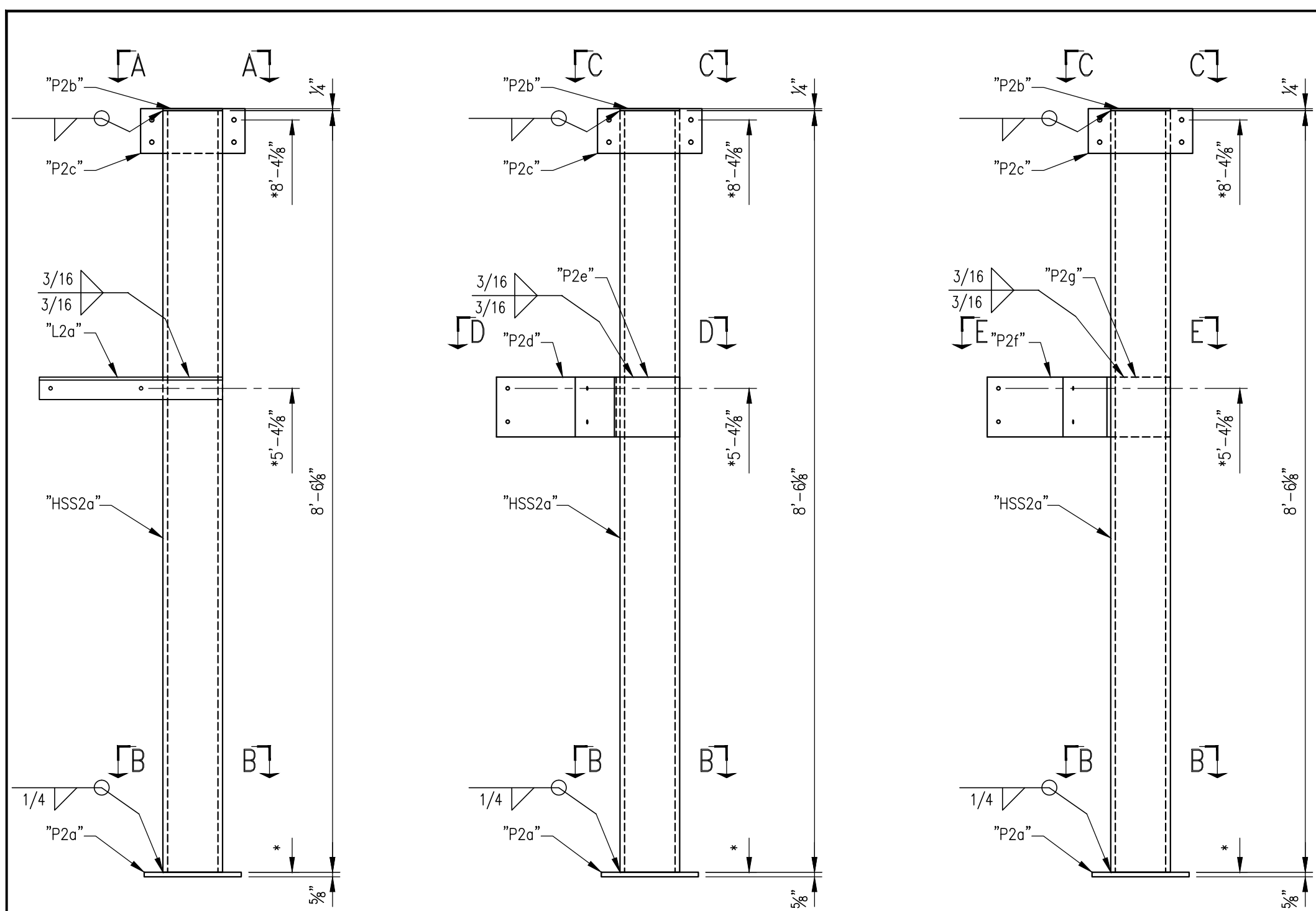
APPROVAL AUTHORITY: VERIFICATION OF DIMENSIONS, DETAILS, ETC ARE REQUESTED WHERE INDICATED. IF EACH VERIFICATION IS NOT NOTED OTHERWISE, IT WILL BE ASSUMED CORRECT AS SHOWN.

THE ENGINEER OF RECORD HAS THE FINAL AND TOTAL RESPONSIBILITY FOR THE ADEQUACY AND SAFETY OF THE STRUCTURE. SINCE HE IS THE ONLY PERSON WHO HAS ALL THE INFORMATION NECESSARY TO EVALUATE THE TOTAL IMPACT OF THE CONNECTION DETAILS ON THE STRUCTURAL DESIGN.

ADDITIONAL COSTS ASSOCIATED WITH FIELD MODIFICATIONS TO ITEMS ON THIS SHEET WILL NOT BE ACCEPTED WITHOUT WRITTEN AUTHORIZATION FROM PMWI TO PROCEED.

TOLERANCE(S) FOR ITEMS DETAILED ON THIS SHEET THAT ARE NOT APPLICABLE TO, OR GOVERNED BY AISC CODE, NAIMM STANDARDS, THE ALUMINUM ASSOC., WILL BE PROVIDED ON REQUEST.

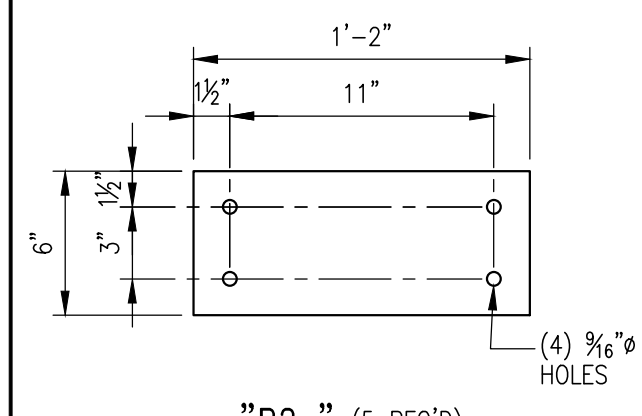
PMWI'S SHOP DRAWINGS ARE PRODUCED PER SPECIFICATIONS & CONTRACT DRAWINGS AND WILL BE DETAILED ONLY ONCE. ANY ADDITIONAL ALTERATIONS OR CHANGES WILL WARRANT A CHANGE ORDER TO PMWI.



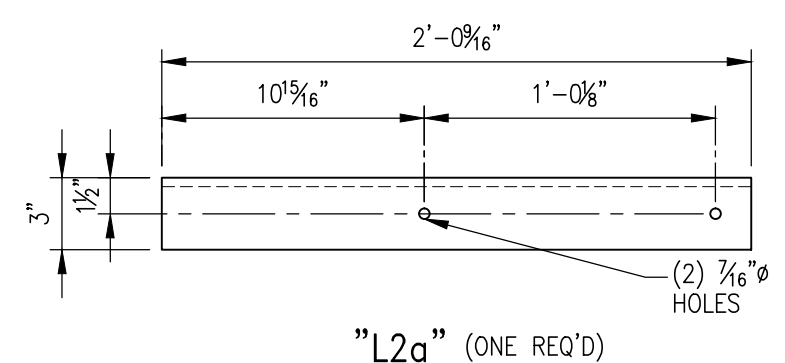
"2CA1" (ONE REQ'D)
BILLING CODE: A-1

"2CA2" (ONE REQ'D)
BILLING CODE: A-1

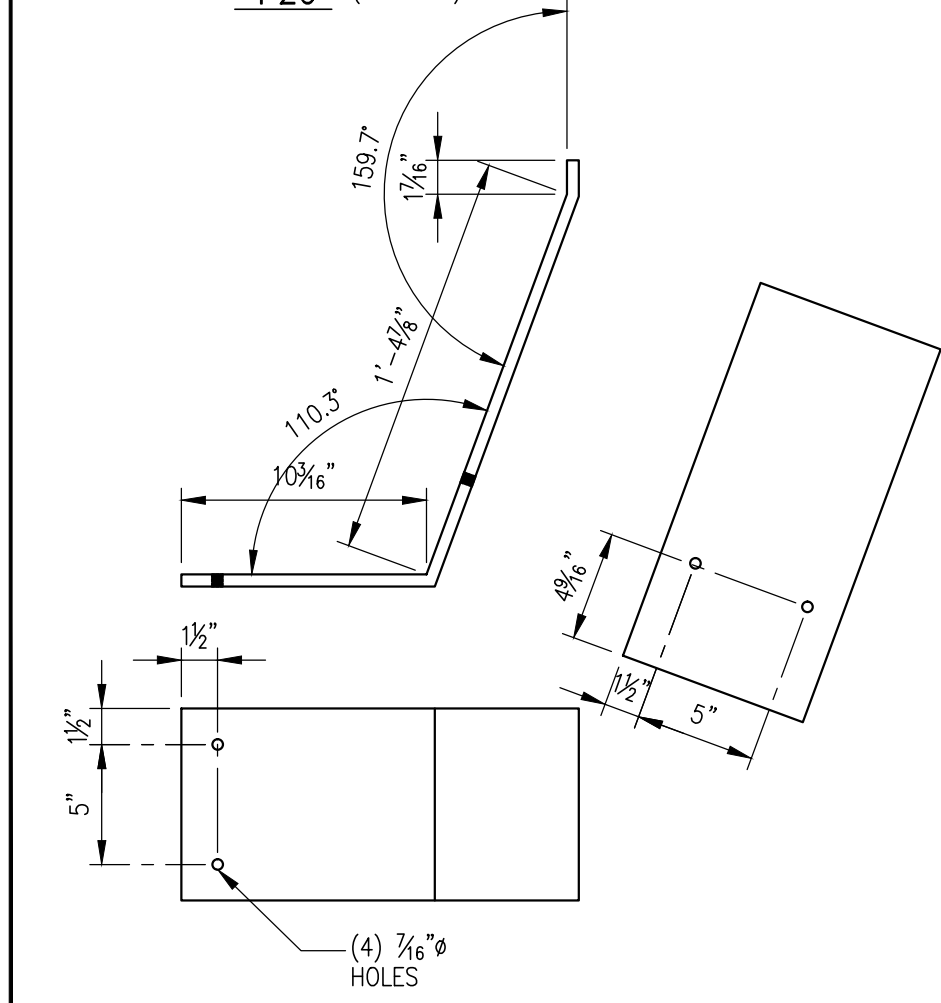
"2CA3" (ONE REQ'D)
BILLING CODE: A-1



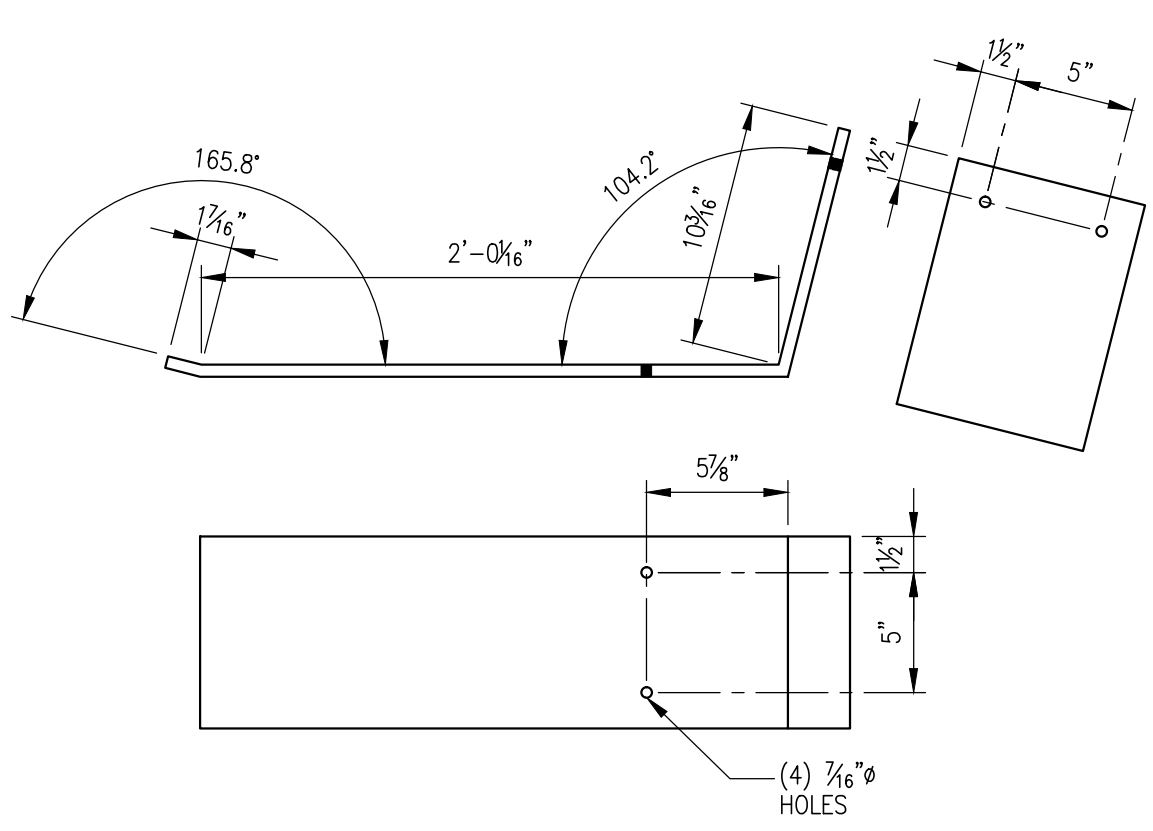
"P2c" (5 REQ'D)



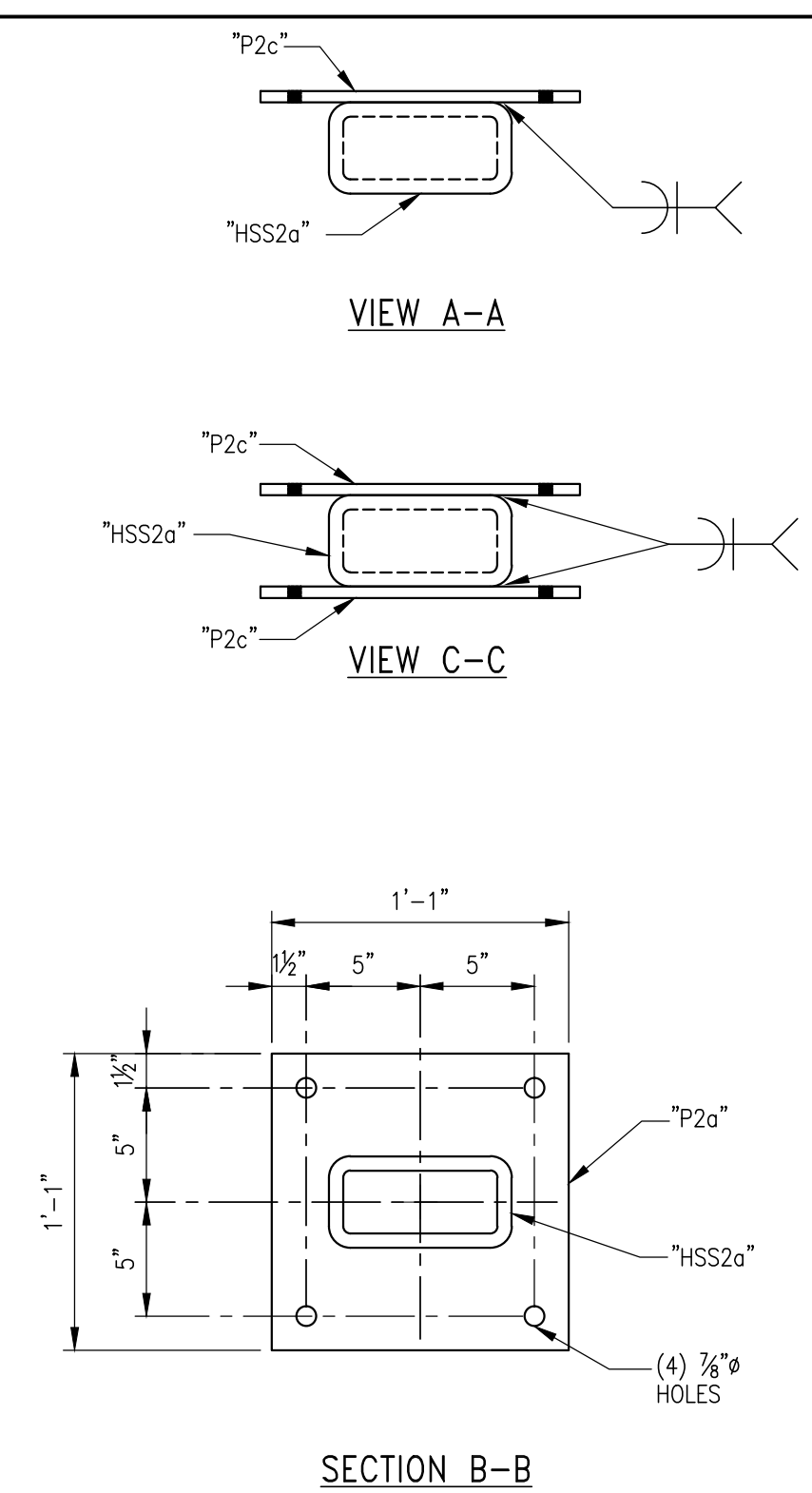
"L2a" (ONE REQ'D)



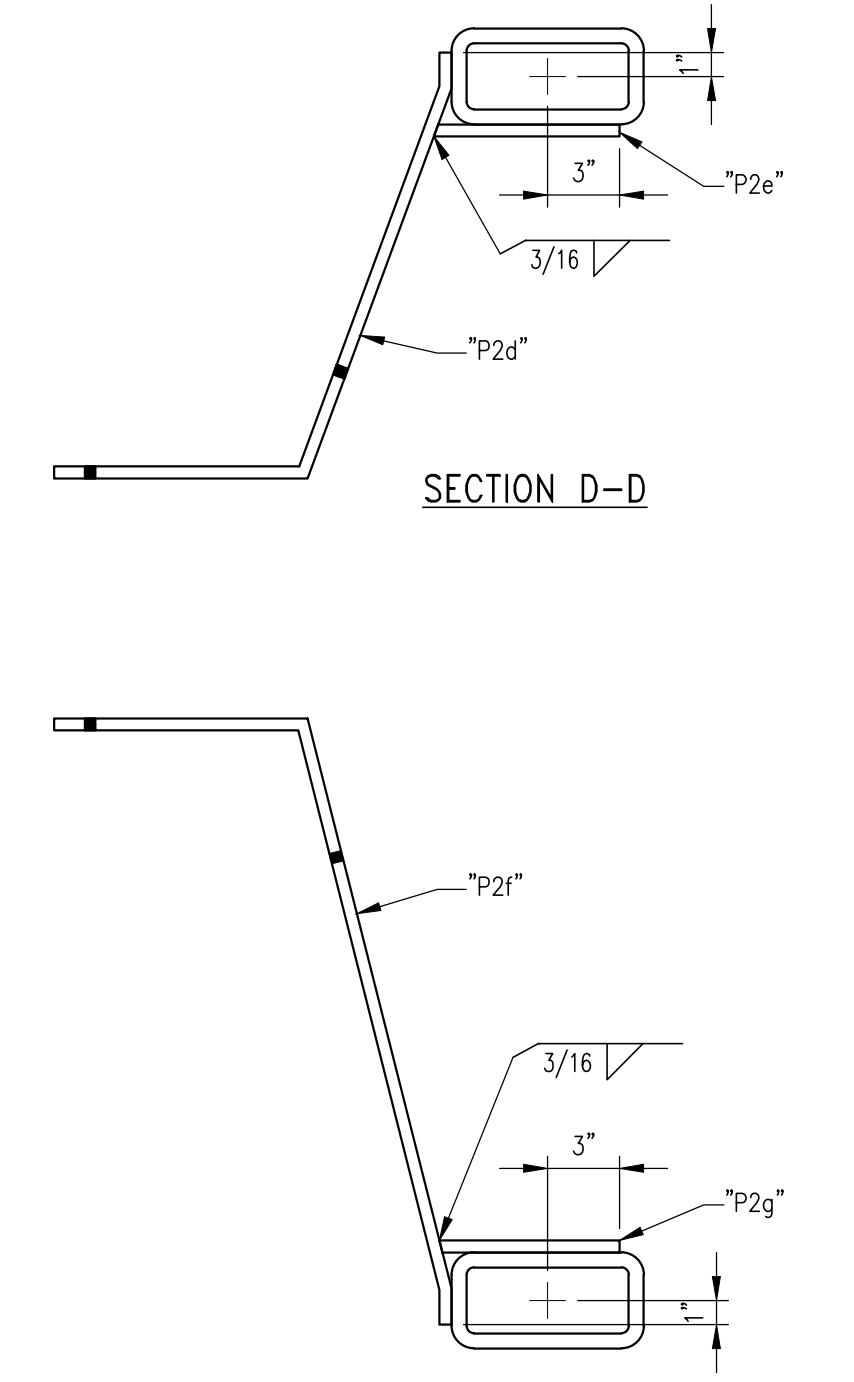
"P2d" (ONE REQ'D)



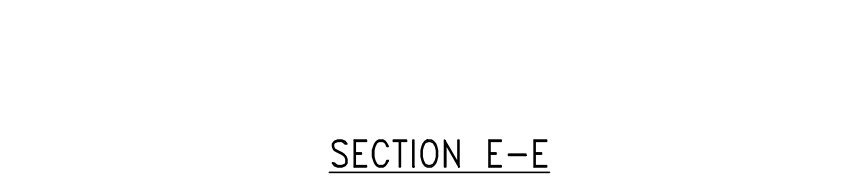
"P2f" (ONE REQ'D)



SECTION B-B



SECTION D-D



SECTION E-E

BILL OF MATERIALS											
REL. DATE	Pcs	Assembly	TEMP	No. Pcs	SECTION	GRADE	LENGTH		FIN.	NOTES	
							FT.	IN.			
H	1	2CA1			COLUMN ASSEMBLY					G	
				HSS2a	1	HSS 8x4x.625	A500-GR C	8	6 1/8	G	
				P2a	1	PL 5/8x 13	A572-GR 50	1	1	G	
				P2b	1	PL 1/4x 4	A572-GR 50	0	8	G	NO DETAIL
				P2c	1	PL 1/2x 6	A572-GR 50	1	2	G	
				L2a	1	L 3x3x3/8	A572-GR 50	2	0 9/16	G	
H	1	2CA2			COLUMN ASSEMBLY					G	
				HSS2a	1	HSS 8x4x.625	A500-GR C	8	6 1/8	G	
				P2a	1	PL 5/8x 13	A572-GR 50	1	1	G	
				P2b	1	PL 1/4x 4	A572-GR 50	0	8	G	NO DETAIL
				P2c	2	PL 1/2x 6	A572-GR 50	1	2	G	
				P2d	1	PL 1/2x 8	A572-GR 50	2	4 15/16	G	FORMED
				P2e	1	PL 1/2x 7 3/4	A572-GR 50	0	8	G	
H	1	2CA3			COLUMN ASSEMBLY					G	
				HSS2a	1	HSS 8x4x.625	A500-GR C	8	6 1/8	G	
				P2a	1	PL 5/8x 13	A572-GR 50	1	1	G	
				P2b	1	PL 1/4x 4	A572-GR 50	0	8	G	NO DETAIL
				P2c	2	PL 1/2x 6	A572-GR 50	1	2	G	
				P2f	1	PL 1/2x 8	A572-GR 50	3	0 1/8	G	FORMED
				P2g	1	PL 1/2x 7 1/2	A572-GR 50	0	8	G	
H	12	2TR1			TR 3/4x9		SS-316-R-N-W				
H	2	2a			HLTI HIT-HY 200R 11.1 oz						

STEEL GALVANIZED FABRICATION NOTES
 ALL WELDING TO BE PERFORMED BY CERTIFIED WELDERS FOLLOWING AISC CODE AND AWS STANDARD PROCEDURE D1.1-10.
 NOTE: ALL WELDING COMPLETED BEFORE GALVANIZING TAKES PLACE ALL GALVANIZED STRUCTURAL STEEL WELDING SHALL UTILIZE THE FCAW PROCESS:
 1) SHIELDING GAS - 100% CO 2
 2) FILLER WIRE - ALL FILLER WIRE SHALL BE AWS A5.20: E71T-1C-DH8/T-1M-D. AWS A5.20:E71T-9C-DH8/T-9M-D. ASME SFA 5.20. ALL HOLES SHALL BE PUNCHED OR DRILLED. SHOP TO ADD WEEP HOLES TO ENSURE ADEQUATE DRAINAGE FOR GALVANIZING.
 STEEL SHAPES SHALL BE ASTM-A572-GR 50 U.N.O.
 FASTENERS SHALL BE TYPE ASTM-A325 U.N.O.
 HOT DIPPED GALVANIZE TO MEET ASTM-A123 AFTER FABRICATION

PMWI BILLING CODE: A-1, A-2
 PHONE: (570) 282-6164 FAX: (570) 281-5931
PLEASANT MOUNT WELDING, INC.
 45 DUNDAFF STREET
 CARBONDALE, PA. 18407
 VISIT US ON THE WEB @ www.pmwi.net STATE OF N.J. CERT. OF AUTH.: 24GA28256200

PMWI **CERTIFIED FABRICATOR**

#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.
 TITLE: PRIMARY SETTLING TANKS REF. C'TRACT DWG.- A-1, S-1
GALV. STEEL DOOR FRAMES - DETAILS

TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	CO	9/29/17	BF	10/5/17	17-3046-0002	

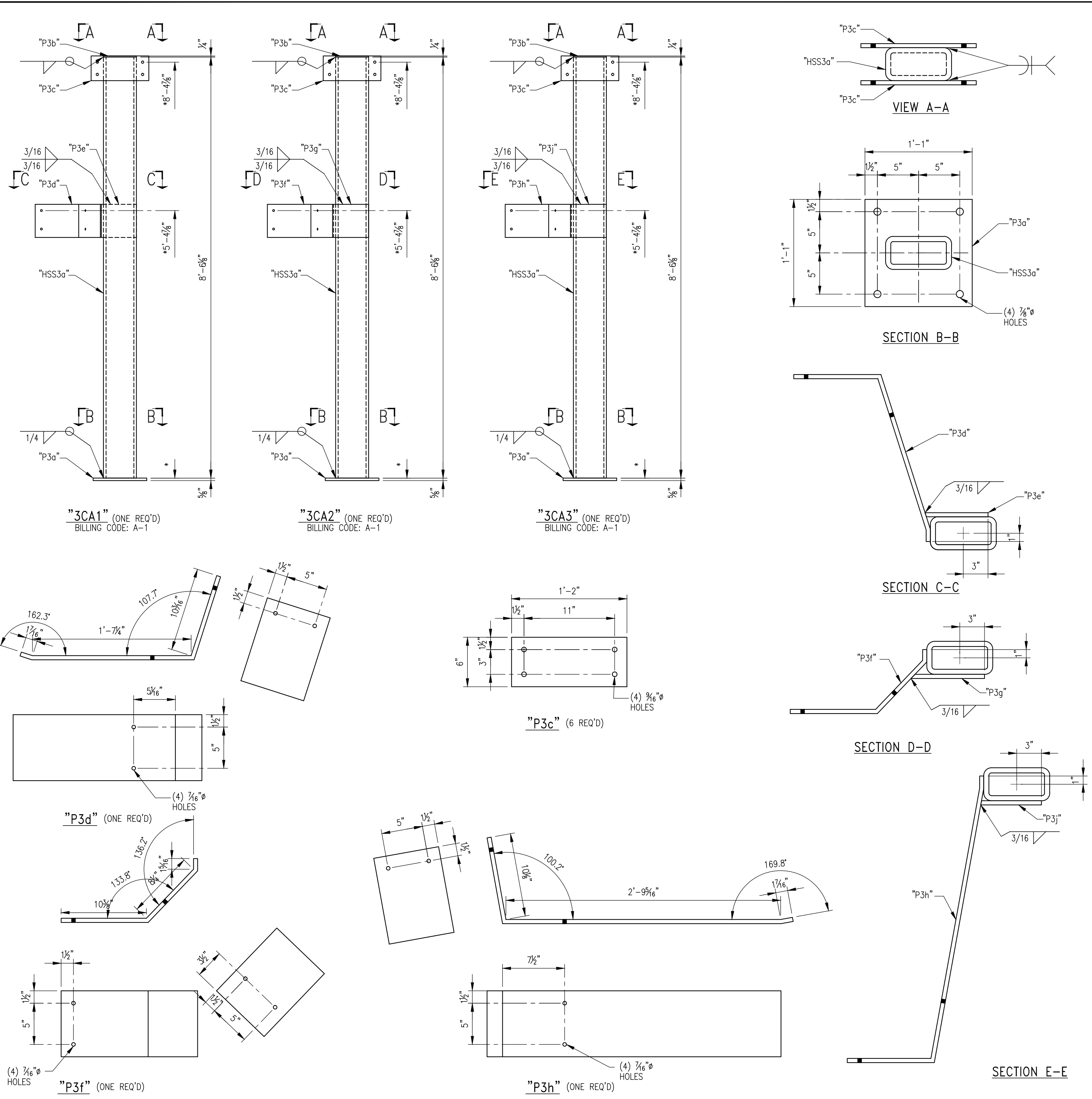
APPROVAL AUTHORITY: VERIFICATION OF DIMENSIONS, DETAILS, ETC ARE REQUESTED WHERE INDICATED. IF EACH VERIFICATION IS NOT NOTED OTHERWISE, IT WILL BE ASSUMED CORRECT AS SHOWN.

THE ENGINEER OF RECORD HAS THE FINAL AND TOTAL RESPONSIBILITY FOR THE ADEQUACY AND SAFETY OF THE STRUCTURE. SINCE HE IS THE ONLY PERSON WHO HAS ALL THE INFORMATION NECESSARY TO EVALUATE THE TOTAL IMPACT OF THE CONNECTION DETAILS ON THE STRUCTURAL DESIGN.

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BILL OF MATERIALS										
REL. DATE	Pcs	Assembly	TEMP	No. Pcs	SECTION	GRADE	LENGTH		FIN.	NOTES
							Ft.	In.		
H	1	3CA1			COLUMN ASSEMBLY					G
				HSS3a	1	HSS 8x4x.625	A500-GR C	8	6 1/8	G
				P3a	1	PL 5/8x 13	A572-GR 50	1	1	G
				P3b	1	PL 1/4x 4	A572-GR 50	0	8	G NO DETAIL
				P3c	2	PL 1/2x 6	A572-GR 50	1	2	G
				P3d	1	PL 1/2x 8	A572-GR 50	2	7 5/16	G FORMED
				P3e	1	PL 1/2x 7 5/8	A572-GR 50	0	8	G
H	1	3CA2			COLUMN ASSEMBLY					G
				HSS3a	1	HSS 8x4x.625	A500-GR C	8	6 1/8	G
				P3a	1	PL 5/8x 13	A572-GR 50	1	1	G
				P3b	1	PL 1/4x 4	A572-GR 50	0	8	G NO DETAIL
				P3c	2	PL 1/2x 6	A572-GR 50	1	2	G
				P3f	1	PL 1/2x 8	A572-GR 50	1	8 5/16	G FORMED
				P3g	1	PL 1/2x 8	A572-GR 50	0	8 15/16	G
H	1	3CA3			COLUMN ASSEMBLY					G
				HSS3a	1	HSS 8x4x.625	A500-GR C	8	6 1/8	G
				P3a	1	PL 5/8x 13	A572-GR 50	1	1	G
				P3b	1	PL 1/4x 4	A572-GR 50	0	8	G NO DETAIL
				P3c	2	PL 1/2x 6	A572-GR 50	1	2	G
				P3h	1	PL 1/2x 8	A572-GR 50	3	9 3/8	G FORMED
				P3j	1	PL 1/2x 7 3/8	A572-GR 50	0	8	G
H	12	3TR1			TR 3/4x9		SS-316-R-N-W			
H	2	3a			HLTI HIT-HY 200R 11.1 oz					

STEEL GALVANIZED FABRICATION NOTES
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 2) FILLER WIRE - ALL FILLER WIRE SHALL BE AWS A5.20: E71T-1C-DH8/T-1M-D, AWS A5.20:E71T-9C-DH8/T-9M-D, ASME SFA 5.20.
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 HOT DIPPED GALVANIZE TO MEET ASTM-A123 AFTER FABRICATION

PMWI BILLING CODE A-1, A-2
 PHONE: (570) 282-6164 FAX: (570) 281-5931
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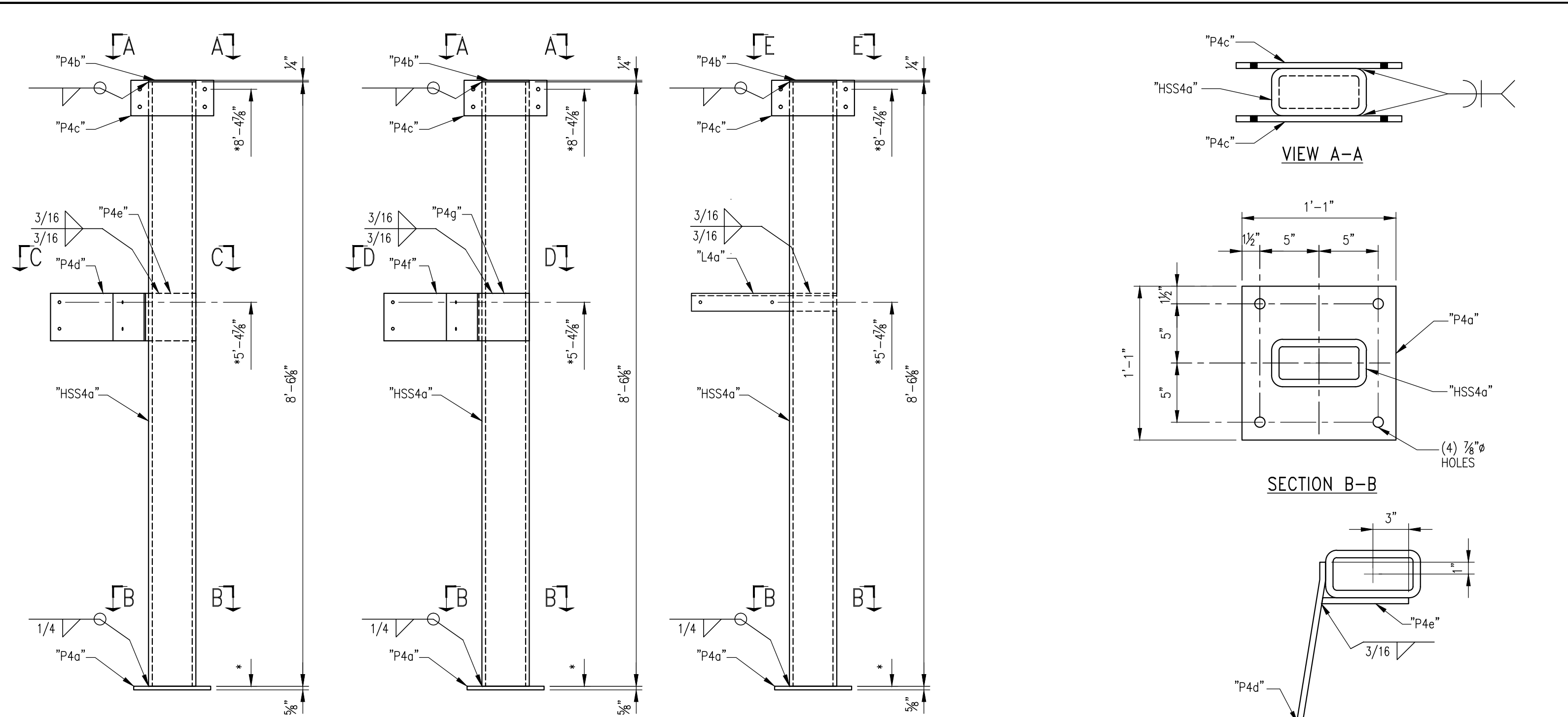
PMWI **CERTIFIED FABRICATOR**

#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.
 TITLE: PRIMARY SETTLING TANKS REF. C'TRACT DWG.- A-1, S-1
GALV. STEEL DOOR FRAMES - DETAILS

TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	CO	9/29/17	BF	10/5/17	17-3046-0003	

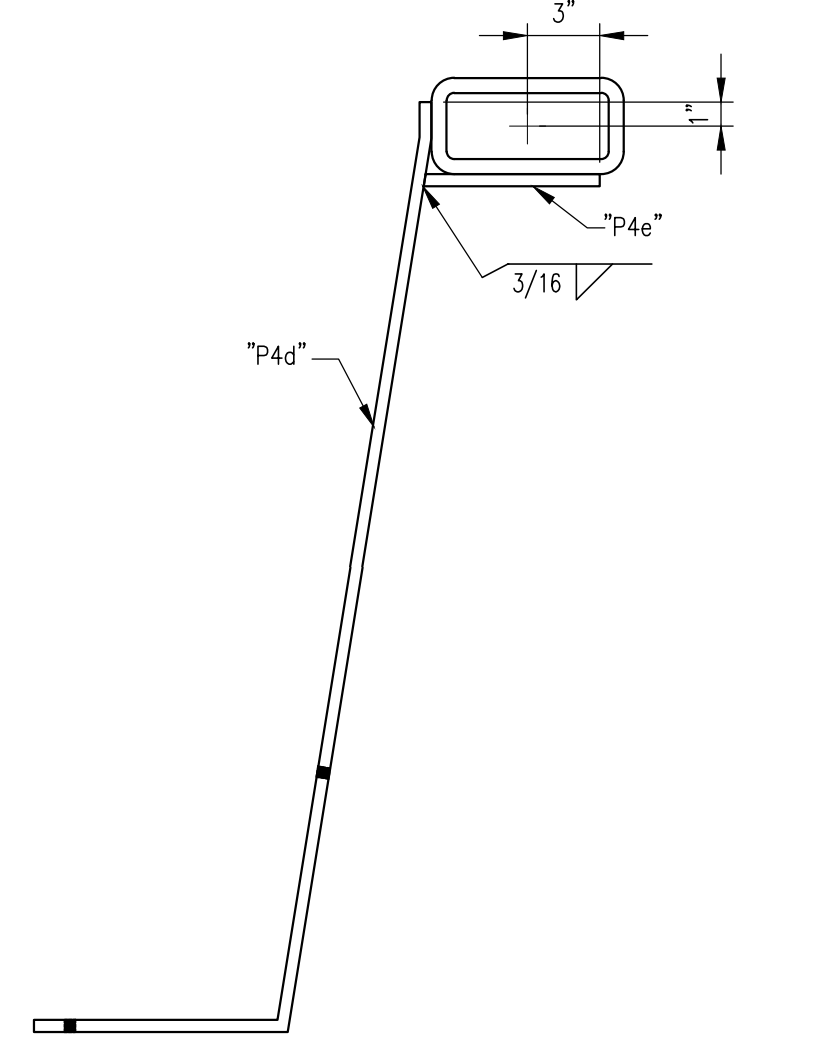
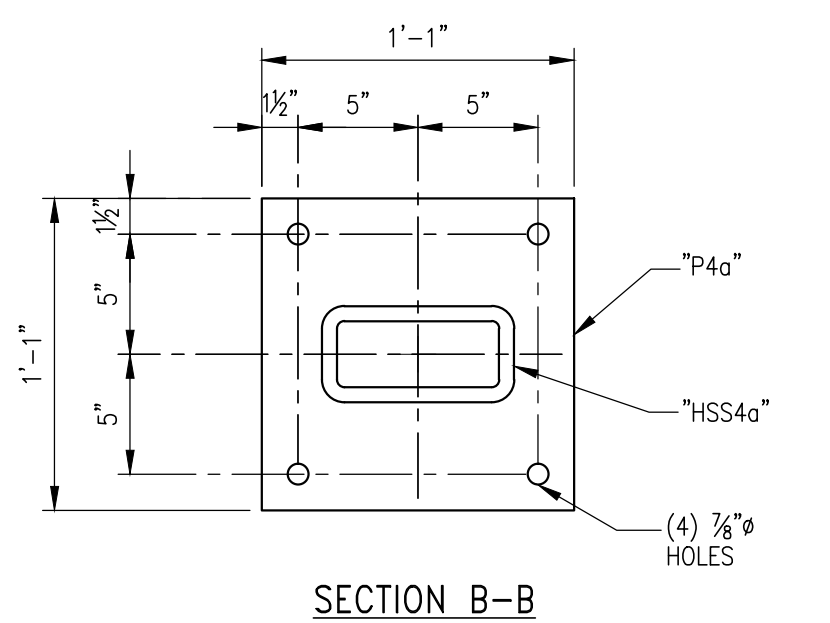
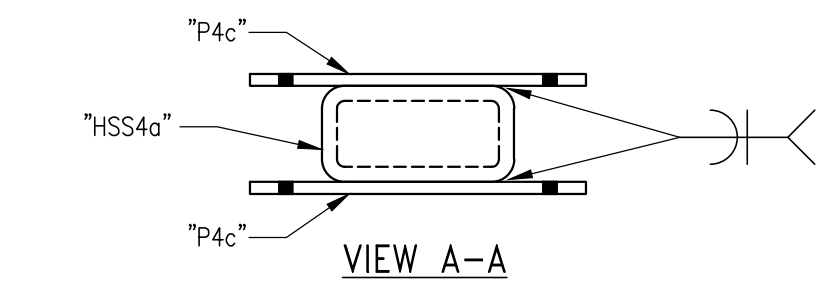
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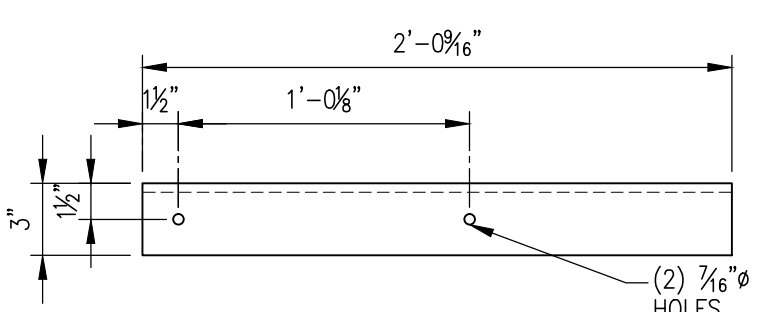
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BILLING CODE: A-1

"4CA2" (ONE REQ'D)
BILLING CODE: A-1

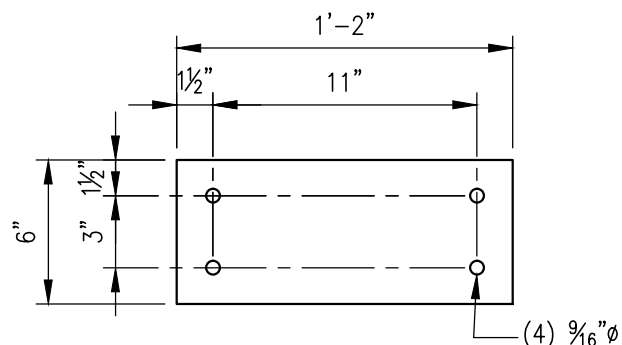
"4CA3" (ONE REQ'D)
BILLING CODE: A-1



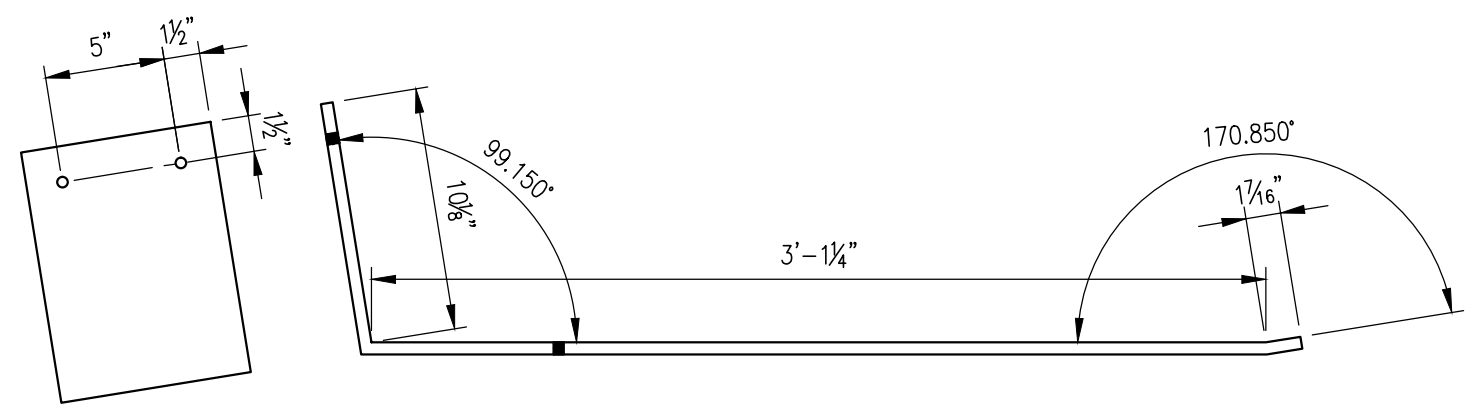
SECTION C-C



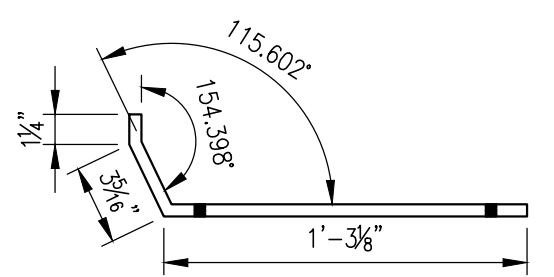
"L4a" (ONE REQ'D)



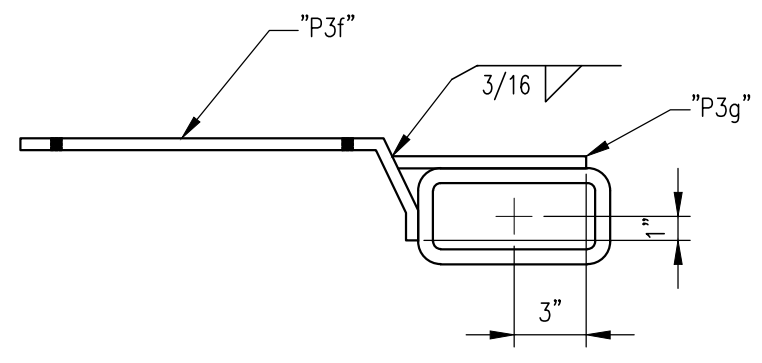
"P4c" (5 REQ'D)



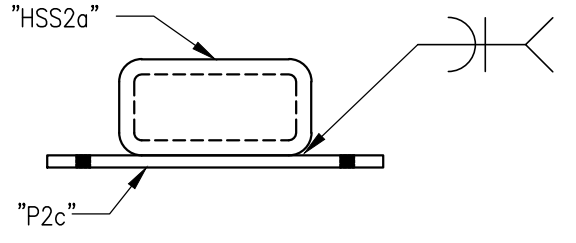
"P4d" (ONE REQ'D)



"P4f" (ONE REQ'D)



SECTION D-D



VIEW E-E

BILL OF MATERIALS										
REL. DATE	Pcs	Assembly	TEMP	No. Pcs	SECTION	GRADE	LENGTH		FIN	NOTES
							Ft.	In.		
H	1	4CA1			COLUMN ASSEMBLY					G
				1	HSS 8x4x.625	A500-GR C	8	6 1/8		G
				1	PL 5/8x 13	A572-GR 50	1	1		G
				1	PL 1/4x 4	A572-GR 50	0	8		G NO DETAIL
				2	PL 1/2x 6	A572-GR 50	1	2		G
				1	PL 1/2x 8	A572-GR 50	4	1 5/16		G FORMED
				1	PL 1/2x 7 5/16	A572-GR 50	0	8		G
H	1	4CA2			COLUMN ASSEMBLY					G
				1	HSS 8x4x.625	A500-GR C	8	6 1/8		G
				1	PL 5/8x 13	A572-GR 50	1	1		G
				1	PL 1/4x 4	A572-GR 50	0	8		G NO DETAIL
				2	PL 1/2x 6	A572-GR 50	1	2		G
				1	PL 1/2x 8	A572-GR 50	1	7 1/4		G FORMED
				1	PL 1/2x 8	A572-GR 50	0	8 1/16		G
H	1	4CA3			COLUMN ASSEMBLY					G
				1	HSS 8x4x.625	A500-GR C	8	6 1/8		G
				1	PL 5/8x 13	A572-GR 50	1	1		G
				1	PL 1/4x 4	A572-GR 50	0	8		G NO DETAIL
				1	PL 1/2x 6	A572-GR 50	1	2		G
				1	L 3x3x3/8	A572-GR 50	2	0 9/16		G
H	12	4TR1			TR 3/4x9	SS-316-R-N-W				
H	2	4a			HLTI HIT-HY 200R 11.1 oz					

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 VISIT US ON THE WEB @ www.pmwi.net STATE OF N.J. CERT. OF AUTH.: 24GA28256200

#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.
 TITLE: PRIMARY SETTLING TANKS REF. C'TRACT DWG.- A-1, S-1
GALV. STEEL DOOR FRAMES - DETAILS

TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	CO	9/29/17	BF	10/5/17	17-3046-0004	

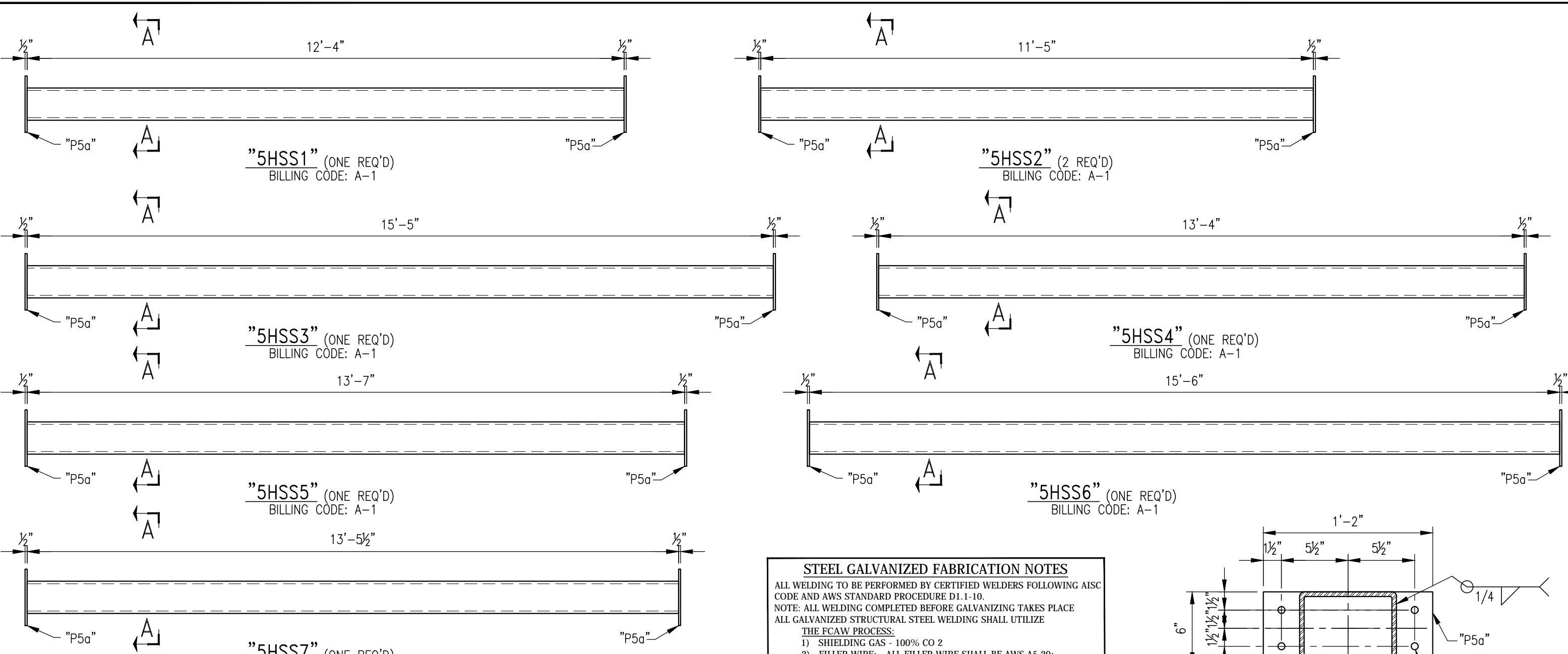
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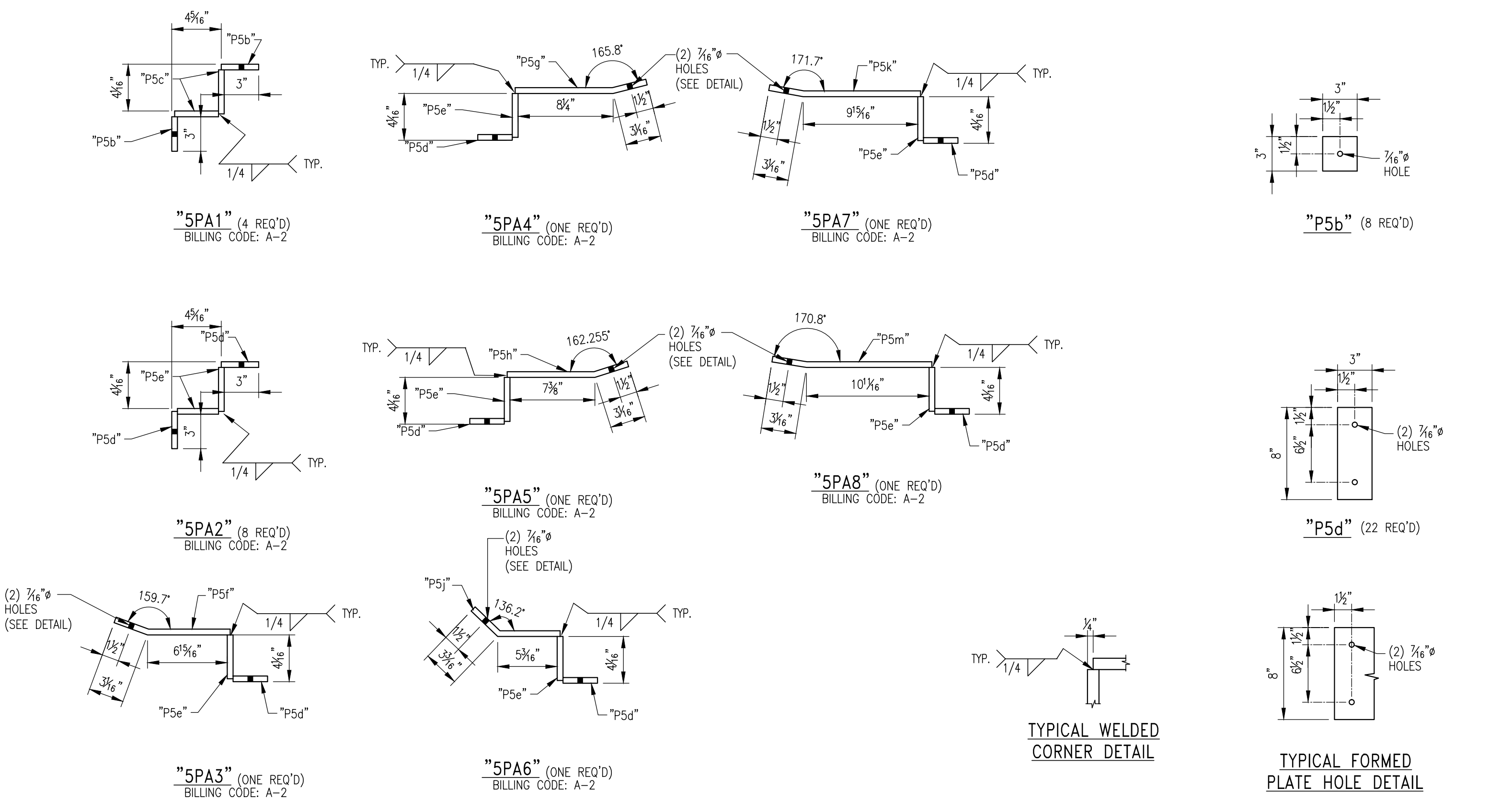
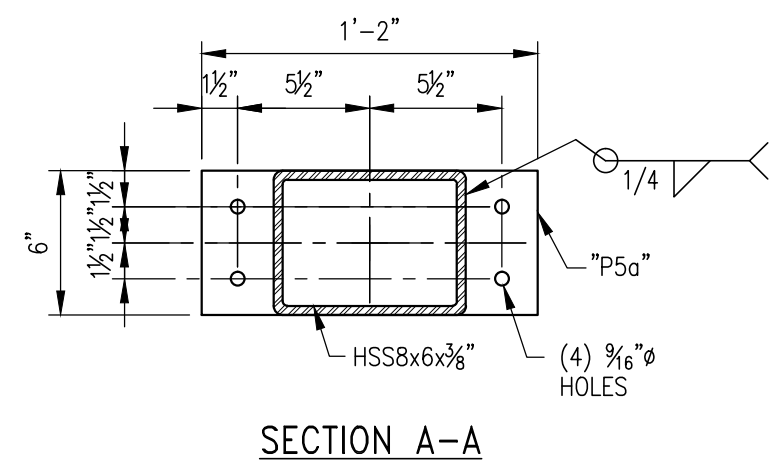
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 FASTENERS SHALL BE TYPE ASTM-A325 U.N.O.
 HOT DIPPED GALVANIZE TO MEET ASTM-A123 AFTER FABRICATION



REL. DATE	Pcs	Assembly	TEMP	No. Pcs	SECTION	GRADE	LENGTH		FIN.	NOTES
							Ft.	In.		
H	1	5HSS1			HSS 8x6x.375	A500-GR C	12	4	G	
			P5a	2	PL 1/2x 6	A572-GR 50	1	2	G	
H	2	5HSS2			HSS 8x6x.375	A500-GR C	11	5	G	
			P5a	2	PL 1/2x 6	A572-GR 50	1	2	G	
H	1	5HSS3			HSS 8x6x.375	A500-GR C	15	5	G	
			P5a	2	PL 1/2x 6	A572-GR 50	1	2	G	
H	1	5HSS4			HSS 8x6x.375	A500-GR C	13	4	G	
			P5a	2	PL 1/2x 6	A572-GR 50	1	2	G	
H	1	5HSS5			HSS 8x6x.375	A500-GR C	13	7	G	
			P5a	2	PL 1/2x 6	A572-GR 50	1	2	G	
H	1	5HSS6			HSS 8x6x.375	A500-GR C	15	6	G	
			P5a	2	PL 1/2x 6	A572-GR 50	1	2	G	
H	1	5HSS7			HSS 8x6x.375	A500-GR C	13	5 1/2	G	
			P5a	2	PL 1/2x 6	A572-GR 50	1	2	G	
H	4	5PA1			PLATE ASSEMBLY				G	
			P5b	2	PL 1/2x 3	A572-GR 50	0	3	G	
			P5c	2	PL 1/2x 3	A572-GR 50	0	3 13/16	G	
H	8	5PA2			PLATE ASSEMBLY				G	
			P5d	16	PL 1/2x 3	A572-GR 50	0	8	G	
			P5e	16	PL 1/2x 3 13/16	A572-GR 50	0	8	G	
H	1	5PA3			PLATE ASSEMBLY				G	
			P5d	1	PL 1/2x 3	A572-GR 50	0	8	G	
			P5e	1	PL 1/2x 3 13/16	A572-GR 50	0	8	G	
			P5f	1	PL 1/2x 9 15/16	A572-GR 50	0	8	G	FORMED
H	1	5PA4			PLATE ASSEMBLY				G	
			P5d	1	PL 1/2x 3	A572-GR 50	0	8	G	
			P5e	1	PL 1/2x 3 13/16	A572-GR 50	0	8	G	
			P5g	1	PL 1/2x 11 3/4	A572-GR 50	0	8	G	FORMED
H	1	5PA5			PLATE ASSEMBLY				G	
			P5d	1	PL 1/2x 3	A572-GR 50	0	8	G	
			P5e	1	PL 1/2x 3 13/16	A572-GR 50	0	8	G	
			P5h	1	PL 1/2x 10 7/8	A572-GR 50	0	8	G	FORMED
H	1	5PA6			PLATE ASSEMBLY				G	
			P5d	1	PL 1/2x 3	A572-GR 50	0	8	G	
			P5e	1	PL 1/2x 3 13/16	A572-GR 50	0	8	G	
			P5j	1	PL 1/2x 8 11/16	A572-GR 50	0	8	G	FORMED
H	1	5PA7			PLATE ASSEMBLY				G	
			P5d	1	PL 1/2x 3	A572-GR 50	0	8	G	
			P5e	1	PL 1/2x 3 13/16	A572-GR 50	0	8	G	
			P5k	1	PL 1/2x 13 7/16	A572-GR 50	0	8	G	FORMED
H	1	5PA8			PLATE ASSEMBLY				G	
			P5d	1	PL 1/2x 3	A572-GR 50	0	8	G	
			P5e	1	PL 1/2x 3 13/16	A572-GR 50	0	8	G	
			P5m	1	PL 1/2x 14 3/16	A572-GR 50	0	8	G	FORMED
H	64	5MB1			MB 1/2x2	A325-B-N-W-GALV				
H	48	5MB2			MB 3/8x1 1/2	A325-B-N-W-GALV				

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GALV. STEEL DOOR FRAMES - DETAILS

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TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	CO	9/29/17	XCHKR	XCHDT	17-3046-0005	

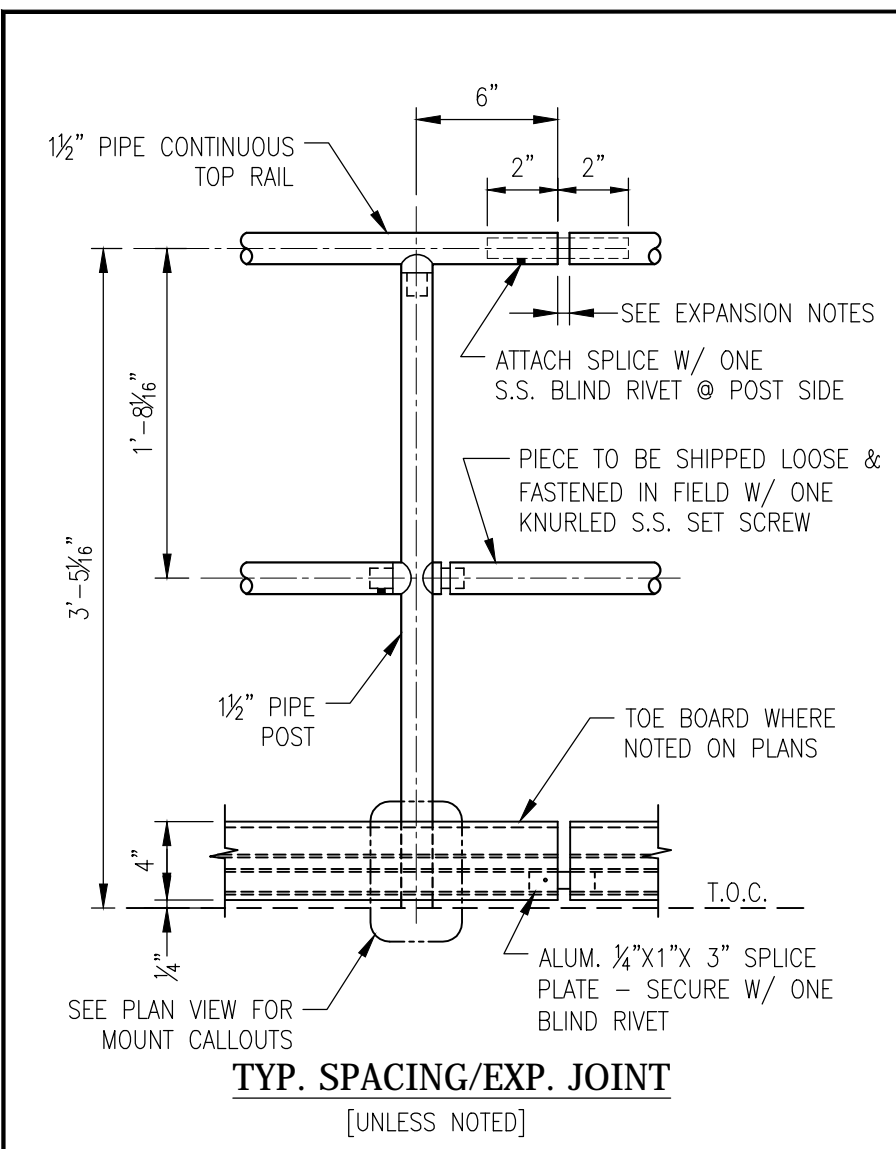
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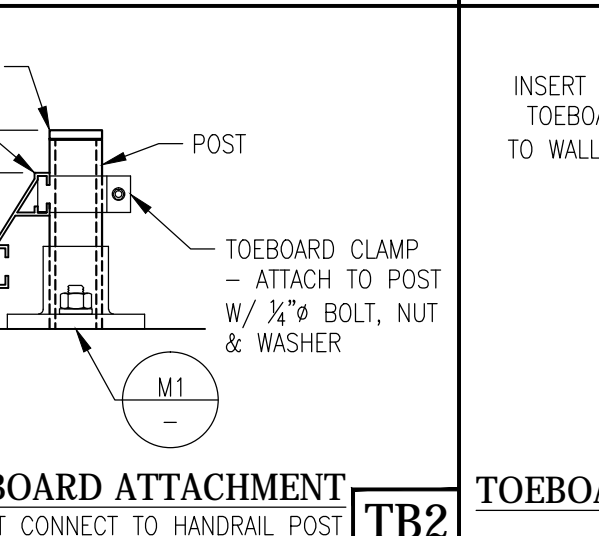
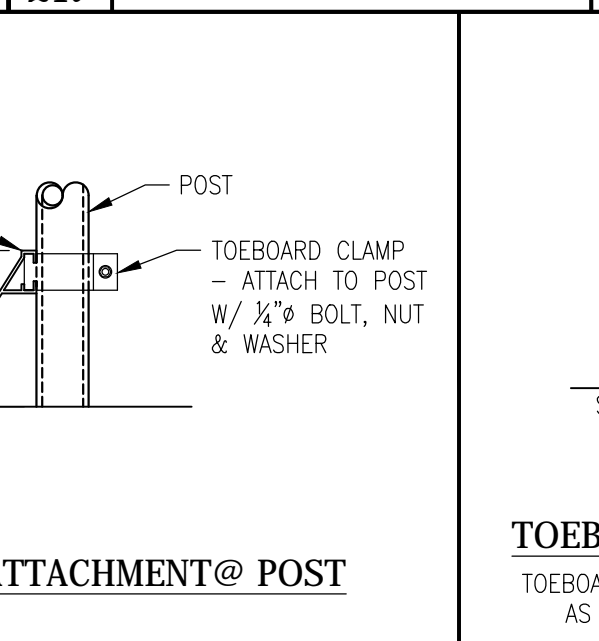
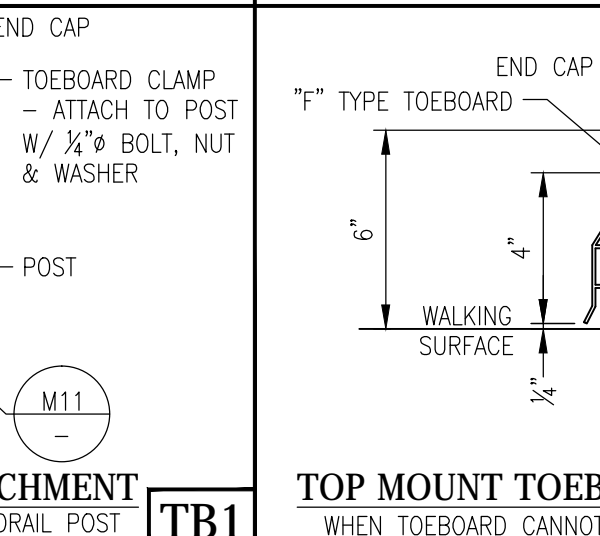
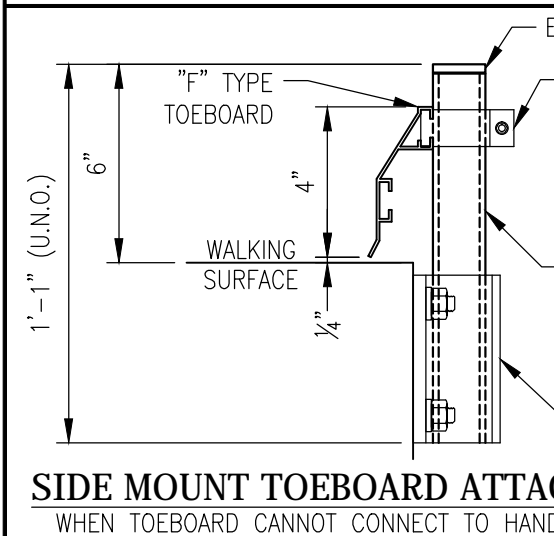
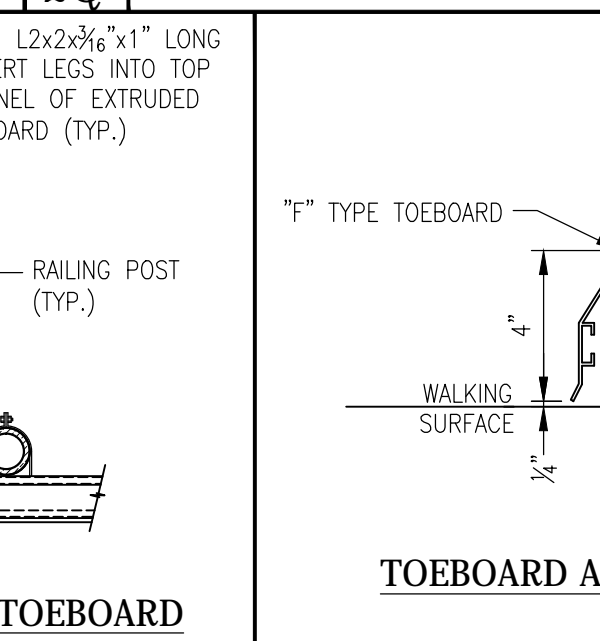
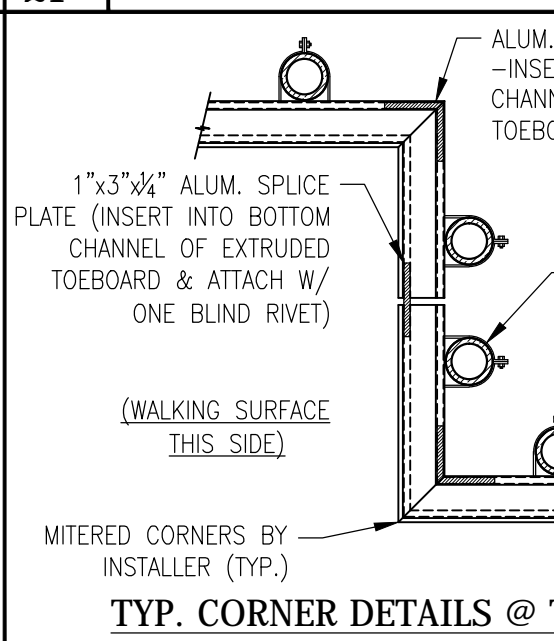
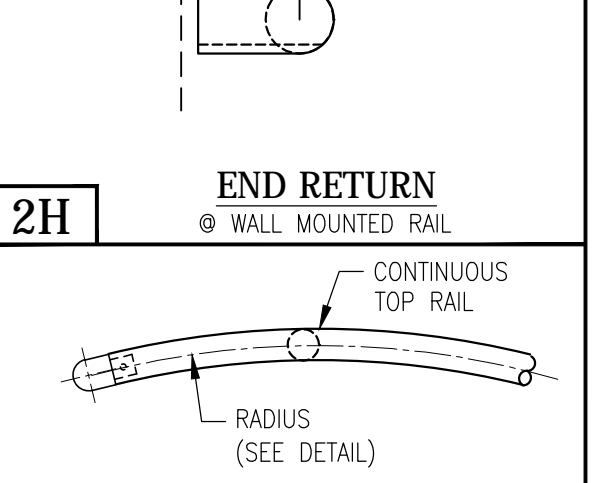
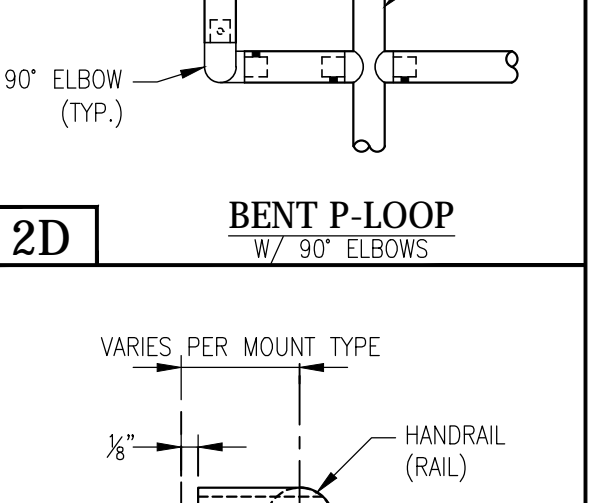
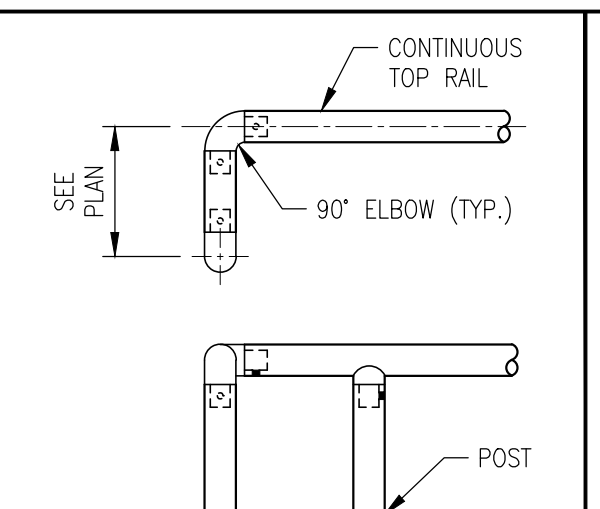
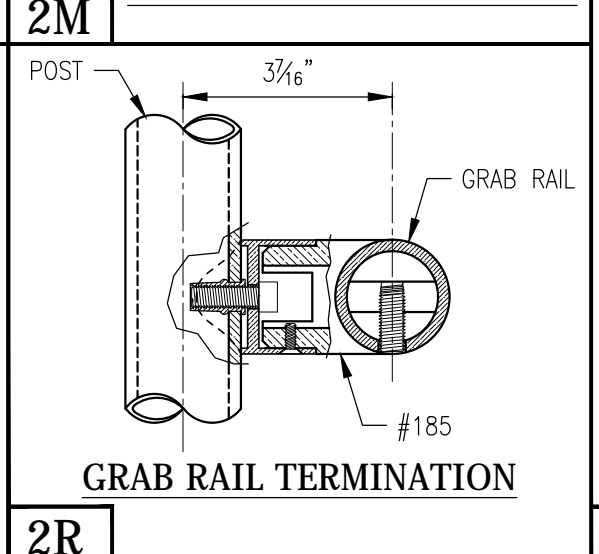
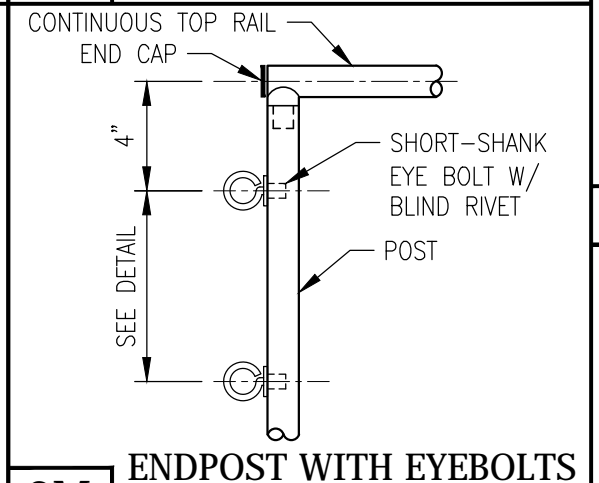
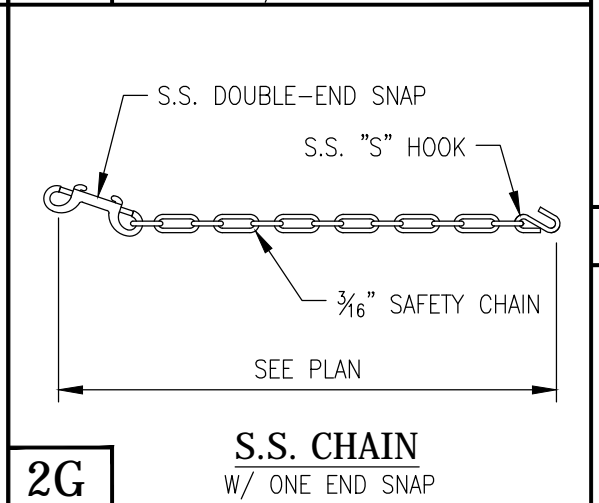
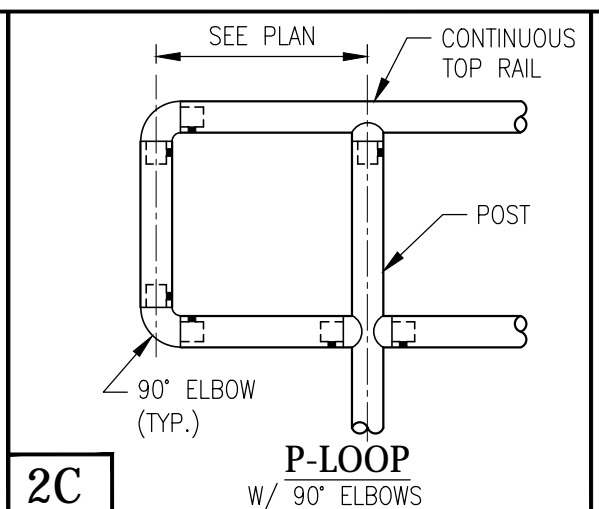
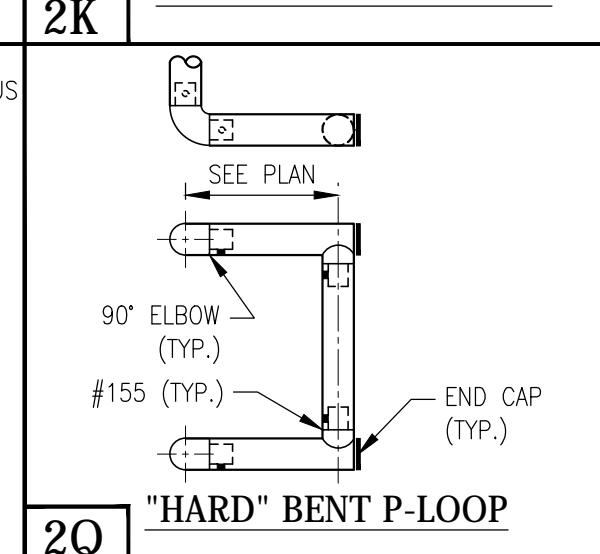
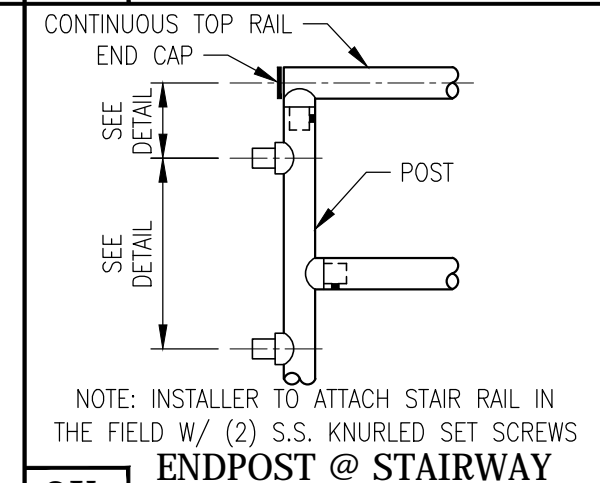
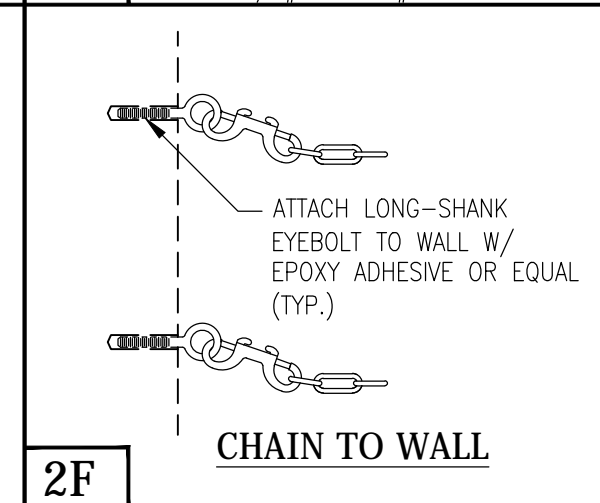
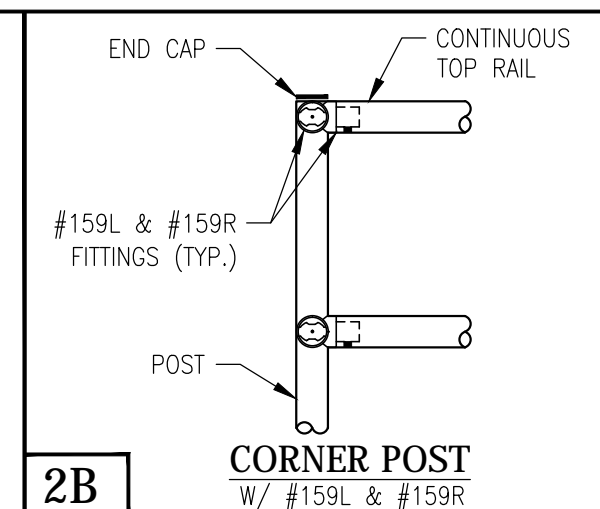
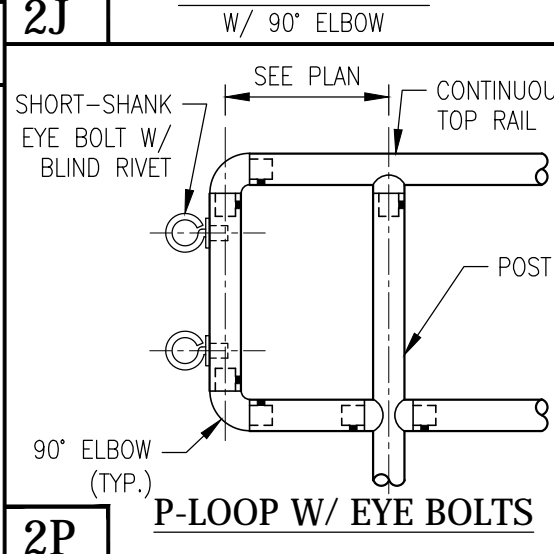
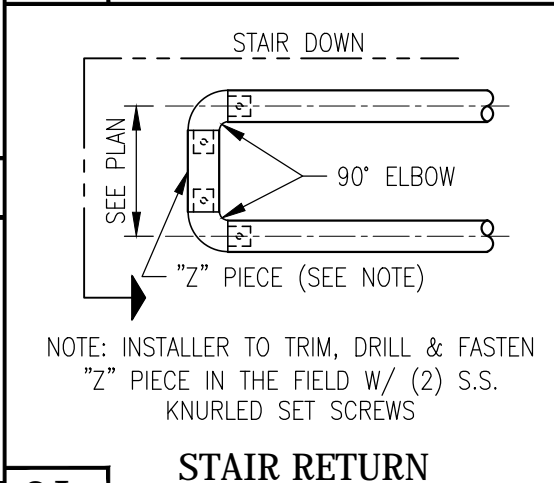
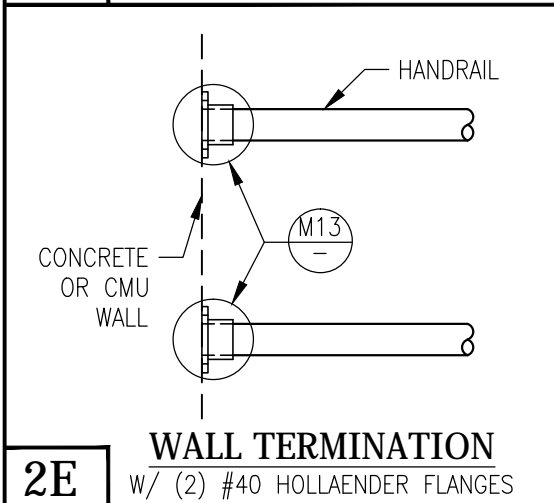
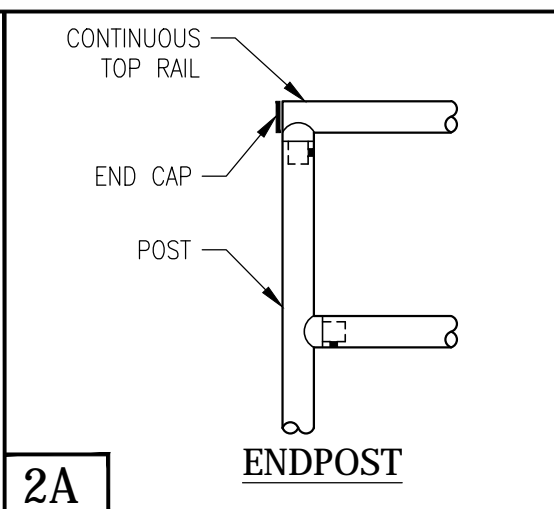
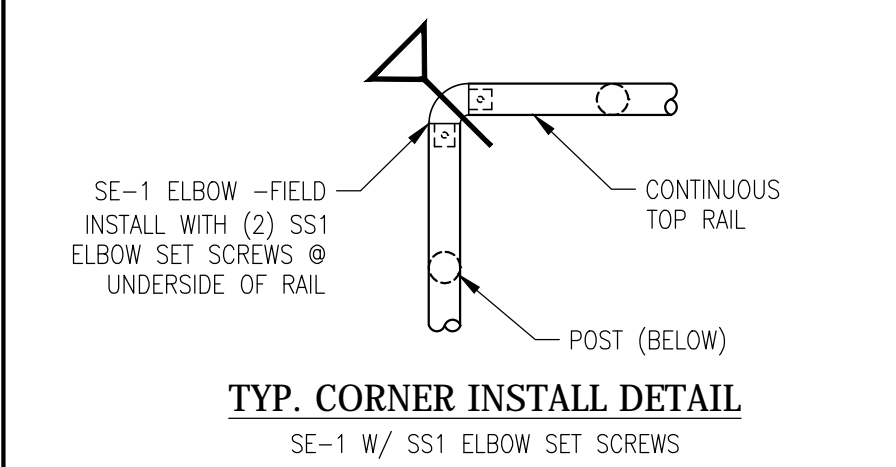


EXPANSION JOINT NOTES

DETERMINE EXPANSION JOINT USING THE FOLLOWING FORMULA:
 $GAP (in.) = 0.000013 \times (105-T) \times \text{NUMBER OF INCHES BETWEEN EXPANSION JOINTS}$
 WHERE "T" EQUALS AMBIENT TEMPERATURE AT TIME OF INSTALLATION. (DEGREES F)

WHILE INSTALLING RAILING IN A CONTROLLED ATMOSPHERE WHEN, AT THE TIME OF INSTALLATION THE AMBIENT TEMPERATURE IS THE "CONTROLLED" TEMPERATURE, SPLICE RAIL SECTIONS WITHOUT A GAP.

PMWI STANDARD ABBREVIATIONS: F.O.C. = FACE OF CHANNEL
 T.O.C. = TOP OF CONCRETE E.O.C. = EDGE OF CONCRETE



GENERAL NOTES

PLEASANT MOUNT WELDING INC. IS SUPPLYING A COMPONENT RAIL SYSTEM UTILIZING HOLLANDER "INTERNA-RAIL" COMPONENTS.

ALL HANDRAIL DIMENSIONS ARE TO CENTER LINE OF PIPE. ALL FASTENERS TO BE SS316 AS PER CONTRACT DWGS. AND/OR SPECIFICATIONS. POST SHALL BE:
 1 1/2" SCH. 80 - 6061-T6 - ANODIZED CLEAR (M12C22A41)
 RAIL SHALL BE:
 1 1/2" SCH. 40 - 6063-T6 - ANODIZED CLEAR (M12C22A41)

RAILS TO BE SHIPPED LOOSE, WHERE DESIGNATED BY "Z" (EX. "1Z1"). MIDDLE RAILS TO BE SHIPPED LOOSE, WHERE DESIGNATED BY "X" (EX. "1X1").

ALL ALUMINUM COMING IN CONTACT WITH ANY AND ALL DISSIMILAR MATERIALS, METALS OR CONCRETE, SHALL BE COATED WITH TNEPEC SERIES 46H-413 @ 5.0 MILS. D.F.T. AS AN ISOLATION BARRIER.

ACCURATE FIELD DIMENSIONS WILL BE REQUIRED FOR ALL RAILING AND POST LOCATIONS PRIOR TO ANY FABRICATION.

MOISTURE DRAINAGE ON POST BASE MOUNTED APPLICATIONS IS PROVIDED NATURALLY DUE TO SYSTEM CONSTRUCTION AND DOES NOT REQUIRE EXTERIOR "WEEP HOLES" TO BE DRILLED. (U.N.O.)

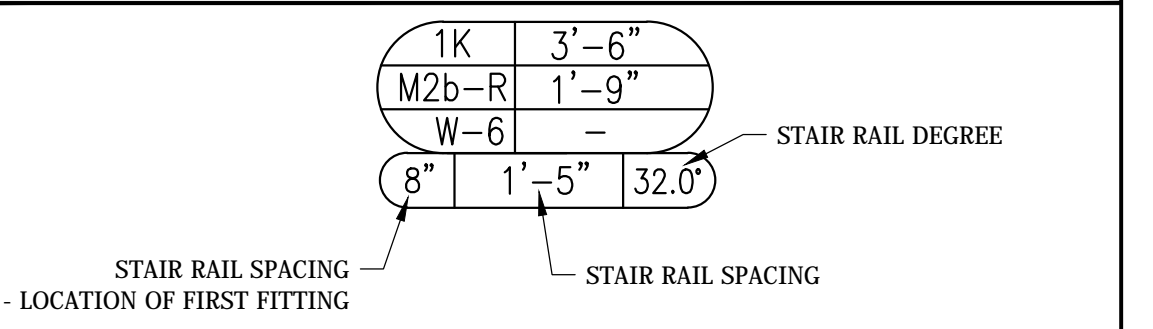
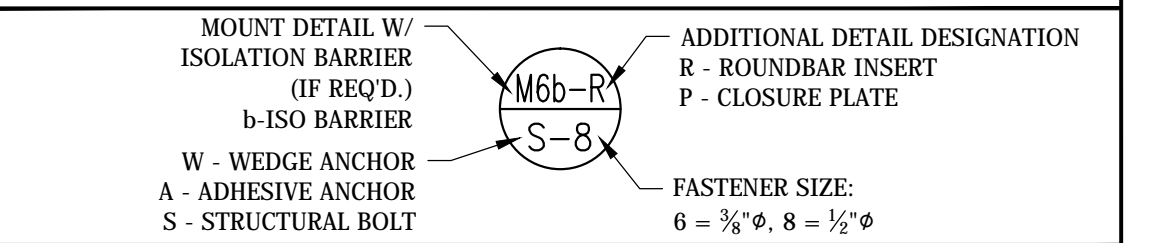
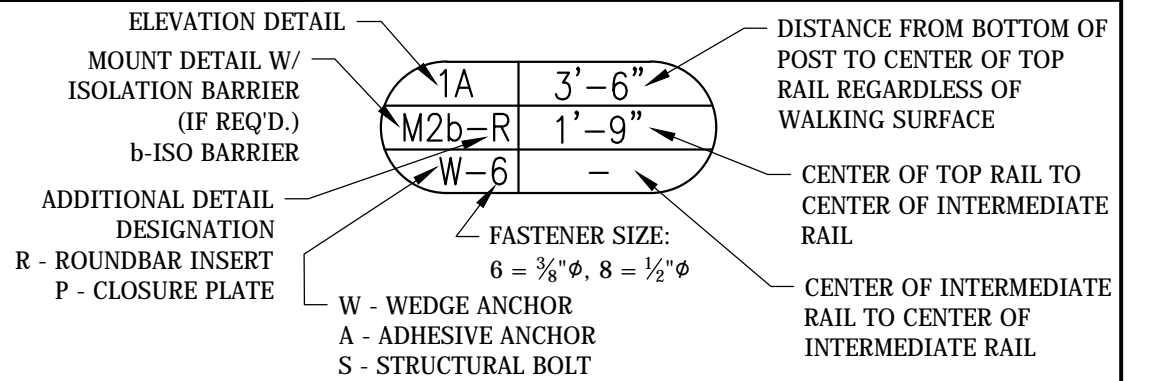
WE ARE PROVIDING OUR STANDARD "F" TYPE TOEBOARD IN ACCORDANCE WITH THE ATTACHED CROSS-SECTION & DETAILS. ALL KICK PLATES TO BE SHIPPED IN STANDARD STOCK LENGTHS, ANY CUTTING IS TO BE PERFORMED IN THE FIELD.

HANDRAIL LOADING & DESIGN CRITERIA:
 IBC 2003 - THE HANDRAIL ASSEMBLY SHALL BE DESIGNED TO WITHSTAND A LOAD OF 50plf APPLIED IN ANY DIRECTION ALONG THE TOP OF THE RAIL, OR A 200lb CONCENTRATED LOAD APPLIED TO THE TOP OF THE RAIL, AT ANY POINT, AND IN ANY DIRECTION. THESE LOADS ARE NOT CONSIDERED TO ACT CONCURRENTLY.

WHEN ATTACHING TO STRUCTURAL MEMBERS (U.N.O.):
 USE 1/2" BOLTS FOR 2 HOLE MOUNTS; USE 3/8" BOLTS FOR 4 HOLE MOUNTS

WHEN ATTACHING TO CONCRETE (U.N.O.):
 TOP MOUNT SIDE MOUNT
 4 HOLE: 3/8" ADH. ANCHORS, 4 1/2" MIN. EMBED. N/A

MAXIMUM POST SPACING TO BE 4'-0" O.C. TOP MOUNT



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 45 DUNDAFF STREET
 CARBONDALE, PA. 18407

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#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.

TITLE: PMWI COMPONENT RAIL SYSTEM
TYPICAL ELEVATIONS, TOEBOARD DETAILS & NOTES

TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	M.H.	9-27-17	N.L.	10/5/17	17-3046-MA2SD1	

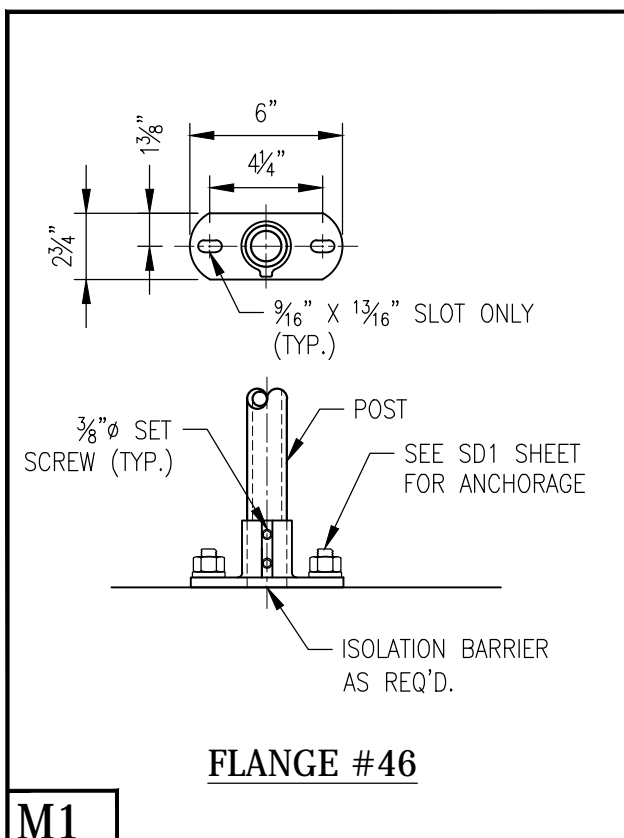
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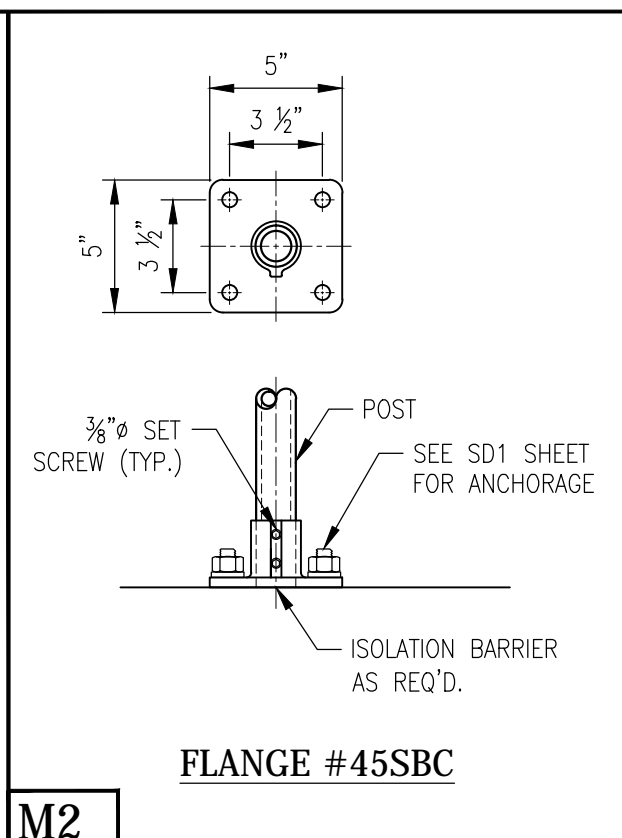
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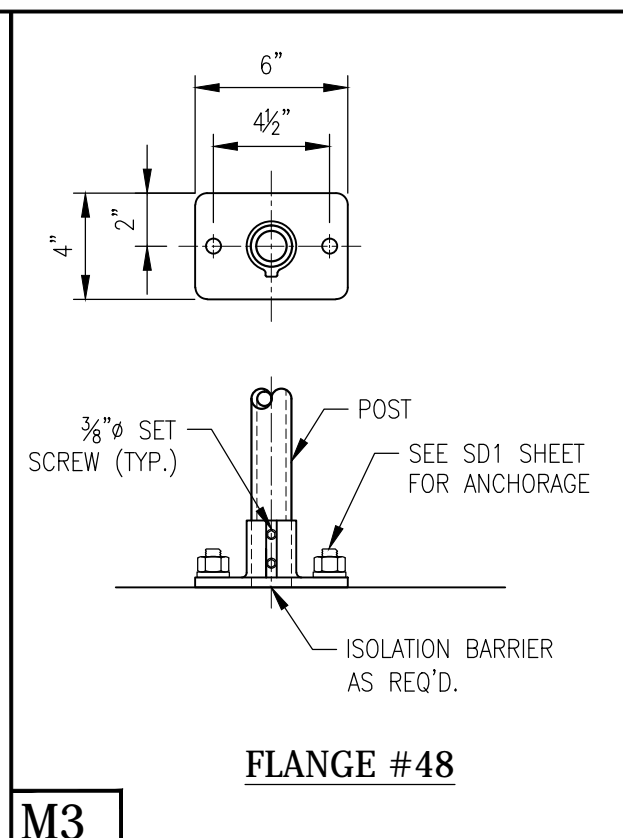
FLANGE #46

M1



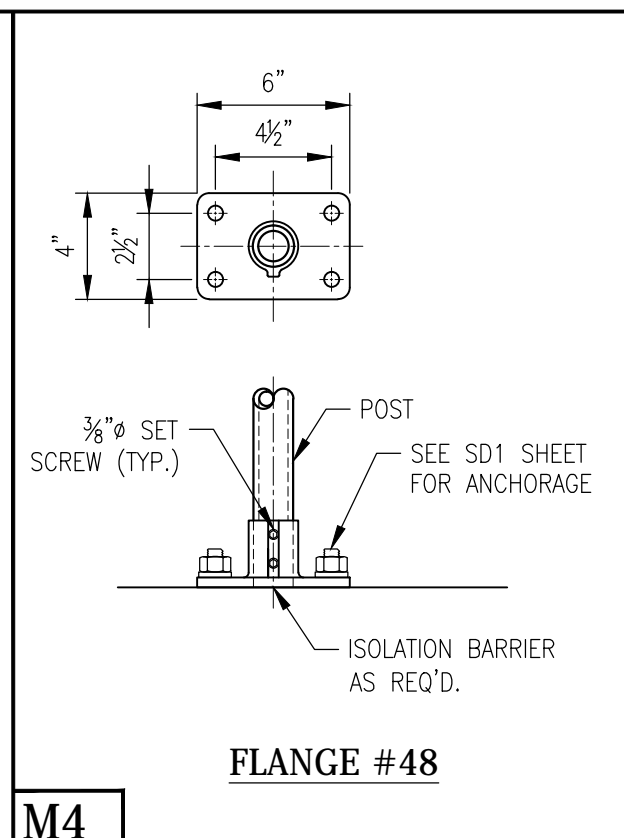
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M2



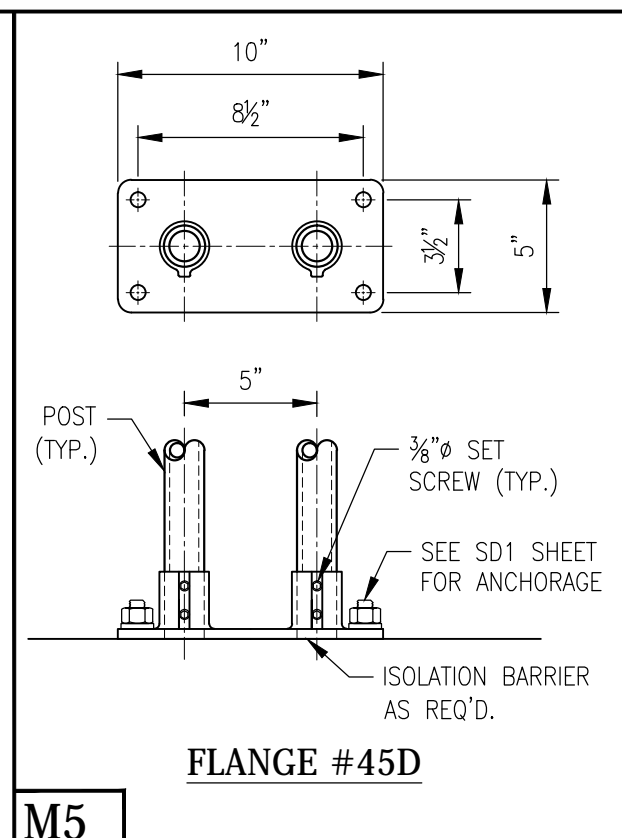
FLANGE #48

M3



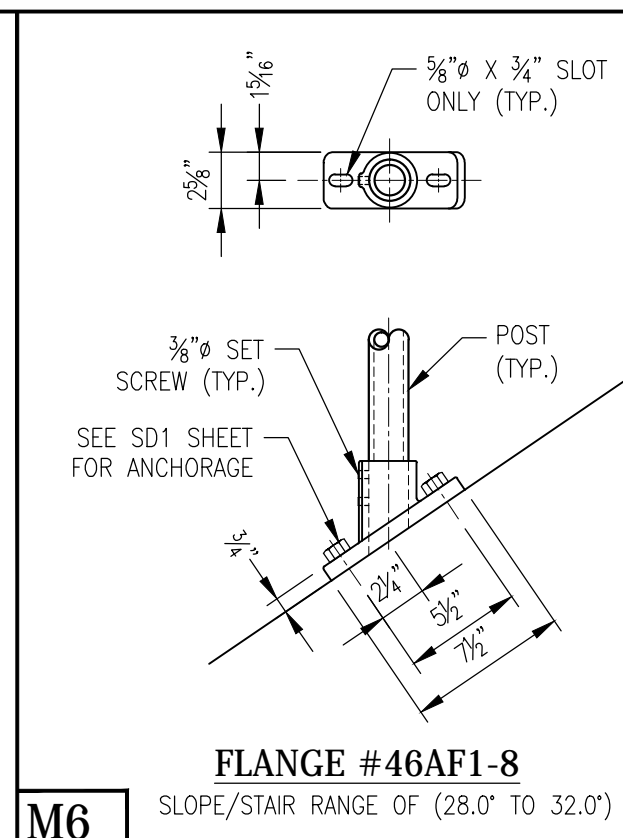
FLANGE #48

M4



FLANGE #45D

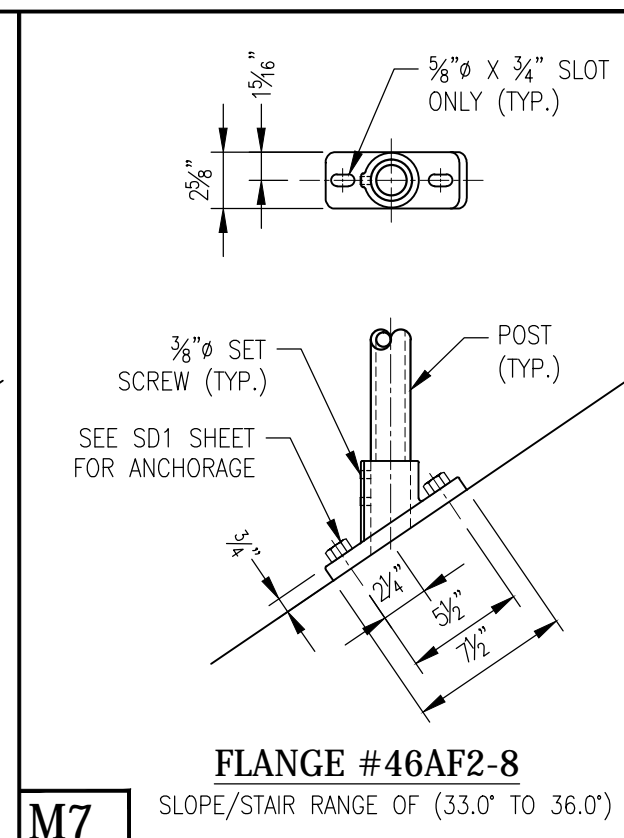
M5



FLANGE #46AF1-8

SLOPE/STAIR RANGE OF (28.0° TO 32.0°)

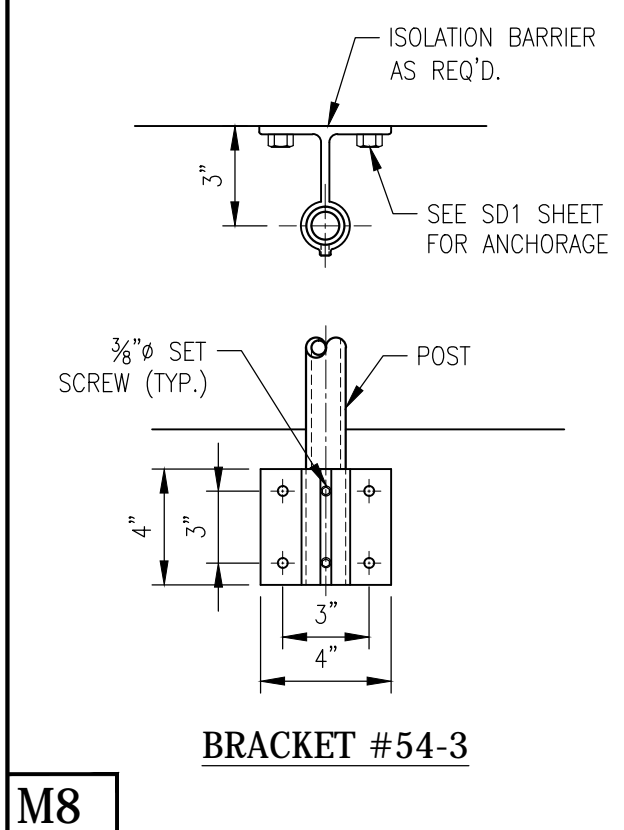
M6



FLANGE #46AF2-8

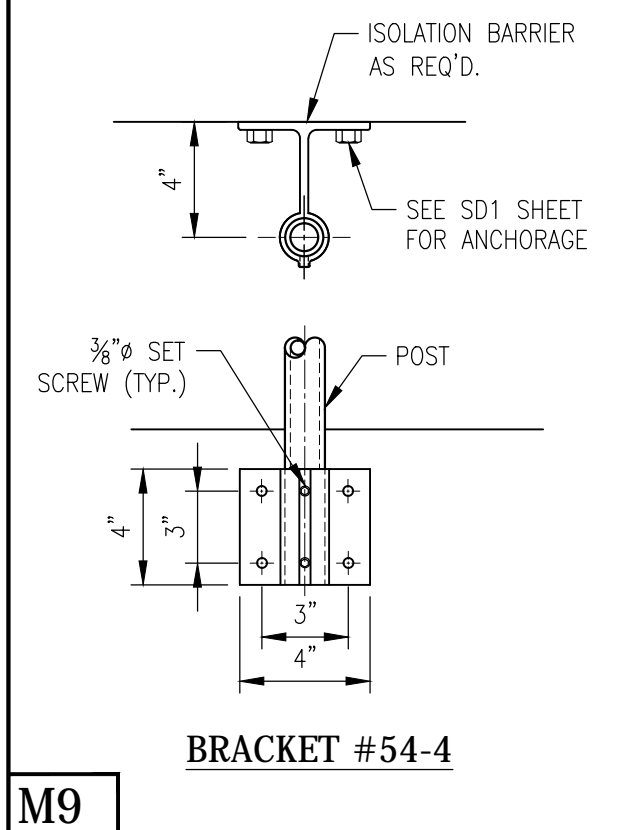
SLOPE/STAIR RANGE OF (33.0° TO 36.0°)

M7



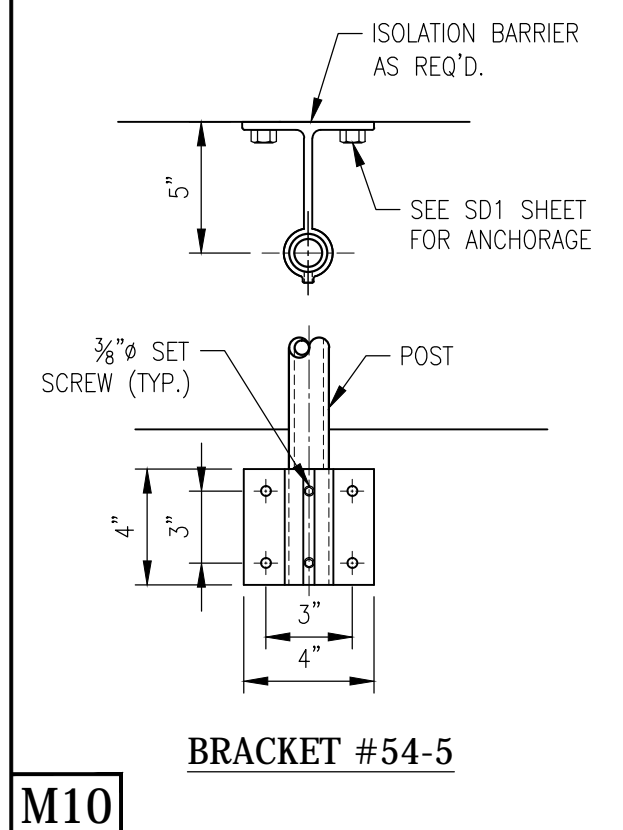
BRACKET #54-3

M8



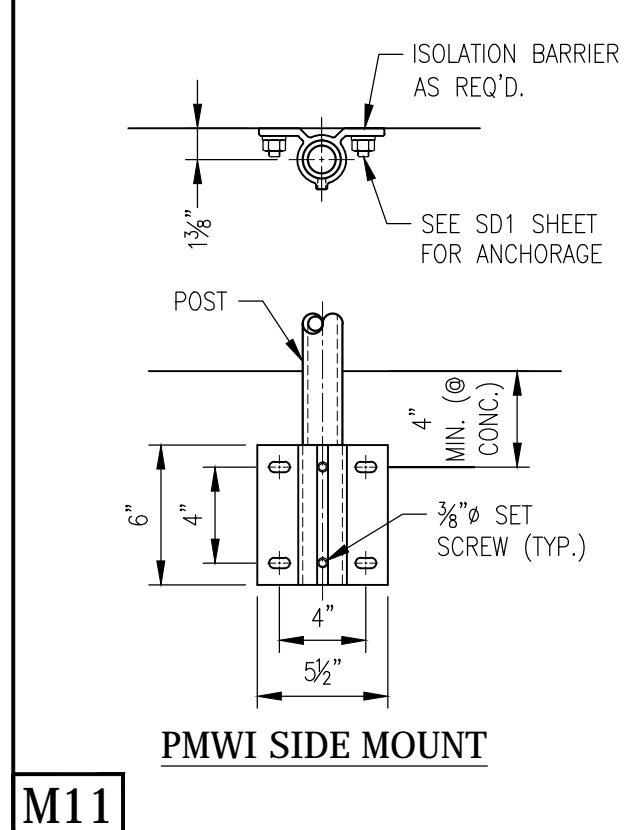
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M9



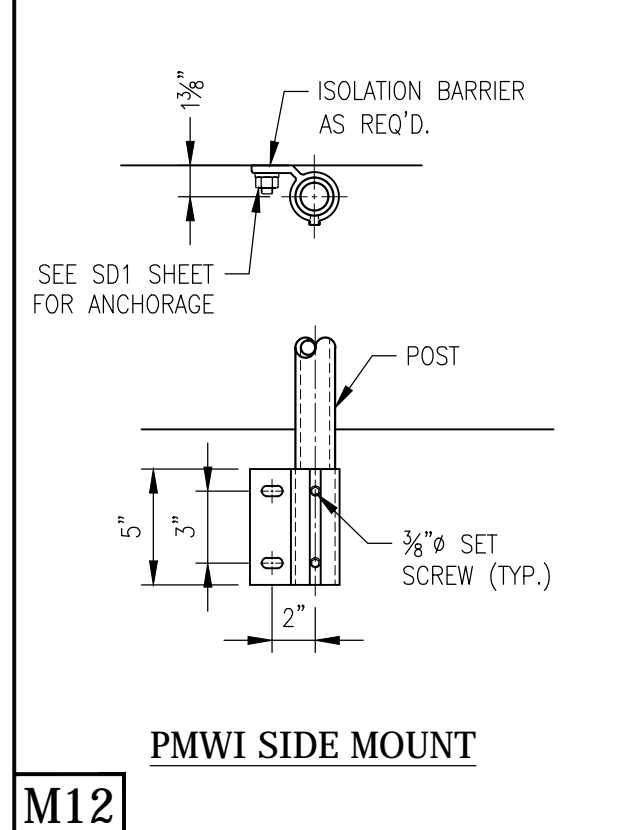
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M10



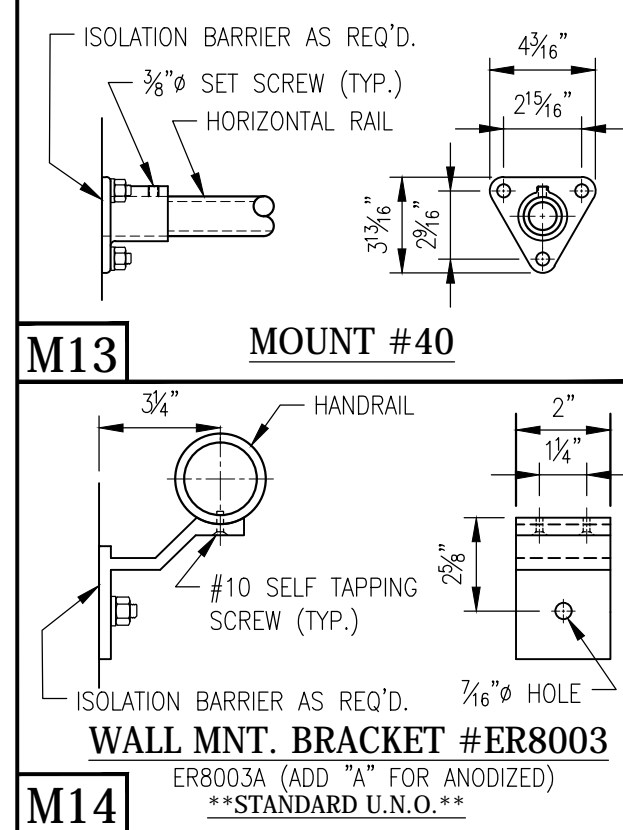
PMWI SIDE MOUNT

M11



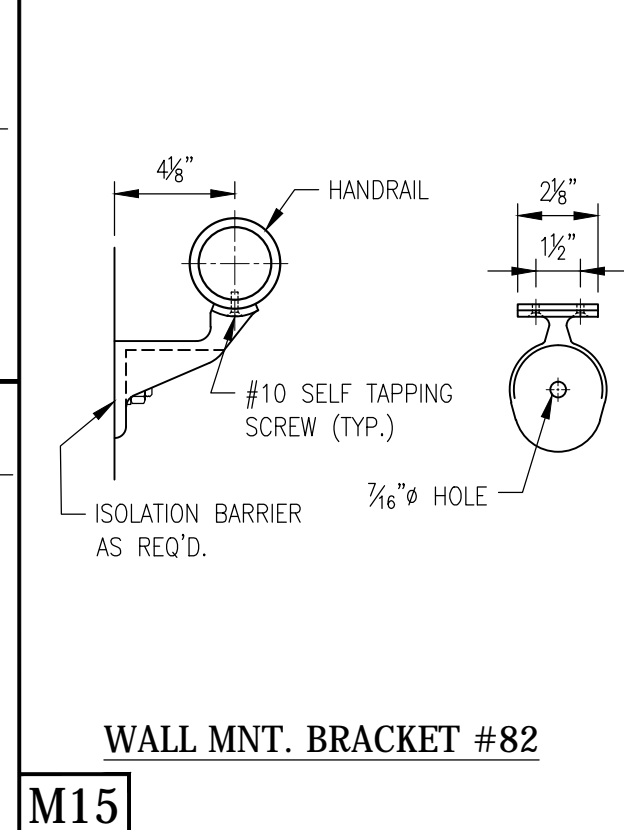
PMWI SIDE MOUNT

M12



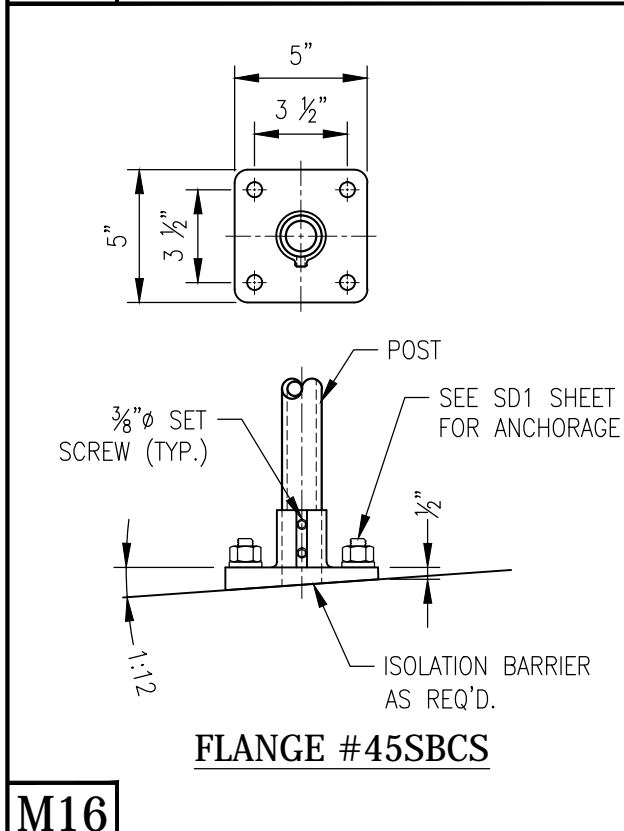
MOUNT #40

M13



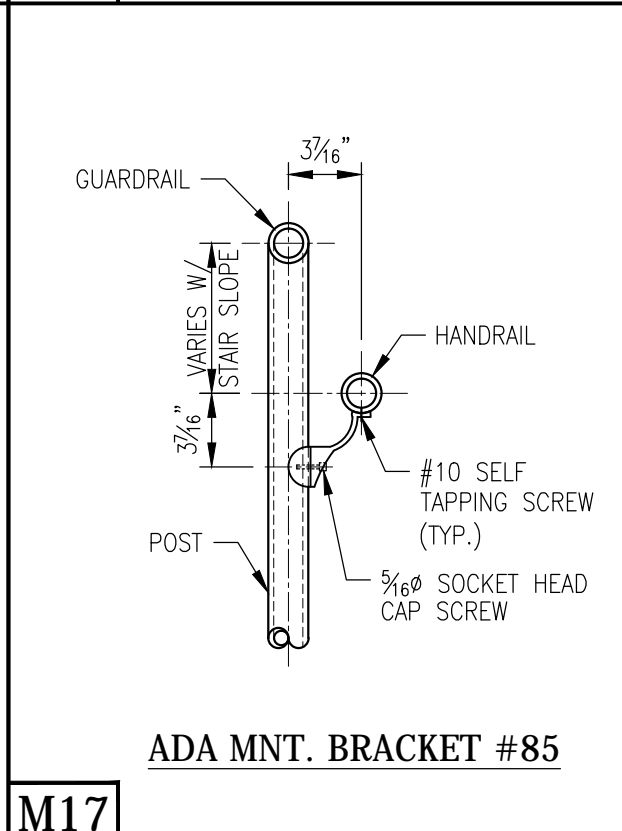
WALL MNT. BRACKET #82

M15



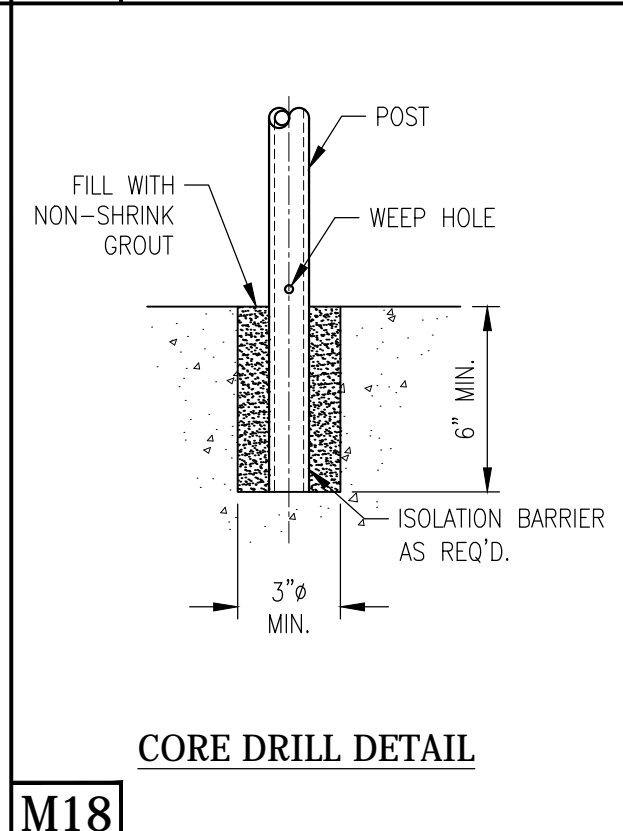
FLANGE #45SBCS

M16



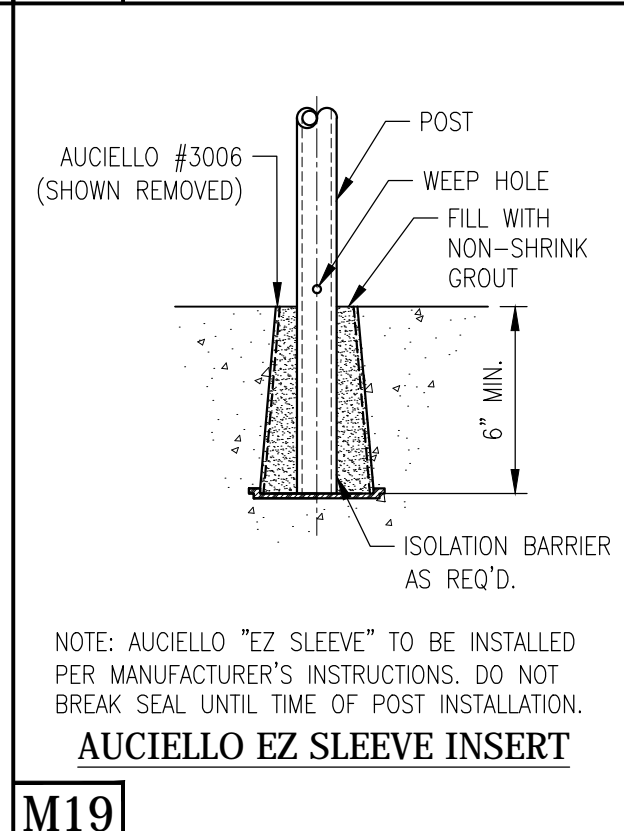
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M17



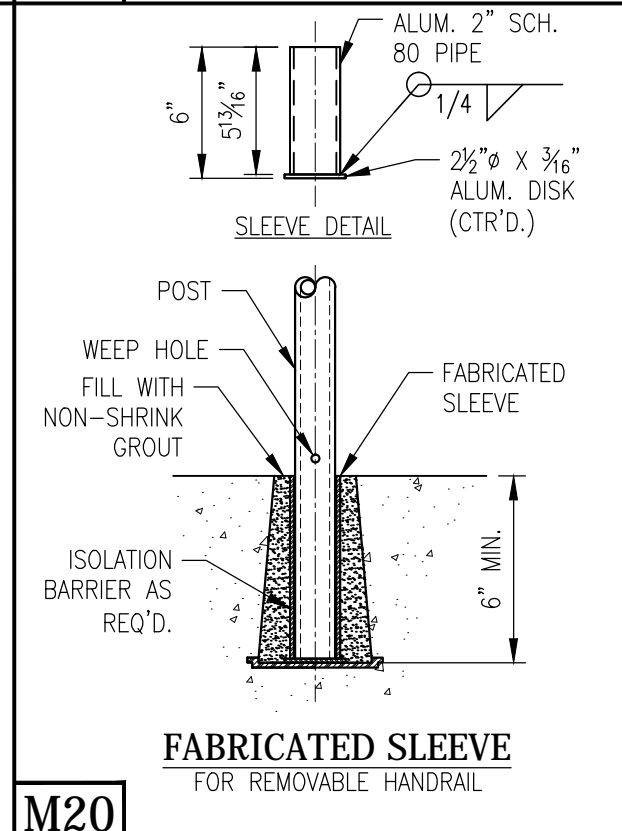
CORE DRILL DETAIL

M18



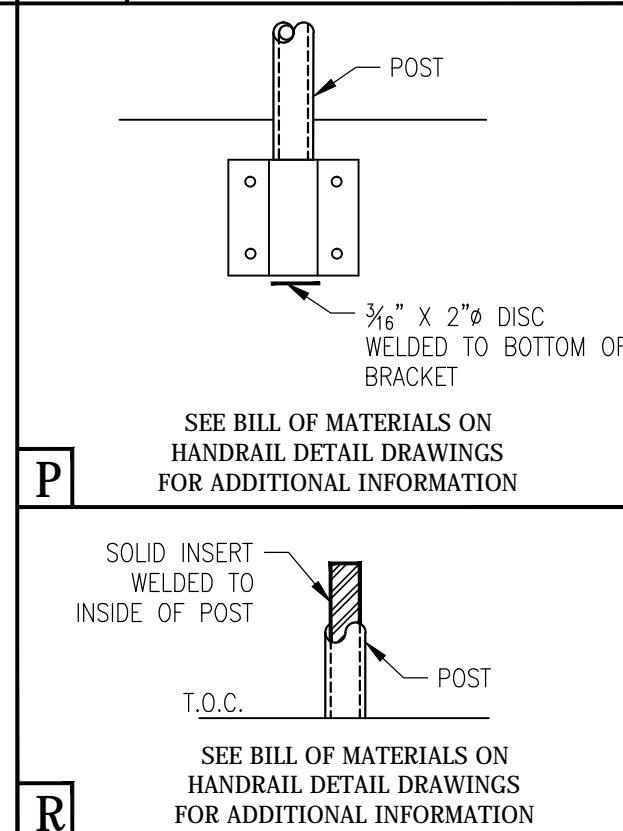
AUCIELLO EZ SLEEVE INSERT

M19



FABRICATED SLEEVE

M20



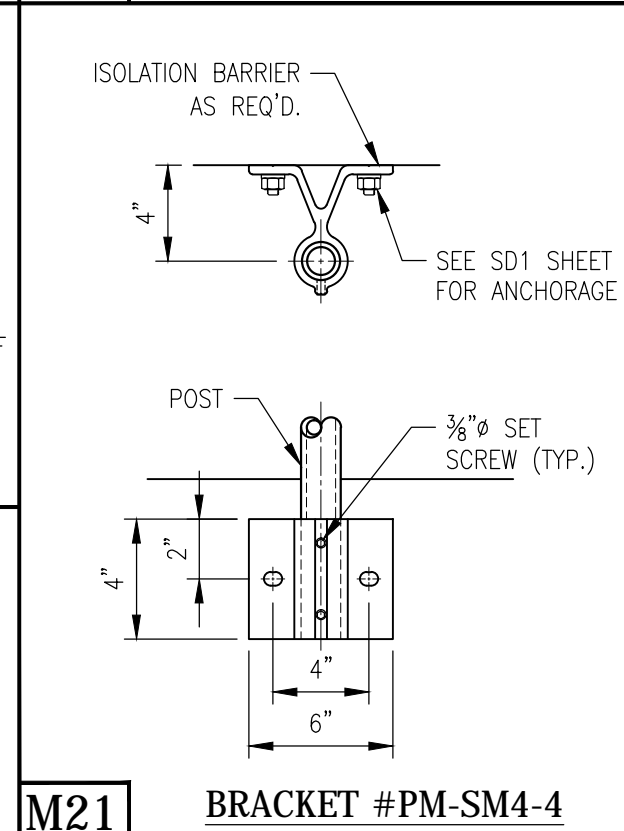
SEE BILL OF MATERIALS ON HANDRAIL DETAIL DRAWINGS FOR ADDITIONAL INFORMATION

SOLID INSERT WELDED TO INSIDE OF POST

T.O.C.

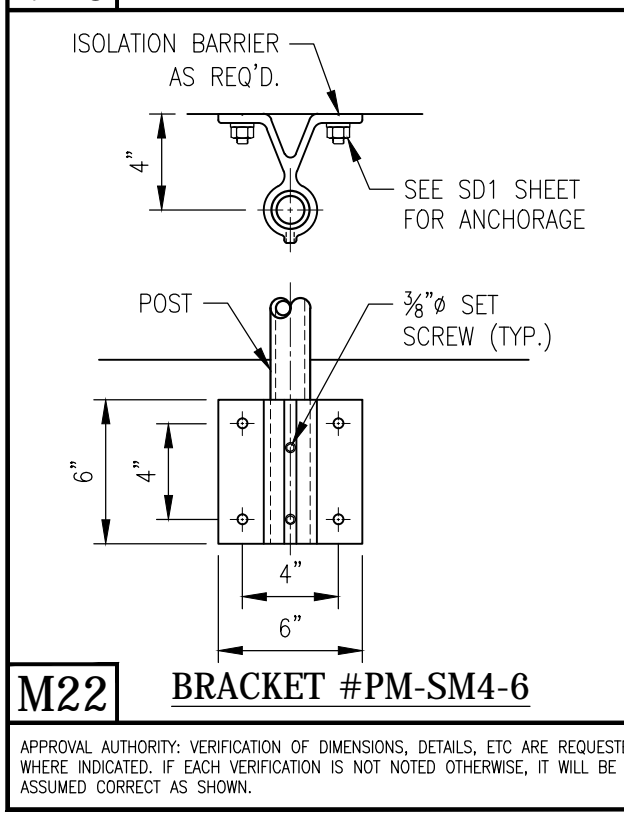
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P



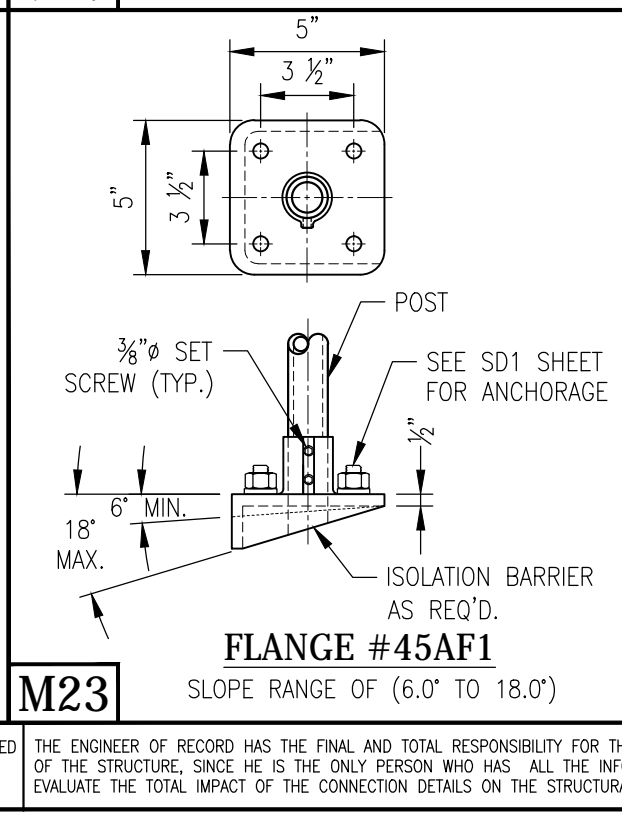
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M21



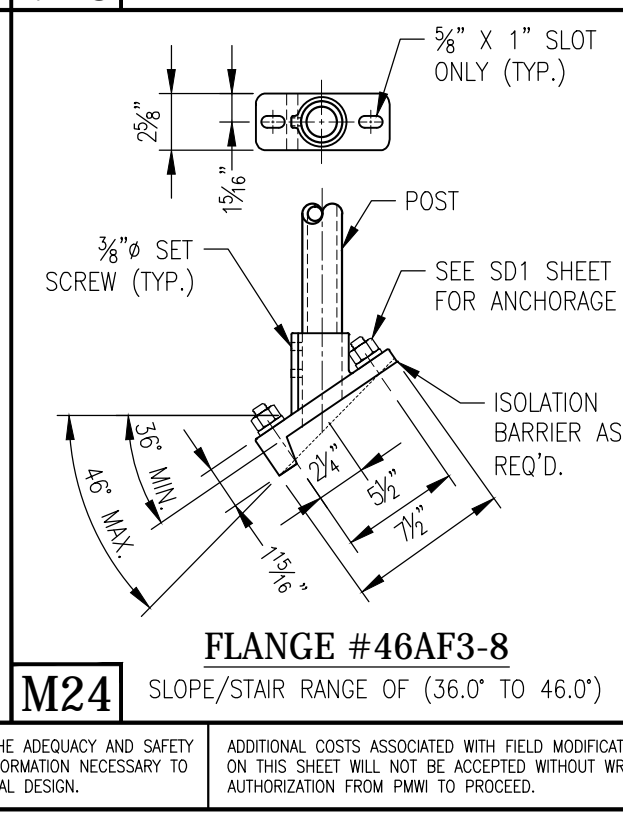
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M22



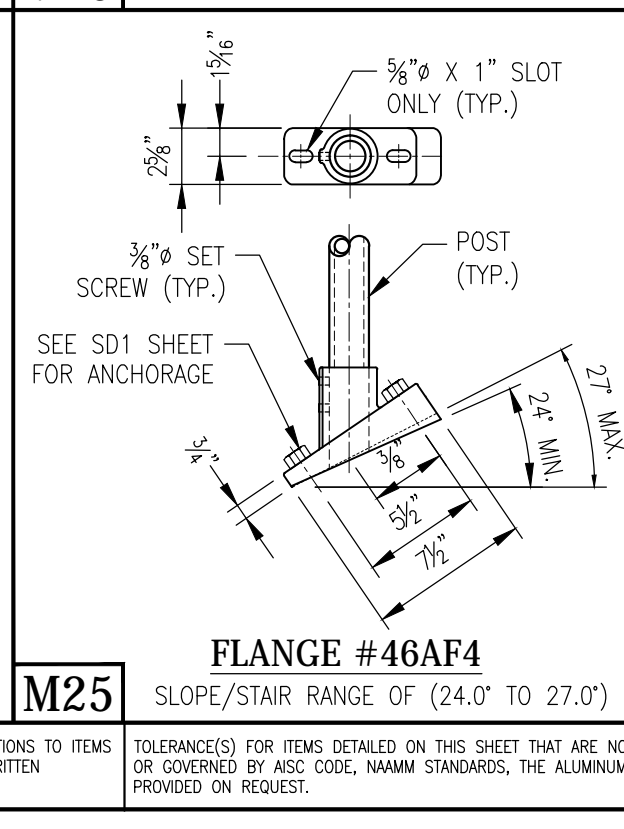
FLANGE #45AF1

M23



FLANGE #46AF3-8

M24



FLANGE #46AF4

M25

PHONE: (570) 282-6164 FAX: (570) 281-5931

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 45 DUNDAFF STREET
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 STATE OF N.J. CERT. OF AUTH.: 24GA28256200

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#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.

TITLE: PMWI COMPONENT RAIL SYSTEM

MOUNT DETAILS

TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	M.H.	9-27-17	N.L.	10/5/17	17-3046-ASD2	

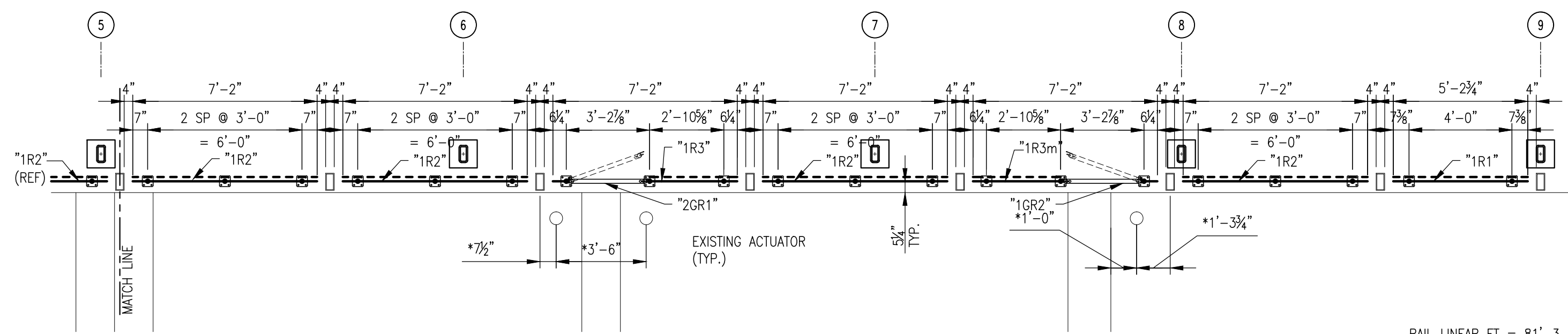
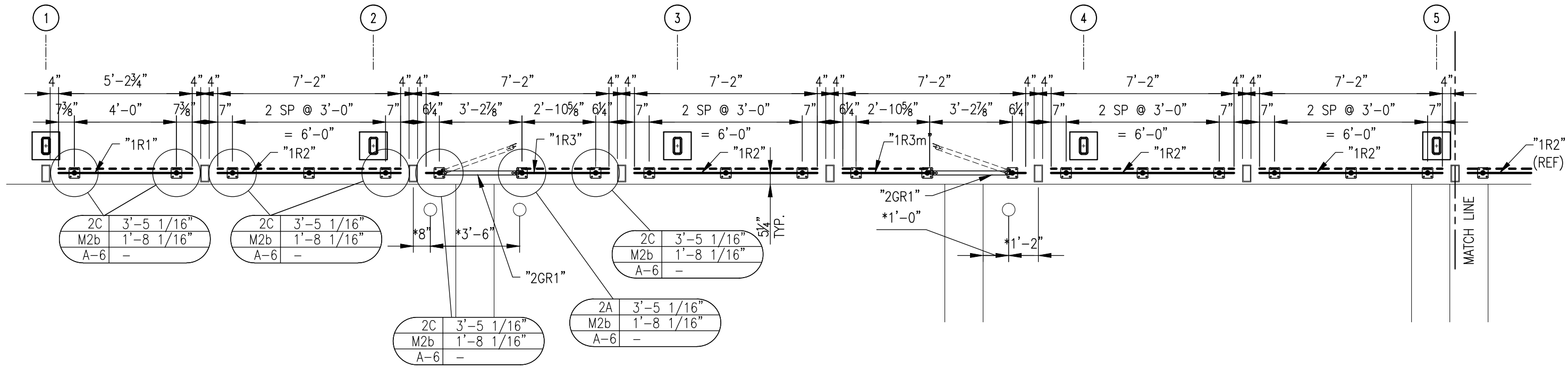
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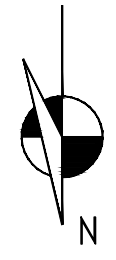
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HANDRAIL PLAN



RAIL LINEAR FT = 81'-3 13/16"
 TL RAIL REQ'D = 211'-0"
 RAIL STICKS REQ'D = 9
 POST LINEAR FT = 147'-0"
 POST STICKS REQ'D = 7
 MOUNT = M2 @ 40

REL. DATE	Pcs	Assembly	TEMP	No. Pcs	SECTION	GRADE	LENGTH		FIN.	NOTES
							Ft.	In.		
H	2	1R1			HANDRAIL					
H	8	1R2			HANDRAIL					
H	2	1R3			HANDRAIL					
H	2	1R3m			HANDRAIL					
H		POST		7	PI 1-1/2 Sch80	6061-T6-A41	24	0		
H		RAIL		9	PI 1-1/2 Sch40	6063-T6-A41	24	0		
H	5	1RTBF			TOEBOARD TYPE-F		24	0		
H	6	1RTBS			TOEBOARD SPLICE					
H	6	1RRIV			1/8x3/8SS-RIVET					
H	80	1RTBC			TOEBOARD CLAMP					
H	40	1RMB1			MB 1/4x1	SS-304-B-N-W				
H		M2-SD2		40	PN-458C-8-A 1/2" HOLES					
H	160	1RTR1			TR 3/8x6	SS-316-R-N-W				
H	5	1Ra			HLTI HIT-HY 200R 11.1 oz					

A/E NOTE:
 WITH MECHANICAL HANDRAIL BEING SUBMITTED; CENTERLINE OF RAILS & POSTS TO BE 5 1/4" FROM EDGE OF TANK TO OBTAIN ANCHOR EDGE DISTANCE. CONFIRM TO BE ACCEPTABLE

NOTE: REFERENCE STANDARD DETAIL DRAWINGS MA2SD1 AND ASD2 FOR TYPICAL HANDRAIL ELEVATIONS, TERMINATIONS AND MOUNT DETAILS SPECIFIC TO THIS HANDRAIL SYSTEM

PMWI BILLING CODE A-3
 PHONE: (570) 282-6164 FAX: (570) 281-5931
PLEASANT MOUNT WELDING, INC.
 45 DUNDAFF STREET
 CARBONDALE, PA. 18407
 VISIT US ON THE WEB @ www.pmwi.net STATE OF N.J. CERT. OF AUTH.: 24GA28256200

#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.

TITLE: PRIMARY SETTLING TANKS REF. CTRACT DWG.- A-1, S-1
ALUM HANDRAIL - PLAN & DETAILS

TEAM	DETAILER	DATE	CHKD BY	DATE	SHEET NO.	REV
MH	CO	9/29/17	BF	10/5/17	17-3046-0001R	

LEGEND	
	HANDRAIL
	TOEBOARD
	HANDRAIL POST
	REM. HANDRAIL POST
	CHAIN
	RIGID FIELD CONNECTION
	SPLICE CONNECTION

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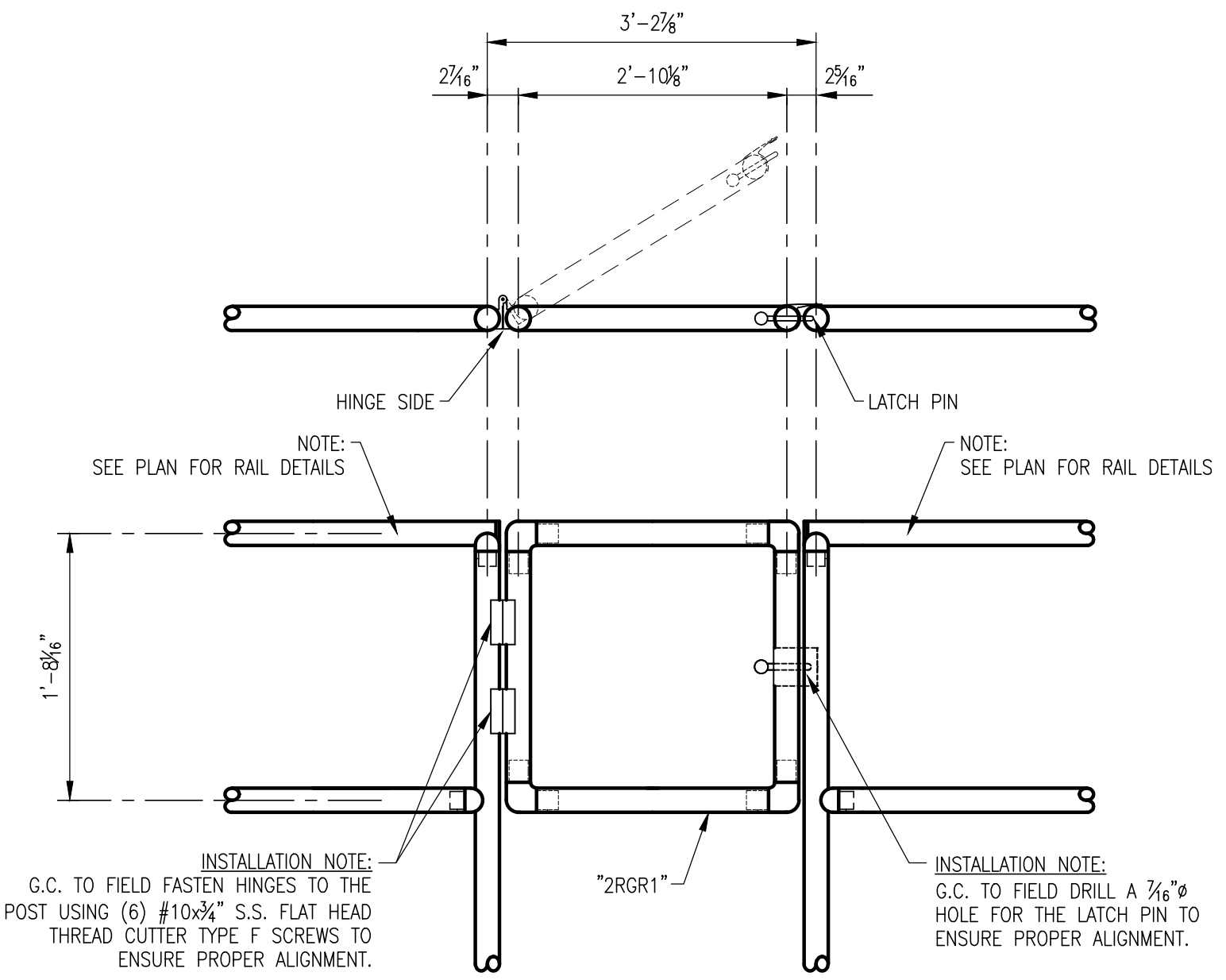
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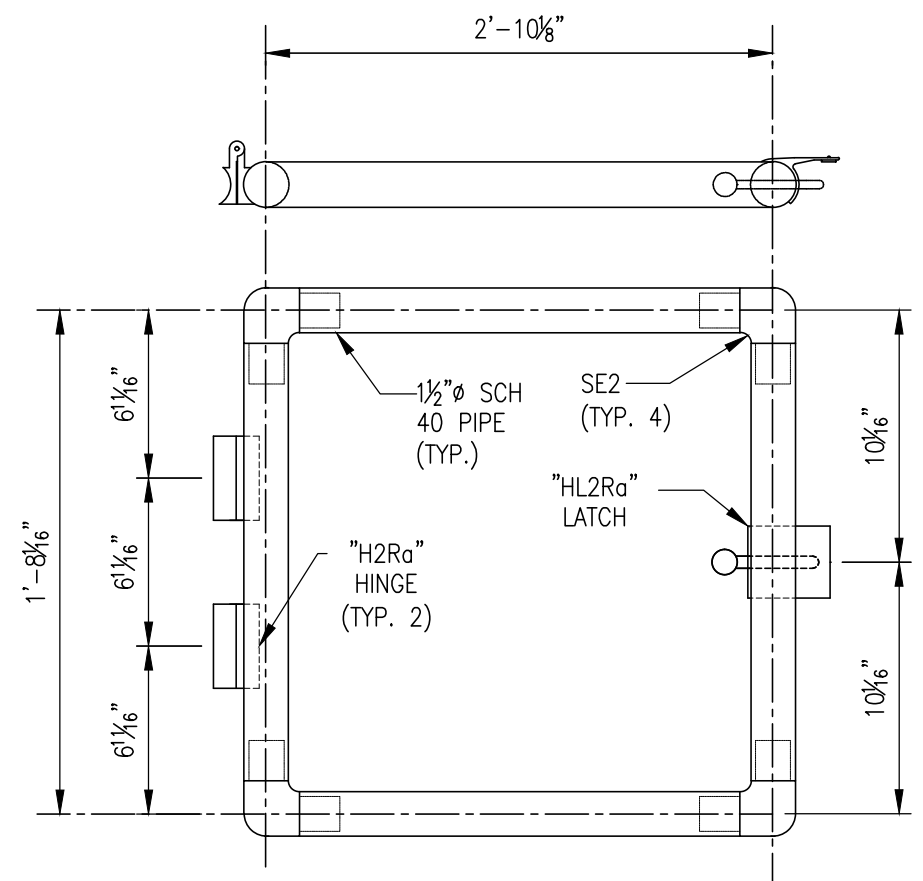
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* GC TO FIELD VERIFY LOCATIONS OF ACTUATORS AS SHOWN, SO GATES CAN BE LOCATED ACCORDINGLY

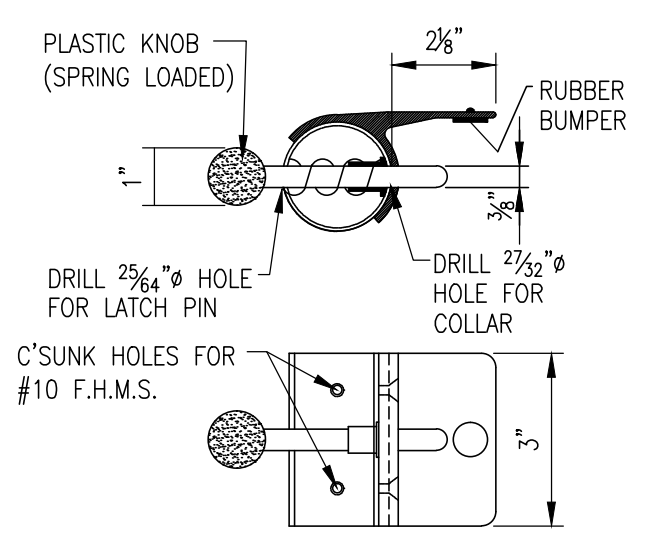
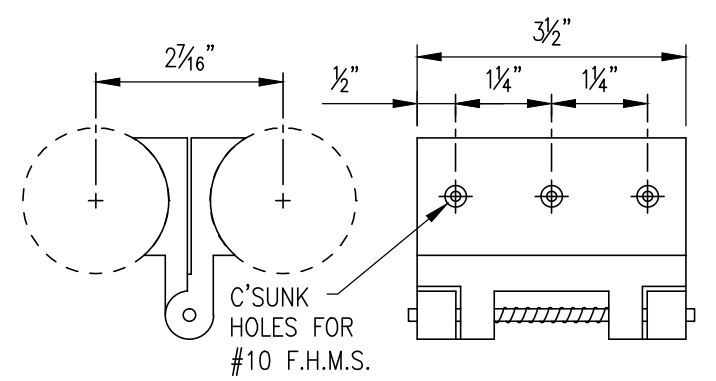


PARTIAL GATE PLAN & ELEVATION
NOTE: SEE HANDRAIL PLAN FOR LOCATION & ORIENTATION



"2RGR1" (4 REQ'D)
BILLING CODE: A-3

FASTEN HINGES TO GATE & LADDER W/
#10x3/4" S.S. FLAT HEAD THREAD CUTTER
TYPE F SCREWS (SHOP LOCATE)
SHOP TO LOCATE 7/16" Ø
HOLE FOR LATCH PIN



"HL2Ra" (4 REQ'D)
R&B WAGNER, INC. P.N. #IR101
SPRING LOADED LATCH ASSEMBLY

BILL OF MATERIALS

REL. DATE	Pcs	Assembly	TEMP	No. Pcs	SECTION	GRADE	LENGTH		FIN.	NOTES
							Ft.	In.		
H	4	2GR1			PI 1 1/2" SCH. 40	6063-T6	24	0	M	
				SE-2	PN-131FT-8					
				ELBOW	ELBOW SET SCREW					
				H2Ra	#IR100	ALUM.			M	HINGE
				HL2Ra	#IR101	ALUM.			M	LATCH

NOTE: REFERENCE STANDARD DETAIL DRAWINGS MA2SD1 AND ASD2 FOR TYPICAL HANDRAIL ELEVATIONS, TERMINATIONS AND MOUNT DETAILS SPECIFIC TO THIS HANDRAIL SYSTEM

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VISIT US ON THE WEB @ www.pmwi.net

#	DATE	REVISIONS & NOTES	BY	CHK

PROJECT: W/ C H NICKERSON AND CO.
MATTABASSETT WPCF- CROMWELL, CT.
TITLE: PRIMARY SETTLING TANKS REF. CTRACT DWG.- A-1, S-1
ALUM GATE - DETAILS

**THE MATTABASSETT DISTRICT
PRIMARY TANKS DOORS
REPLACEMENT PROJECT
CROMWELL, CT**

"I hereby certify that I have carefully examined the enclosed submittal and have determined and verified all field measurements, construction criteria, materials, catalog numbers and similar data, coordinated the submittal with other submissions and the work of other trades and contractors, and that to the best of my knowledge and belief, the enclosed submittal is in full compliance with the Contract Documents, except for the following deviations:"

DATE 11/09/17

CHECKED BY DAN TISO

SPEC REF. 08330 Roll Up Doors

SUBMITTAL NO.: 503-02

CHN JOB NO. 500-503
C.H. NICKERSON & CO.,INC.
TORRINGTON, CT 06790



SECTION 08 33 36
OVERHEAD COILING DOORS

ITEM #	QTY	SERIES	DOOR WIDTH	DOOR HEIGHT	OPENING WIDTH	OPENING HEIGHT	OPERATION	MOUNTING	JAMB TYPE
1	1	610	12' 6"	8' 2"	12' 6"	8' 2"	CHAIN HOIST	EXTERIOR	STEEL
2	2	610	11' 7"	8' 2"	11' 7"	8' 2"	CHAIN HOIST	EXTERIOR	STEEL
3	1	610	15' 7"	8' 2"	15' 7"	8' 2"	CHAIN HOIST	EXTERIOR	STEEL
4	1	610	13' 6"	8' 2"	13' 6"	8' 2"	CHAIN HOIST	EXTERIOR	STEEL
5	1	610	13' 9"	8' 2"	13' 9"	8' 2"	CHAIN HOIST	EXTERIOR	STEEL
6	1	610	15' 8"	8' 2"	15' 8"	8' 2"	CHAIN HOIST	EXTERIOR	STEEL
7	1	610	13' 7.5"	8' 2"	13' 7.5"	8' 2"	CHAIN HOIST	EXTERIOR	STEEL

PART 1 GENERAL

1.1 SECTION INCLUDES

- A. Overhead coiling service doors.

1.2 RELATED SECTIONS

- A. Section 05 50 00 - Metal Fabrications.
- B. Section 06 20 00 - Finish Carpentry.
- C. Section 08333 - Security Grilles.
- D. Section 08 71 53 - Security Door Hardware.
- E. Section 09 90 00 - Painting and Coating.
- F. Section 27 05 39 - Surface Raceways for Communications Systems.
- G. Section 26 05 00 - Common Work Results for Electrical.

1.3 REFERENCES

- A. ANSI/DASMA 108 - American National Standards Institute Standard Method For Testing Sectional Garage Doors And Rolling Doors: Determination Of Structural Performance Under Uniform Static Air Pressure Difference.
- B. NFRC 102 - Test Procedure for Measuring the Steady-State Thermal Transmittance of Fenestration Systems.
- C. ASTM E 90 - Standard Test Method for Laboratory Measurement of Airborne Sound Transmission Loss of Building Partitions and Element.
- D. ASTM E 330 - Standard Test Method for Structural Performance of Exterior Windows, Doors, Skylights and Curtain Walls by Uniform Static Air Pressure Difference.
- E. ASTM A 653 - Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.

- F. ASTM A 666 - Standard Specification for Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
- G. ASTM A 924 - Standard Specification for General Requirements for Steel Sheet, Metallic-Coated by the Hot-Dip Process.
- H. ASTM B 221 - Standard Specification for Aluminum and Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
- I. NEMA 250 - Enclosures for Electrical Equipment (1000 Volts Maximum).
- J. NEMA MG 1 - Motors and Generators.

1.4 DESIGN / PERFORMANCE REQUIREMENTS

- A. Overhead coiling service doors:
 - 1. Wind Loads: Design door assembly to withstand wind/suction load of 50/50 psf without damage to door or assembly components in conformance with ASTM E 330.
 - 2. Operation: Design door assembly, including operator, to operate for not less than 20,000 cycles.
- B. Single-Source Responsibility: Provide doors, tracks, motors, and accessories from one manufacturer for each type of door. Provide secondary components from source acceptable to manufacturer of primary components.
- C. Products Requiring Electrical Connection: Listed and classified by Underwriters Laboratories, Inc. acceptable to authority having jurisdiction as suitable for purpose specified.

1.5 SUBMITTALS

- A. Submit under provisions of Section 01 30 00 - Administrative Requirements.
- B. Product Data: Manufacturer's data sheets on each product to be used, including:
 - 1. Preparation instructions and recommendations.
 - 2. Storage and handling requirements and recommendations.
 - 3. Details of construction and fabrication.
 - 4. Installation instructions.
- C. Shop Drawings: Include detailed plans, elevations, details of framing members, anchoring methods, required clearances, hardware, and accessories. Include relationship with adjacent construction.
- D. Selection Samples: For each finish product specified, two complete sets of color chips representing manufacturer's full range of available colors and patterns.
- E. Verification Samples: For each finish product specified, two samples, minimum size 6 inches (150 mm) long, representing actual product, color, and patterns.
- F. Manufacturer's Certificates: Certify products meet or exceed specified requirements.
- G. Operation and Maintenance Data: Submit lubrication requirements and frequency, and periodic adjustments required.

1.6 QUALITY ASSURANCE

- A. Manufacturer Qualifications: Company specializing in performing Work of this section with a minimum of five years experience in the fabrication and installation of security closures.

- B. Installer Qualifications: Installer Qualifications: Company specializing in performing Work of this section with minimum three years and approved by manufacturer.
- C. Mock-Up: Provide a mock-up for evaluation of surface preparation techniques and application workmanship.
 - 1. Finish areas designated by Architect.
 - 2. Do not proceed with remaining work until workmanship, color, and sheen are approved by Architect.
 - 3. Refinish mock-up area as required to produce acceptable work.

1.7 DELIVERY, STORAGE, AND HANDLING

- A. Store products in manufacturer's unopened packaging until ready for installation.
- B. Protect materials from exposure to moisture. Do not deliver until after wet work is complete and dry.
- C. Store materials in a dry, warm, ventilated weathertight location.

1.8 PROJECT CONDITIONS

- A. Maintain environmental conditions (temperature, humidity, and ventilation) within limits recommended by manufacturer for optimum results. Do not install products under environmental conditions outside manufacturer's absolute limits.

1.9 COORDINATION

- A. Coordinate Work with other operations and installation of adjacent materials to avoid damage to installed materials.

1.10 WARRANTY

- A. Warranty: Manufacturer's limited door and operator system, except the counterbalance spring and finish, to be free from defects in materials and workmanship for 3 years or 20,000 cycles, whichever occurs first.
- B. Warranty: Manufacturer's limited door system warranty for 2 years for all parts and components.

PART 2 PRODUCTS

2.1 MANUFACTURERS

- A. Acceptable Manufacturer: Overhead Door Corp., 2501 S. State Hwy. 121, Suite 200, Lewisville, TX 75067.
- B. Substitutions: Not permitted.
- C. Requests for substitutions will be considered in accordance with provisions of Section 01 60 00 - Product Requirements.

2.2 OVERHEAD COILING SERVICE DOORS

- A. Industrial Doors: Overhead Door Corporation, Model 610 Service Doors.
 - 1. Curtain: Interlocking roll-formed slats as specified following. Endlocks shall be attached to each end of alternate slats to prevent lateral movement.
 - a. Flat profile type F-265 for doors up to 18 feet 4 inches (5.59 m) wide, fabricated of:

- 1) 22 gauge galvanized steel.
2. Finish:
 - a. Galvanized Steel: Slats and hood galvanized in accordance with ASTM A 653 and receive rust-inhibitive, roll coating process, including 0.2 mils thick baked-on prime paint, and 0.6 mils thick baked-on polyester top coat.
 - 1) Powder Coat:
 - a) Premium powder coat color as selected by the Architect. (To be determined) Must select several color samples from the Tiger Drylac RAL color chart (supplied in this submittal package) and OHD of Norwich will send request for true samples to be approved in writing.
 - 2) Non-galvanized exposed ferrous surfaces shall receive one coat of rust-inhibitive primer.
3. Weather seals:
 - a. Vinyl bottom seal.
4. Bottom Bar:
 - a. Two primed steel angles
 - b. Guides: Three structural steel angles with vinyl weather stripping inside and outside
 - c. Finish: Premium powder coat color as selected by the Architect. (see above notes)
5. Brackets:
 - a. Hot rolled steel to support counterbalance, curtain and hood.
6. Counterbalance: Helical torsion spring type housed in a steel tube or pipe barrel, supporting the curtain with deflection limited to 0.03 inch per foot of span. Counterbalance is adjustable by means of an adjusting tension wheel.
7. Hood:
 - a. 24 gauge galvanized steel with intermediate supports as required.
8. Manual Operation:
 - a. Chain hoist
9. Wind load Design:
 - a. Standard wind load shall be 50/50 PSF.
10. Locking:
 - a. Two interior bottom bar slide bolts for manually operated doors.
11. Wall Mounting Condition:
 - a. Between jambs mounting.
 - b. Exterior Mounted on Tube steel supplied and installed by others and not Overhead Door Company of Norwich, Inc.

PART 3 EXECUTION

3.1 EXAMINATION

- A. Verify opening sizes, tolerances and conditions are acceptable.
- B. Examine conditions of substrates, supports, and other conditions under which this work is to be performed.
- C. If substrate preparation is the responsibility of another installer, notify Architect of unsatisfactory preparation before proceeding.

3.2 PREPARATION

- A. Clean surfaces thoroughly prior to installation.
- B. Prepare surfaces using the methods recommended by the manufacturer for achieving the best result for the substrate under the project conditions.

3.3 INSTALLATION

- A. Install in accordance with manufacturer's instructions.
- B. Use anchorage devices to securely fasten assembly to wall construction and building framing without distortion or stress.
- C. Securely and rigidly brace components suspended from structure. Secure guides to structural members only.
- D. Fit and align assembly including hardware; level and plumb, to provide smooth operation.
- E. Coordinate installation of electrical service with Section 26 05 00 - Common Work Results for Electrical. Complete wiring from disconnect to unit components.
- F. Coordinate installation of sealants and backing materials at frame perimeter as specified in Section 07 90 00 - Joint Protection.
- G. Install perimeter trim and closures.
- H. Instruct Owner's personnel in proper operating procedures and maintenance schedule.

3.4 ADJUSTING

- A. Test for proper operation and adjust as necessary to provide proper operation without binding or distortion.
- B. Adjust hardware and operating assemblies for smooth and noiseless operation.

3.5 CLEANING

- A. Clean curtain and components using non-abrasive materials and methods recommended by manufacturer.
- B. Remove labels and visible markings.
- C. Touch-up, repair or replace damaged products before Substantial Completion.

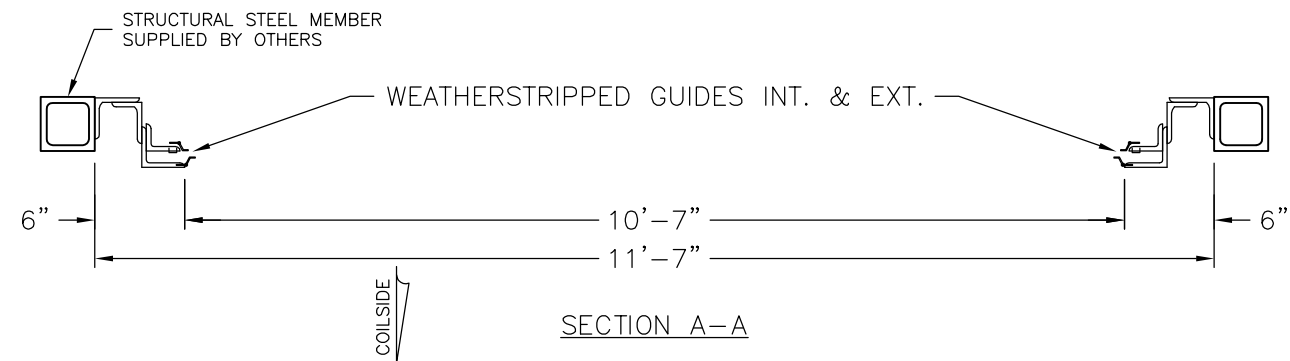
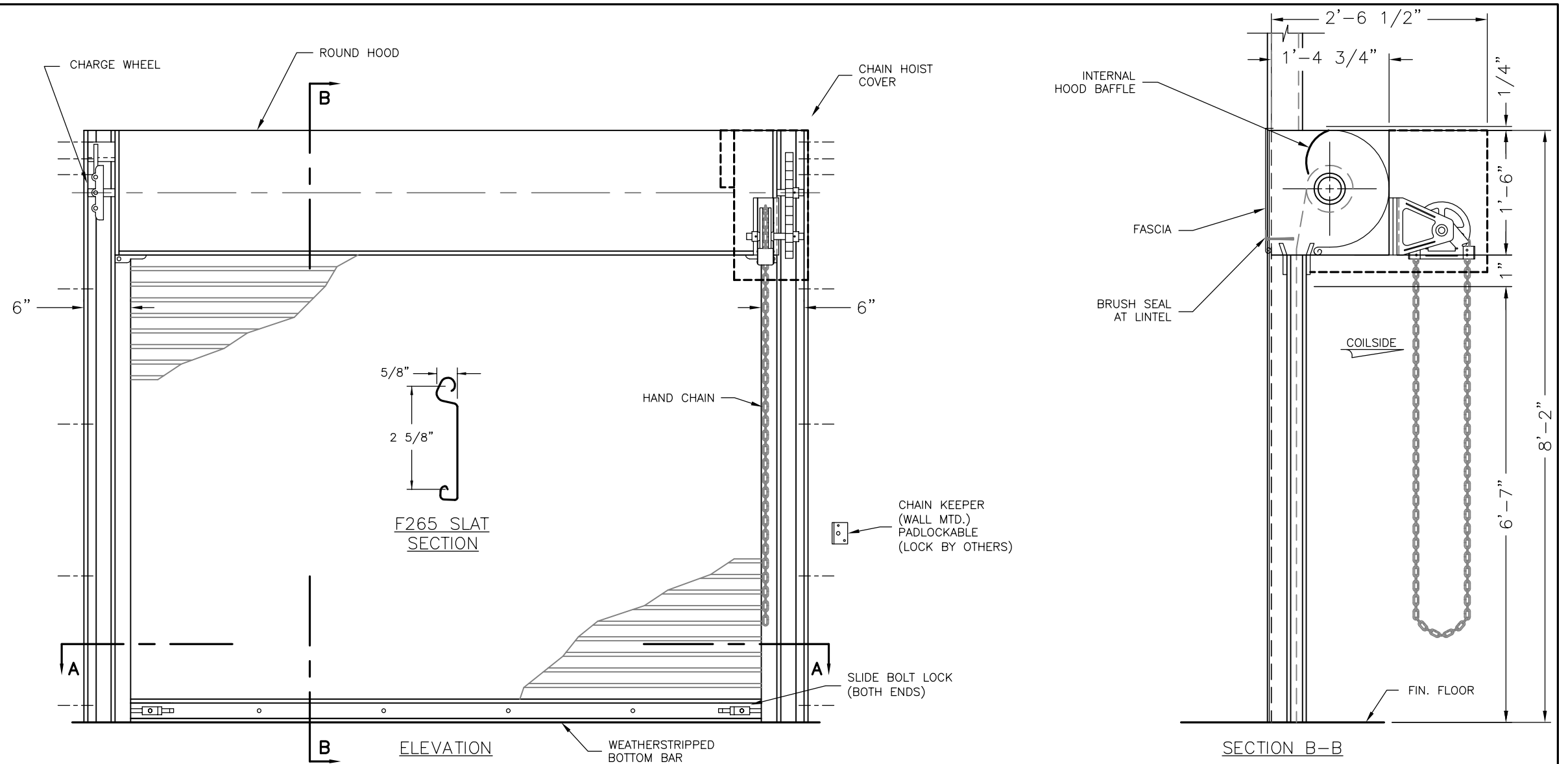
3.6 PROTECTION

- A. Protect installed products until completion of project.


*** All opening preparations, including jambs, jambs extended above the header, spring mounting pads, all to be done by others and not Overhead Door Company of Norwich, Inc. ***

END OF SECTION

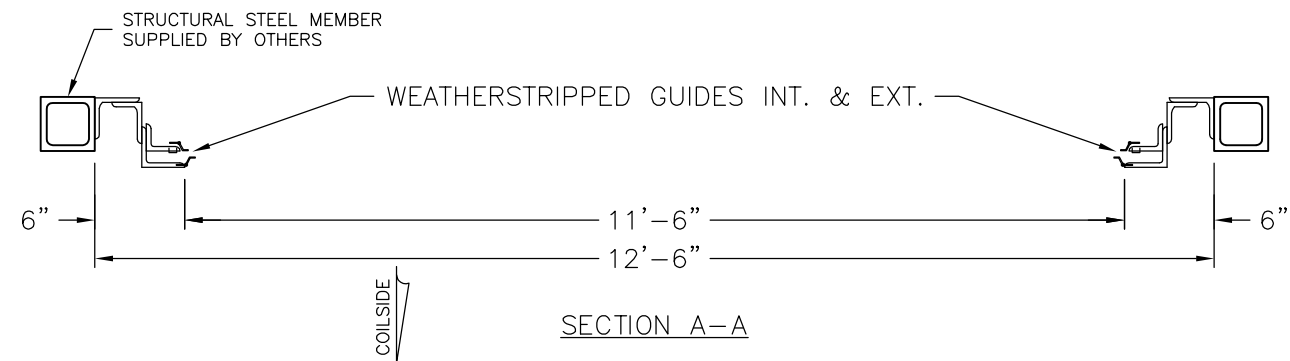
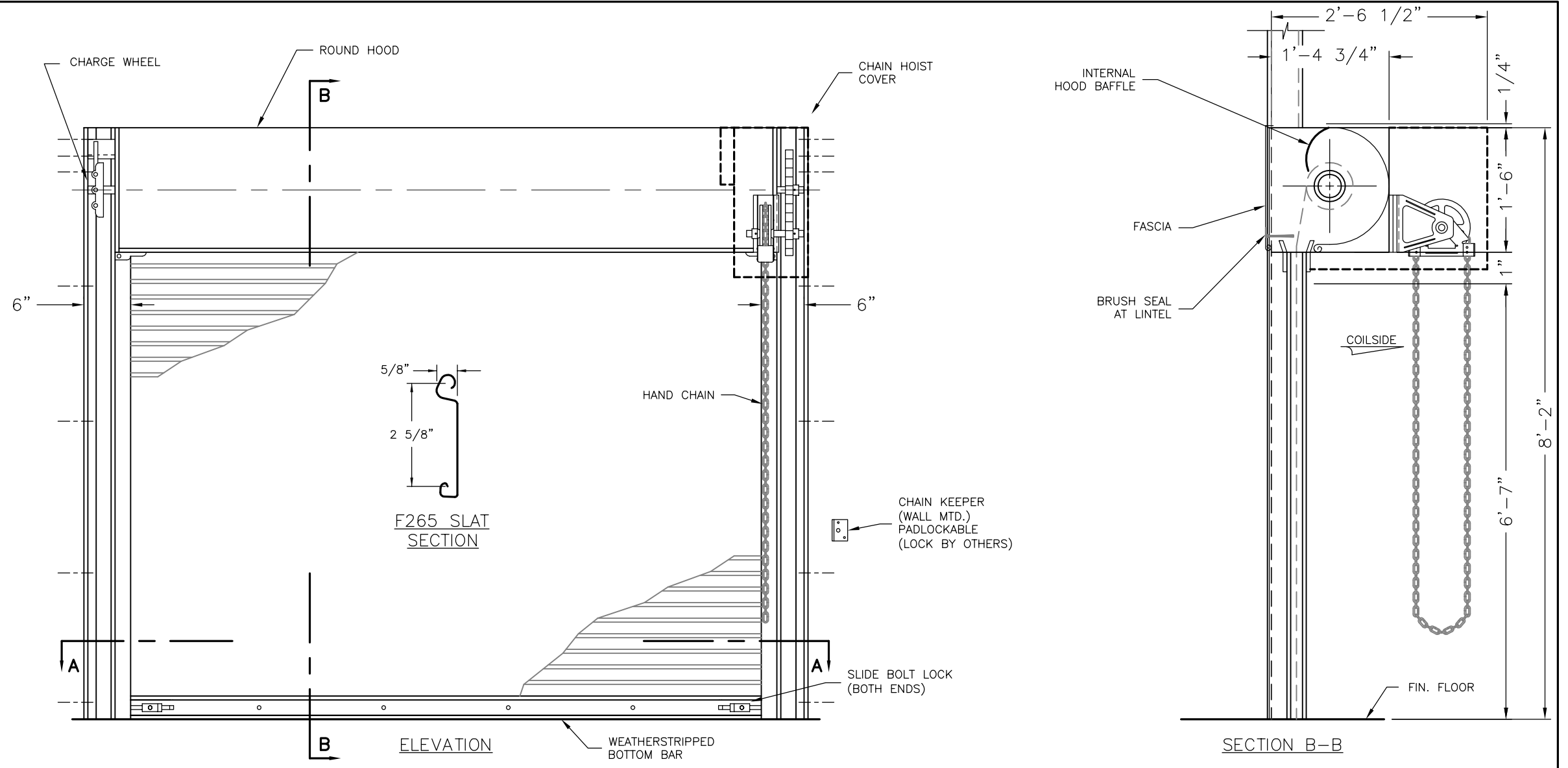
SPECIFICATIONS	
DOOR MARK	ITEM "A"
QUANTITY	TWO
WIDTH	11'-7" (BACK OF GUIDES)
HEIGHT	8'-2" (TOP OF COIL)
OPERATION	RIGHT HAND, CHAIN
MOUNT	EXTERIOR, BETWEEN JAMB
ENDLOCKS	SEE WINDLOCKS
WINDLOAD	50 P.S.F.
WINDLOCKS	ALTERNATE MALLEABLE IRON
MATERIAL	
CURTAIN	22 GA. GALVANIZED STEEL
HOOD/FASCIA	24 GA. GALVANIZED STEEL (G-90)
GUIDES	STEEL L's
BOTTOM BAR	STEEL A's
FINISH	
COMPLETE DOOR	POWDER COATED, SPECIFY
NOTES:	
1.	




* All opening preparations, including jambs, jambs extended above the header, tubes, hood supports as shown on drawings, steel for back of hood to seal against, all to be done by others and not Overhead Door Company of Norwich, Inc. *

DISTRIBUTOR: OVERHEAD DOOR CO. OF NORWICH			P.O.# _____			 THE MATTERBASSETT DISTRICT CH NICKERSON	DRAWING NO. D17-1764	SERIES 610
DATE 11/7/17	REVISION REV A - T.H.	SHEET NO. 1 OF 7	JOB NO.		DR. BY T.H.		DATE: 10/25/17	SCALE: N.T.S.

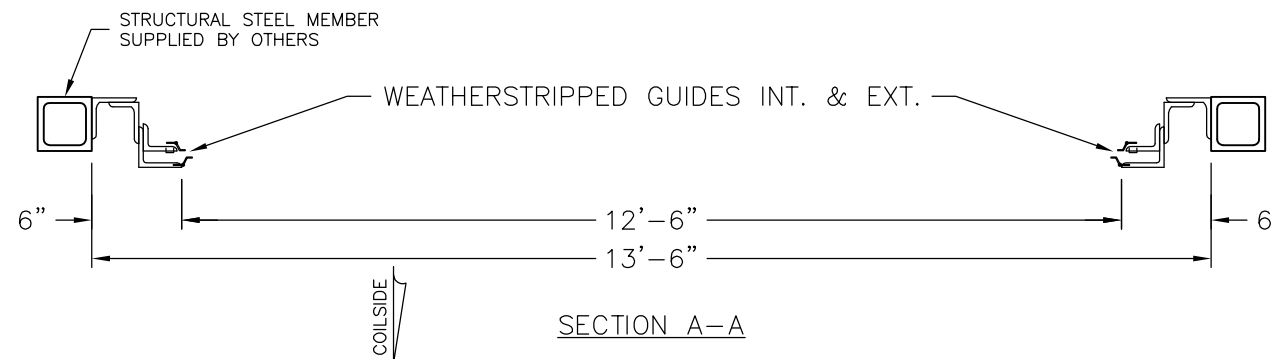
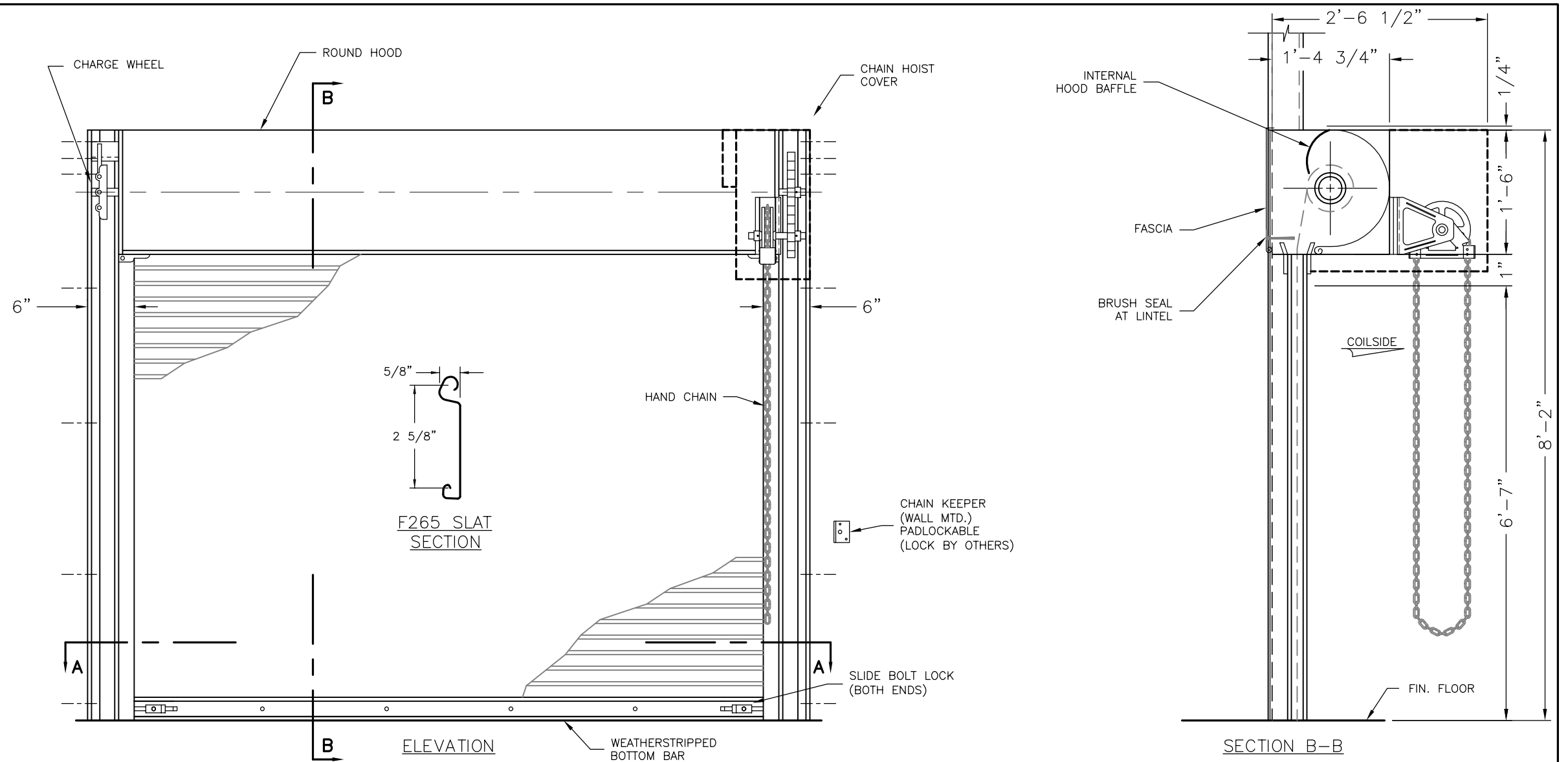
SPECIFICATIONS	
DOOR MARK	ITEM "B"
QUANTITY	ONE
WIDTH	12'-6" (BACK OF GUIDES)
HEIGHT	8'-2" (TOP OF COIL)
OPERATION	RIGHT HAND, CHAIN
MOUNT	EXTERIOR, BETWEEN JAMB
ENDLOCKS	SEE WINDLOCKS
WINDLOAD	50 P.S.F.
WINDLOCKS	ALTERNATE MALLEABLE IRON
MATERIAL	
CURTAIN	22 GA. GALVANIZED STEEL
HOOD/FASCIA	24 GA. GALVANIZED STEEL (G-90)
GUIDES	STEEL L's
BOTTOM BAR	STEEL A's
FINISH	
COMPLETE DOOR	POWDER COATED, SPECIFY
NOTES:	
1.	




* All opening preparations, including jambs, jambs extended above the header, tubes, hood supports as shown on drawings, steel for back of hood to seal against, all to be done by others and not Overhead Door Company of Norwich, Inc. *

DISTRIBUTOR: OVERHEAD DOOR CO. OF NORWICH			P.O.# _____				DRAWING NO. D17-1764	SERIES 610
DATE 11/7/17	REVISION REV A - T.H.	SHEET NO. 2 OF 7	JOB NO.		THE MATTERBASSETT DISTRICT CH NICKERSON		OVERHEAD DOOR CORPORATION 2501 S. STATE HWY 121, STE 200 LEWISVILLE, TX 75067	
		DR. BY T.H.	DATE: 10/25/17	SCALE: N.T.S.				

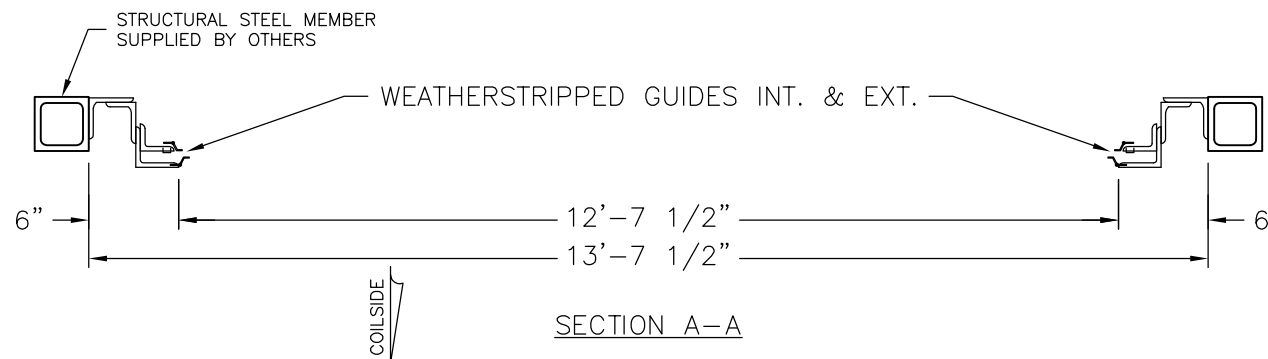
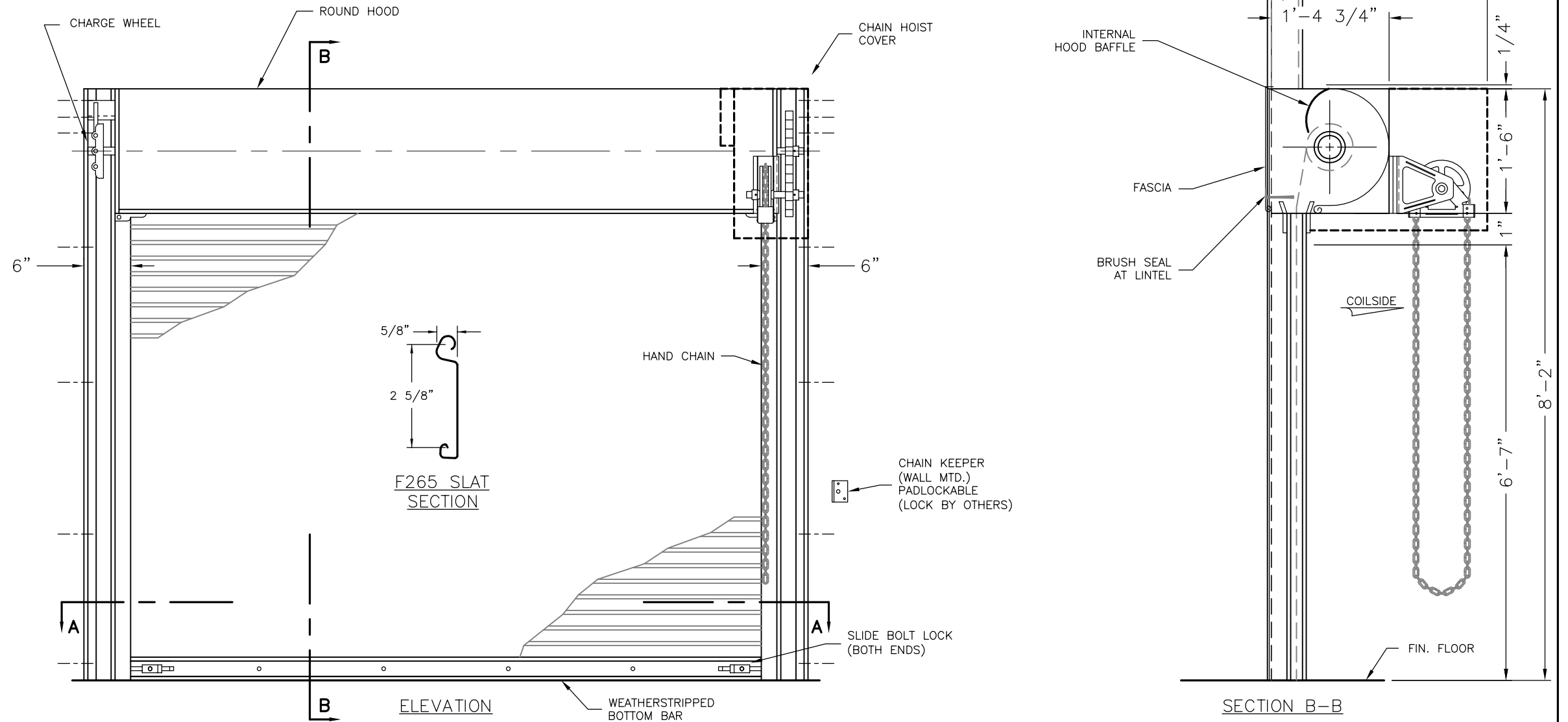
SPECIFICATIONS	
DOOR MARK	ITEM "C"
QUANTITY	ONE
WIDTH	13'-6" (BACK OF GUIDES)
HEIGHT	8'-2" (TOP OF COIL)
OPERATION	RIGHT HAND, CHAIN
MOUNT	EXTERIOR, BETWEEN JAMB
ENDLOCKS	SEE WINDLOCKS
WINDLOAD	50 P.S.F.
WINDLOCKS	ALTERNATE MALLEABLE IRON
MATERIAL	
CURTAIN	22 GA. GALVANIZED STEEL
HOOD/FASCIA	24 GA. GALVANIZED STEEL (G-90)
GUIDES	STEEL L's
BOTTOM BAR	STEEL A's
FINISH	
COMPLETE DOOR	POWDER COATED, SPECIFY
NOTES:	
1.	




* All opening preparations, including jambs, jambs extended above the header, tubes, hood supports as shown on drawings, steel for back of hood to seal against, all to be done by others and not Overhead Door Company of Norwich, Inc. *

DISTRIBUTOR: OVERHEAD DOOR CO. OF NORWICH				P.O.# _____			DRAWING NO. D17-1764	SERIES 610
DATE 11/7/17	REVISION REV A - T.H.	SHEET NO. 3 OF 7	JOB NO.		THE MATTERBASSETT DISTRICT CH NICKERSON		OVERHEAD DOOR CORPORATION 2501 S. STATE HWY 121, STE 200 LEWISVILLE, TX 75067	
		DR. BY T.H.	DATE: 10/25/17	SCALE: N.T.S.				

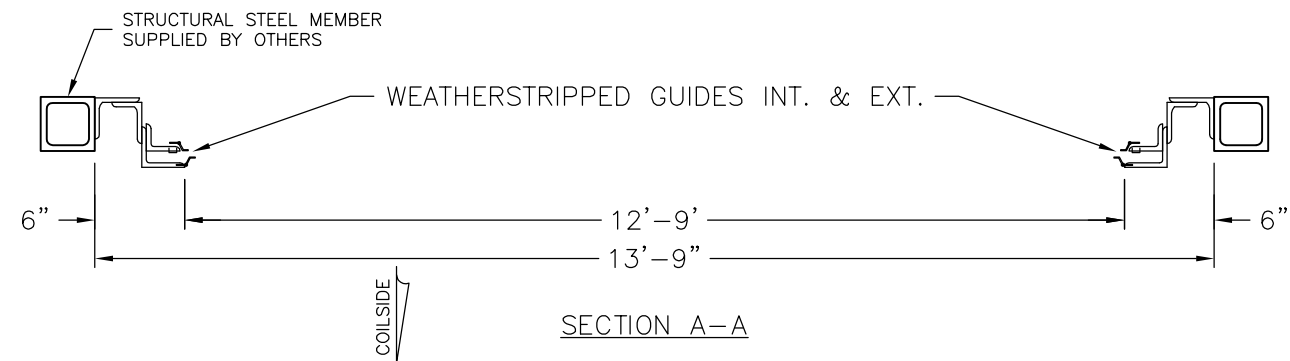
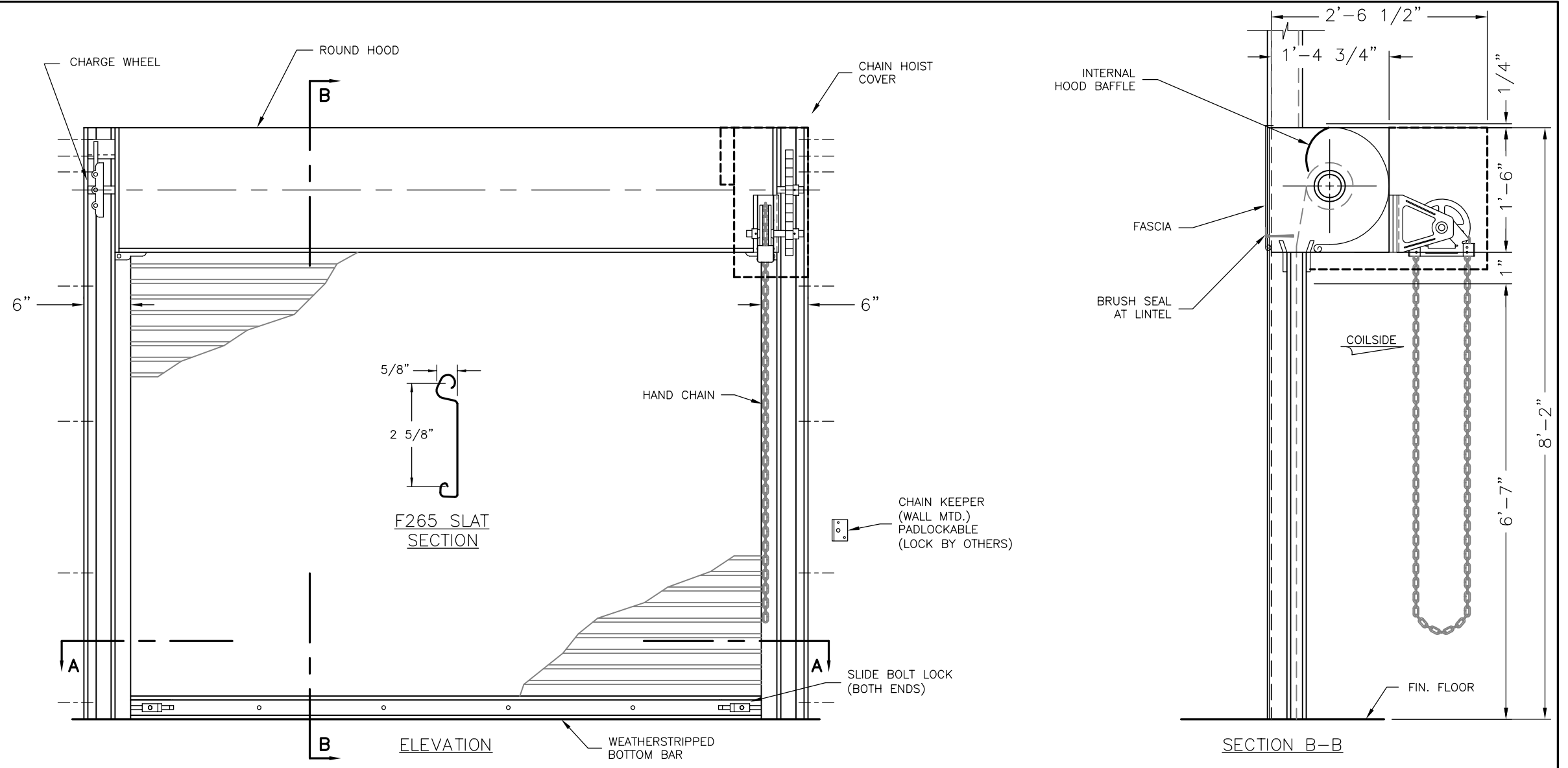
SPECIFICATIONS	
DOOR MARK	ITEM "D"
QUANTITY	ONE
WIDTH	13'-7 1/2" (BACK OF GUIDES)
HEIGHT	8'-2" (TOP OF COIL)
OPERATION	RIGHT HAND, CHAIN
MOUNT	EXTERIOR, BETWEEN JAMB
ENDLOCKS	SEE WINDLOCKS
WINDLOAD	50 P.S.F.
WINDLOCKS	ALTERNATE MALLEABLE IRON
MATERIAL	
CURTAIN	22 GA. GALVANIZED STEEL
HOOD/FASCIA	24 GA. GALVANIZED STEEL (G-90)
GUIDES	STEEL L's
BOTTOM BAR	STEEL A's
FINISH	
COMPLETE DOOR	POWDER COATED, SPECIFY
NOTES:	1.




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DATE 11/7/17	REVISION REV A - T.H.	SHEET NO. 4 OF 7	JOB NO.			THE MATTERBASSETT DISTRICT CH NICKERSON	OVERHEAD DOOR CORPORATION 2501 S. STATE HWY 121, STE 200 LEWISVILLE, TX 75067
		DR. BY T.H.	DATE: 10/25/17	SCALE: N.T.S.			

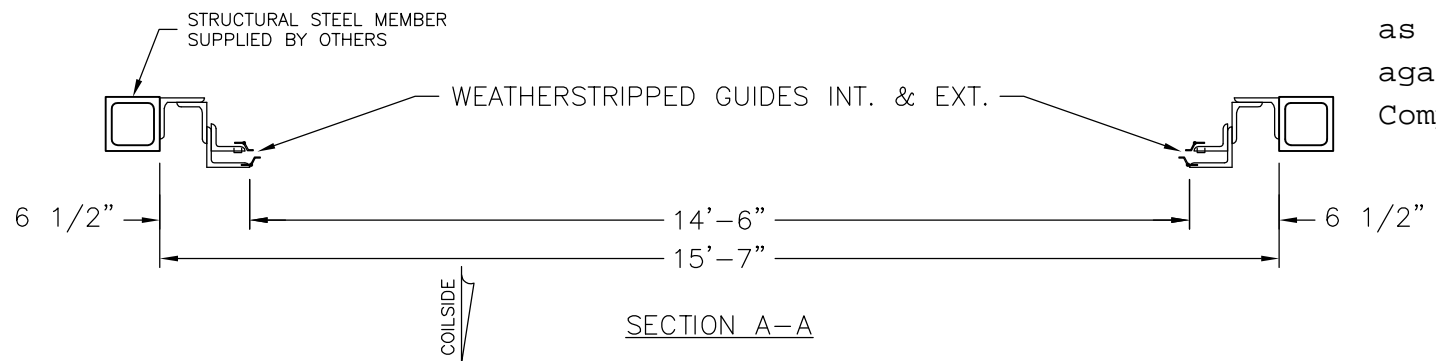
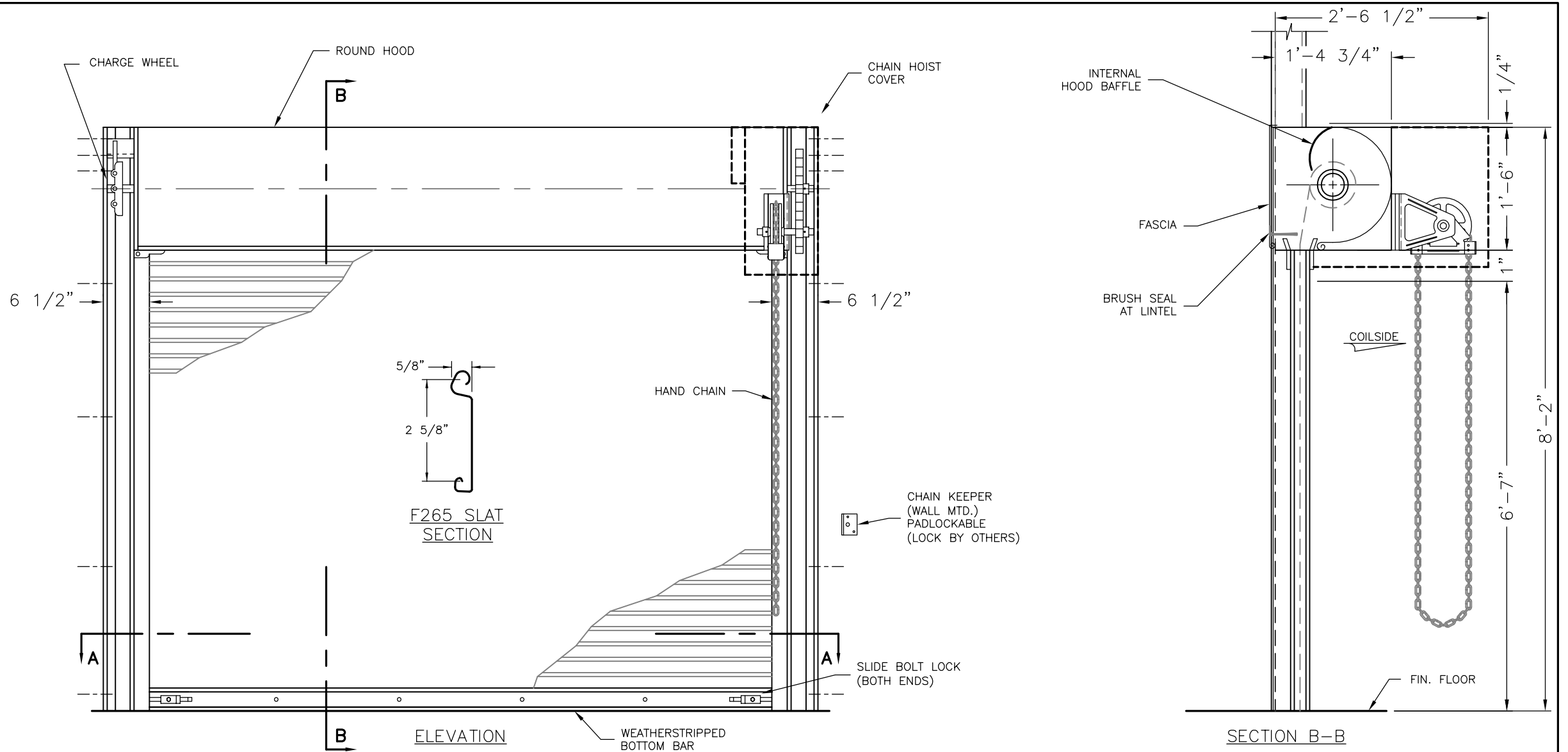
SPECIFICATIONS	
DOOR MARK	ITEM "E"
QUANTITY	ONE
WIDTH	13'-9" (BACK OF GUIDES)
HEIGHT	8'-2" (TOP OF COIL)
OPERATION	RIGHT HAND, CHAIN
MOUNT	EXTERIOR, BETWEEN JAMB
ENDLOCKS	SEE WINDLOCKS
WINDLOAD	50 P.S.F.
WINDLOCKS	ALTERNATE MALLEABLE IRON
MATERIAL	
CURTAIN	22 GA. GALVANIZED STEEL
HOOD/FASCIA	24 GA. GALVANIZED STEEL (G-90)
GUIDES	STEEL L's
BOTTOM BAR	STEEL A's
FINISH	
COMPLETE DOOR	POWDER COATED, SPECIFY
NOTES:	
1.	




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DATE 11/7/17	REVISION REV A - T.H.	SHEET NO. 5 OF 7	JOB NO.		DR. BY T.H.		DATE: 10/25/17	SCALE: N.T.S.

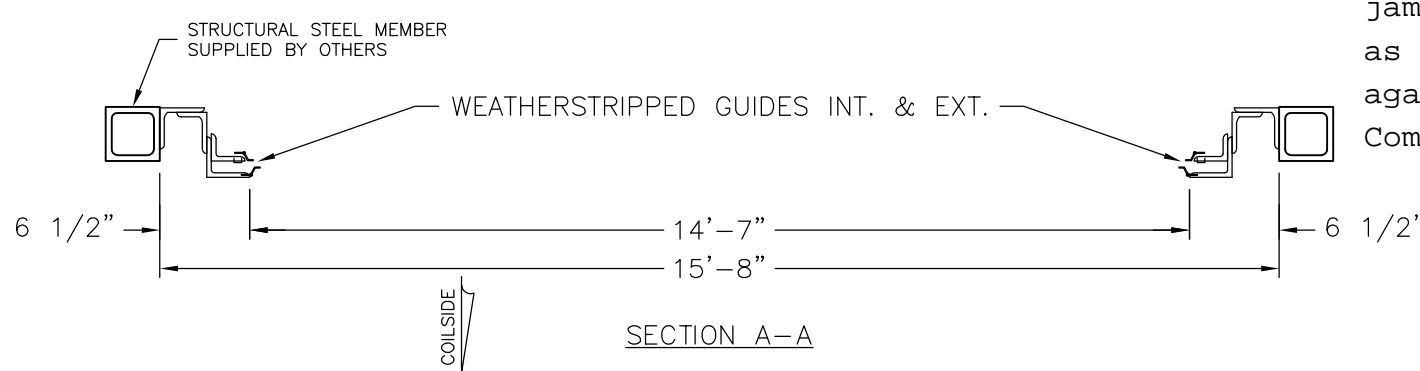
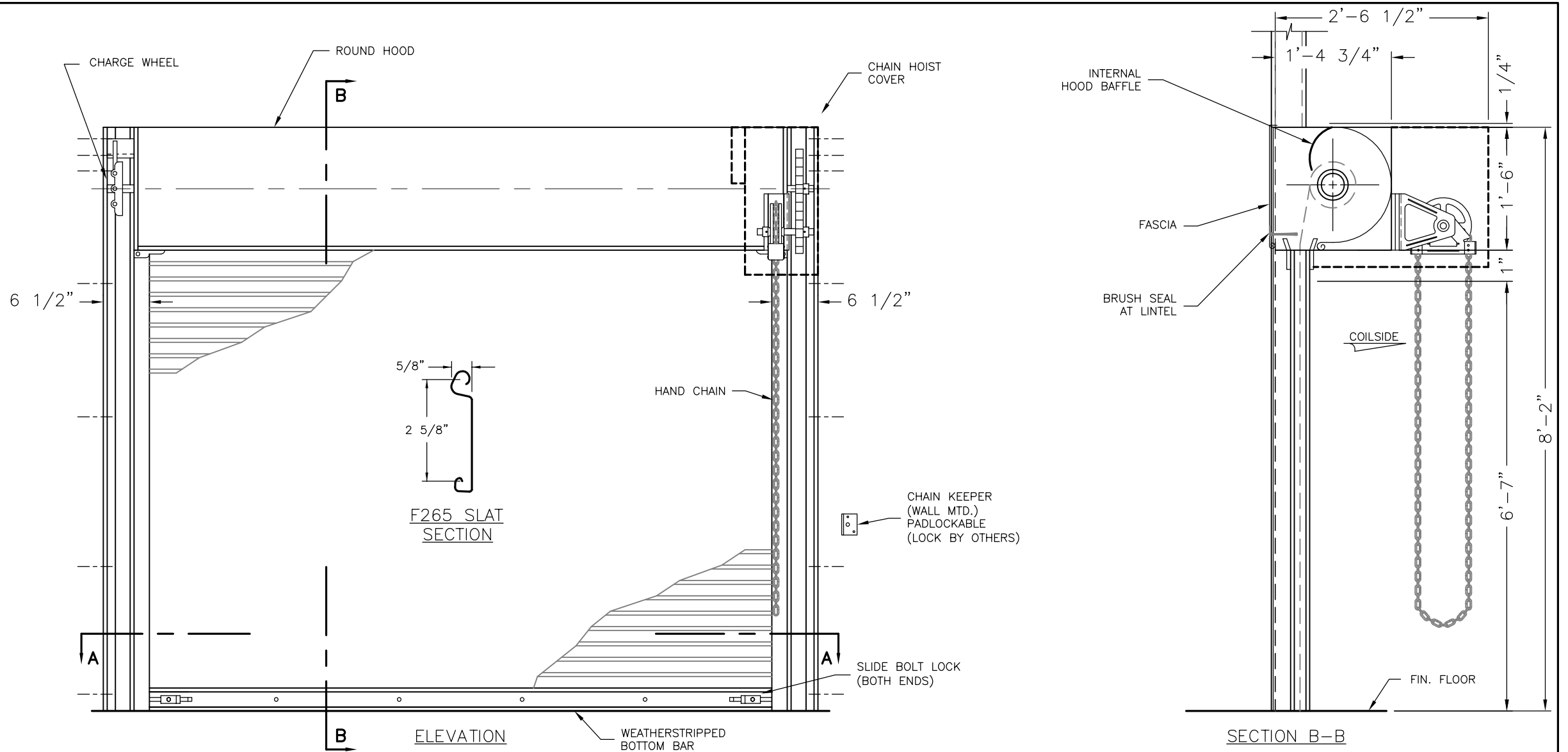
SPECIFICATIONS	
DOOR MARK	ITEM "E"
QUANTITY	ONE
WIDTH	15'-7" (BACK OF GUIDES)
HEIGHT	8'-2" (TOP OF COIL)
OPERATION	RIGHT HAND, CHAIN
MOUNT	EXTERIOR, BETWEEN JAMB
ENDLOCKS	SEE WINDLOCKS
WINDLOAD	50 P.S.F.
WINDLOCKS	ALTERNATE MALLEABLE IRON
MATERIAL	
CURTAIN	22 GA. GALVANIZED STEEL
HOOD/FASCIA	24 GA. GALVANIZED STEEL (G-90)
GUIDES	STEEL L's
BOTTOM BAR	STEEL A's
FINISH	
COMPLETE DOOR	POWDER COATED, SPECIFY
NOTES:	1.




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DISTRIBUTOR: OVERHEAD DOOR CO. OF NORWICH			P.O.# _____				DRAWING NO. D17-1764	SERIES 610
DATE 11/7/17	REVISION REV A - T.H.	SHEET NO. 6 OF 7	JOB NO.		THE MATTERBASSETT DISTRICT CH NICKERSON		OVERHEAD DOOR CORPORATION 2501 S. STATE HWY 121, STE 200 LEWISVILLE, TX 75067	
		DR. BY T.H.	DATE: 10/25/17	SCALE: N.T.S.				

SPECIFICATIONS	
DOOR MARK	ITEM "G"
QUANTITY	ONE
WIDTH	15'-8" (BACK OF GUIDES)
HEIGHT	8'-2" (TOP OF COIL)
OPERATION	RIGHT HAND, CHAIN
MOUNT	EXTERIOR, BETWEEN JAMB
ENDLOCKS	SEE WINDLOCKS
WINDLOAD	50 P.S.F.
WINDLOCKS	ALTERNATE MALLEABLE IRON
MATERIAL	
CURTAIN	22 GA. GALVANIZED STEEL
HOOD/FASCIA	24 GA. GALVANIZED STEEL (G-90)
GUIDES	STEEL L's
BOTTOM BAR	STEEL A's
FINISH	
COMPLETE DOOR	POWDER COATED, SPECIFY
NOTES:	
1.	



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		DR. BY T.H.	DATE: 10/25/17	SCALE: N.T.S.				

WRIGHT-PIERCE TM
Engineering a Better Environment

APPENDIX B

Wage Rates

Minimum Rates and Classifications for Heavy/Highway Construction

ID#: 22-33974

**Connecticut Department of Labor
Wage and Workplace Standards**

By virtue of the authority vested in the Labor Commissioner under provisions of Section 31-53 of the General Statutes of Connecticut, as amended, the following are declared to be the prevailing rates and welfare payments and will apply only where the contract is advertised for bid within 20 days of the date on which the rates are established. Any contractor or subcontractor not obligated by agreement to pay to the welfare and pension fund shall pay this amount to each employee as part of his/her hourly wages.

Project Number: Project Town: Cromwell
 State#: FAP#:
 Project: Primary Sedimentation Basin No. 1 Primary Scum Skimmer System Upgrade

CLASSIFICATION	Hourly Rate	Benefits
1) Boilermaker	33.79	34% + 8.96
1a) Bricklayer, Cement Masons, Cement Finishers, Plasterers, Stone Masons	38.27	34.47
2) Carpenters, Piledrivermen	35.57	25.65
2a) Diver Tenders	35.57	25.65
3) Divers	44.03	25.65
03a) Millwrights	36.32	26.81
4) Painters: (Bridge Construction) Brush, Roller, Blasting (Sand, Water, etc.), Spray	54.0	22.90
4a) Painters: Brush and Roller	36.42	22.90
4b) Painters: Spray Only	39.42	22.90
4c) Painters: Steel Only	38.42	22.90

4d) Painters: Blast and Spray	39.42	22.90
4e) Painters: Tanks, Tower and Swing	38.42	22.90
5) Electrician (Trade License required: E-1,2 L-5,6 C-5,6 T-1,2 L-1,2 V-1,2,7,8,9)	40.75	30.47+3% of gross wage
6) Ironworkers: Ornamental, Reinforcing, Structural, and Precast Concrete Erection	38.17	38.02 + a
7) Plumbers (Trade License required: (P-1,2,6,7,8,9 J-1,2,3,4 SP-1,2) and Pipefitters (Including HVAC Work) (Trade License required: S-1,2,3,4,5,6,7,8 B-1,2,3,4 D-1,2,3,4 G-1, G-2, G-8, G-9)	45.83	33.50
----LABORERS----		
8) Group 1: Laborer (Unskilled), Common or General, acetylene burner, concrete specialist	32.0	24.40
9) Group 2: Chain saw operators, fence and guard rail erectors, pneumatic tool operators, powdermen	32.25	24.40
10) Group 3: Pipelayers	32.5	24.40
11) Group 4: Jackhammer/Pavement breaker (handheld); mason tenders (cement/concrete), catch basin builders, asphalt rakers, air track operators, block paver, curb setter and forklift operators	32.5	24.40
12) Group 5: Toxic waste removal (non-mechanical systems)	34.0	24.40
13) Group 6: Blasters	33.75	24.40
Group 7: Asbestos/lead removal, non-mechanical systems (does not include leaded joint pipe)	33.0	24.40

Group 8: Traffic control signalmen	18.0	24.40
Group 9: Hydraulic Drills	32.75	24.40
----LABORERS (TUNNEL CONSTRUCTION, FREE AIR). Shield Drive and Liner Plate Tunnels in Free Air.----		
13a) Miners, Motormen, Mucking Machine Operators, Nozzle Men, Grout Men, Shaft & Tunnel Steel & Rodmen, Shield & Erector, Arm Operator, Cable Tenders	34.23	24.40 + a
13b) Brakemen, Trackmen, Miners' Helpers and all other men	33.26	24.40 + a
----CLEANING, CONCRETE AND CAULKING TUNNEL----		
14) Concrete Workers, Form Movers, and Strippers	33.26	24.40 + a
15) Form Erectors	33.59	24.40 + a
----ROCK SHAFT LINING, CONCRETE, LINING OF SAME AND TUNNEL IN FREE AIR:----		
16) Brakemen, Trackmen, Tunnel Laborers, Shaft Laborers, Miners Helpers	33.26	24.40 + a
17) Laborers Topside, Cage Tenders, Bellman	33.15	24.40 + a
18) Miners	34.23	24.40 + a
----TUNNELS, CAISSON AND CYLINDER WORK IN COMPRESSED AIR: ----		
18a) Blaster	40.72	24.40 + a

19) Brakemen, Trackmen, Groutman, Laborers, Outside Lock Tender, Gauge Tenders	40.52	24.40 + a
20) Change House Attendants, Powder Watchmen, Top on Iron Bolts	38.54	24.40 + a
21) Mucking Machine Operator, Grout Boss, Track Boss	41.31	24.40 + a
----TRUCK DRIVERS----(*see note below)		
Two Axle Trucks, Helpers	31.16	28.78 + a
Three Axle Trucks; Two Axle Ready Mix	31.27	28.78 + a
Three Axle Ready Mix	31.33	28.78 + a
Four Axle Trucks	31.39	28.78 + a
Four Axle Ready-Mix	31.44	28.78 + a
Heavy Duty Trailer (40 tons and over)	33.66	28.78 + a
Specialized earth moving equipment other than conventional type on-the road trucks and semi-trailer (including Euclids)	31.44	28.78 + a
Heavy Duty Trailer (up to 40 tons)	32.39	28.78 + a
Snorkle Truck	31.54	28.78 + a
----POWER EQUIPMENT OPERATORS----		
Group 1: Crane Handling or Erecting Structural Steel or Stone, Hoisting Engineer (2 drums or over). (Trade License Required)	50.27	26.80 + a

Group 1a: Front End Loader (7 cubic yards or over); Work Boat 26 ft. and over.	46.07	26.80 + a
Group 2: Cranes (100 ton rate capacity and over); Bauer Drill/Caisson. (Trade License Required)	49.91	26.80 + a
Group 2a: Cranes (under 100 ton rated capacity).	49.06	26.80 + a
Group 2b: Excavator over 2 cubic yards; Pile Driver (\$3.00 premium when operator controls hammer).	45.71	26.80 + a
Group 3: Excavator; Gradall; Master Mechanic; Hoisting Engineer (all types of equipment where a drum and cable are used to hoist or drag material regardless of motive power of operation), Rubber Tire Excavator (Drott-1085 or similar); Grader Operator; Bulldozer Fine Grade (slopes, shaping, laser or GPS, etc.). (Trade License Required)	44.86	26.80 + a
Group 4: Trenching Machines; Lighter Derrick; CMI Machine or Similar; Koehring Loader (Skooper).	44.42	26.80 + a
Group 5: Specialty Railroad Equipment; Asphalt Paver; Asphalt Spreader; Asphalt Reclaiming Machine; Line Grinder; Concrete Pumps; Drills with Self Contained Power Units; Boring Machine; Post Hole Digger; Auger; Pounder; Well Digger; Milling Machine (over 24" mandrel)	43.73	26.80 + a
Group 5 continued: Side Boom; Combination Hoe and Loader; Directional Driller.	43.73	26.80 + a
Group 6: Front End Loader (3 up to 7 cubic yards); Bulldozer (rough grade dozer).	43.38	26.80 + a
Group 7: Asphalt Roller; Concrete Saws and Cutters (ride on types); Vermeer Concrete Cutter; Stump Grinder; Scraper; Snooper; Skidder; Milling Machine (24" and under Mandrel)	42.99	26.80 + a
Group 8: Mechanic, Grease Truck Operator, Hydroblaster, Barrier Mover, Power Stone Spreader; Welder; Work Boat under 26 ft.; Transfer Machine.	42.54	26.80 + a

Group 9: Front End Loader (under 3 cubic yards), Skid Steer Loader regardless of attachments (Bobcat or Similar); Fork Lift, Power Chipper; Landscape Equipment (including hydroseeder), Vacuum Excavation Truck and Hydrovac Excavation Truck (27 HG pressure or greater).	42.04	26.80 + a
Group 10: Vibratory Hammer, Ice Machine, Diesel and Air Hammer, etc.	39.7	26.80 + a
Group 11: Conveyor, Earth Roller; Power Pavement Breaker (whiphammer), Robot Demolition Equipment.	39.7	26.80 + a
Group 12: Wellpoint Operator.	39.63	26.80 + a
Group 13: Compressor Battery Operator.	38.97	26.80 + a
Group 14: Elevator Operator; Tow Motor Operator (Solid Tire No Rough Terrain).	37.66	26.80 + a
Group 15: Generator Operator; Compressor Operator; Pump Operator; Welding Machine Operator; Heater Operator.	37.2	26.80 + a
Group 16: Maintenance Engineer.	36.46	26.80 + a
Group 17: Portable Asphalt Plant Operator; Portable Crusher Plant Operator; Portable Concrete Plant Operator., Portable Grout Plant Operator, Portable Water Filtration Plant Operator.	41.39	26.80 + a
Group 18: Power Safety Boat; Vacuum Truck; Zim Mixer; Sweeper; (minimum for any job requiring CDL license).	38.61	26.80 + a

**NOTE: SEE BELOW

----LINE CONSTRUCTION----(Railroad Construction and Maintenance)----

20) Lineman, Cable Splicer, Technician	48.19	6.5% + 22.00
21) Heavy Equipment Operator	42.26	6.5% + 19.88
22) Equipment Operator, Tractor Trailer Driver, Material Men	40.96	6.5% + 19.21
23) Driver Groundmen	26.5	6.5% + 9.00
23a) Truck Driver	40.96	6.5% + 17.76
----LINE CONSTRUCTION----		
24) Driver Groundmen	30.92	6.5% + 9.70
25) Groundmen	22.67	6.5% + 6.20
26) Heavy Equipment Operators	37.1	6.5% + 10.70
27) Linemen, Cable Splicers, Dynamite Men	41.22	6.5% + 12.20
28) Material Men, Tractor Trailer Drivers, Equipment Operators	35.04	6.5% + 10.45

Welders: Rate for craft to which welding is incidental.

**Note: Hazardous waste removal work receives additional \$1.25 per hour for truck drivers.*

***Note: Hazardous waste premium \$3.00 per hour over classified rate*

- Crane with 150 ft. boom (including jib) - \$1.50 extra
- Crane with 200 ft. boom (including jib) - \$2.50 extra
- Crane with 250 ft. boom (including jib) - \$5.00 extra
- Crane with 300 ft. boom (including jib) - \$7.00 extra
- Crane with 400 ft. boom (including jib) - \$10.00 extra

All classifications that indicate a percentage of the fringe benefits must be calculated at the percentage rate times the "base hourly rate".

Apprentices duly registered under the Commissioner of Labor's regulations on "Work Training Standards for Apprenticeship and Training Programs" Section 31-51-d-1 to 12, are allowed to be paid the appropriate percentage of the prevailing journeymen hourly base and the full fringe benefit rate, providing the work site ratio shall not be less than one full-time journeyman instructing and supervising the work of each apprentice in a specific trade.

--Connecticut General Statute Section 31-55a: Annual Adjustments to wage rates by contractors doing state work
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The Prevailing wage rates applicable to this project are subject to annual adjustments each July 1st for the duration of the project.

Each contractor shall pay the annual adjusted prevailing wage rate that is in effect each July 1st, as posted by the Department of Labor.

It is the contractor's responsibility to obtain the annual adjusted prevailing wage rate increases directly from the Department of Labor's website.

The annual adjustments will be posted on the Department of Labor's Web page:

www.ct.gov/dol. For those without internet access, please contact the division listed below.

The Department of Labor will continue to issue the initial prevailing wage rate schedule to the Contracting Agency for the project.

All subsequent annual adjustments will be posted on our Web Site for contractor access.

Contracting Agencies are under no obligation pursuant to State labor law to pay any increase due to the annual adjustment provision.

Effective October 1, 2005 - Public Act 05-50: any person performing the work of any mechanic, laborer, or worker shall be paid prevailing wage

All Person who perform work ON SITE must be paid prevailing wage for the appropriate mechanic, laborer, or worker classification.

All certified payrolls must list the hours worked and wages paid to All Persons who perform work ON SITE regardless of their ownership i.e.: (Owners, Corporate Officers, LLC Members, Independent Contractors, et. al)

Reporting and payment of wages is required regardless of any contractual relationship alleged to exist between the contractor and such person.

~~Unlisted classifications needed for work not included within the scope of the classifications listed may be added after award only as provided in the labor standards contract clause (29 CFR 5.5 (a) (1) (ii)).

Please direct any questions which you may have pertaining to classification of work and payment of prevailing wages to the Wage and Workplace Standards Division, telephone (860)263-6790.

As of: April 20, 2022