July 2, 2019

ADDENDUM NO. 1

TO PROSPECTIVE BIDDERS ON CONTRACT GWB-244.112 – GEORGE WASHINGTON BRIDGE – REHABILITATION OF STRUCTURAL STEEL, REMOVAL OF LEAD BASED PAINT AND REPAINTING THE UNDERSIDE OF LOWER LEVEL

The following changes are hereby made in the Contract Documents for the subject Contract.

This communication should be physically annexed to back cover of the book and initialed by each bidder before submitting his bid.

In case any bidder fails to conform to these instructions, his Bid will nevertheless be construed as though this communication had been so physically annexed and initialed.

CHANGES IN THE CONTRACT BOOKLET

Page vi  Delete this page in its entirety and substitute therefor new page vi which is attached hereto and made a part hereof.

Pages 219 Through 227  Delete these pages in their entireties and substitute therefor new pages 219 through 227C (12 pages) which are attached hereto and made a part hereof.

Page 228  Delete this page in its entirety and substitute therefor new page 228 which is attached hereto and made a part hereof.

Pages 246 through 252  Delete these pages in their entireties and substitute therefor new pages 246 through 252A (8 pages) which are attached hereto and made a part hereof.

Page 313  Immediately following this page, insert new pages 313A through 313G (7 pages) which are attached hereto and made a part hereof.
Page 456
Immediately following this page, insert new pages 457 through 538 (82 pages) which are attached hereto and made a part hereof.

Page 557
Delete this page in its entirety and substitute therefor new page 557 which is attached hereto and made a part hereof.

THE PORT AUTHORITY OF NEW YORK AND NEW JERSEY

James Starace, P.E.
Chief Engineer/Director

INITIALLED BY THE BIDDER:

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SECTION 020950
LEAD BASED PAINT REMOVAL CONTAINMENT, WORKER, AND ENVIRONMENTAL PROTECTION

APPENDIX "A"
SUBMITTALS

Submit the following in accordance with the requirements of "Shop Drawings, Catalog Cuts and Samples" of Division 1 - GENERAL PROVISIONS:

Shop Drawings

020950A01 Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Containment Plans and Drawings - Detailed drawings signed and stamped by Professional Engineer(s) licensed in the States of New York and New Jersey. Have the engineer(s) analyze the system for the effects of wind forces on the bridge structure and the containment system itself, and all other maximum live and dead imposed loads (e.g., platforms, equipment, personnel, waste, traffic, etc.). Do not allow the containment system to induce a load on the bridge which will create an overstress condition, exceed the limits given on the Contract Drawings, or otherwise affect the structural integrity of the bridge or the containment or temporary structures, and do not allow the system to encroach upon the required bridge clearances.

020950A02 Dimensioned elevation and sectional views showing all containments and encroachments of waterway or highway traffic created by the containment, debris collection equipment, and ventilation or recycled abrasive systems.

Catalog Cuts

020950B01 Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Plan for Monitoring of Weather and Wind Conditions: Provide catalog cuts of radios that will be used to monitor weather conditions and wind velocity, and the name, address, phone number, and contact of the weather service that will be used and a copy of the contract with the weather monitoring service.

Samples

020950C01 1. Provide a complete analytical package of TCLP test results of waste samples within 15 days after sample collection, but not later than 45 days after start-up.

2. Provide a complete analytical package of waste water test results of waste sample collection within 15 days after sample collection, but not later than 45 days after start-up.
Product Data

020950D01 Technical data sheets, specification sheets, any other information needed to thoroughly describe the containment plan and materials proposed for use. Include a two (2) sq. ft. sample of each of the proposed enclosure material(s), together with the manufacturer's specifications on light transmittance, flame spread, and fuel contributed, burst strength, abrasion durability, and unit weight of material.

020950D02 A description of debris collection and air filtration equipment, including the equipment data sheets, airflow capacity, fan curves, equipment weights and temporary utility service requirements.

020950D03 Information on any temporary heating units proposed for use, fuel to be used and the safety measures to be employed for heater use and fuel storage.

020950D04 Provide catalog cuts and technical data sheets of construction equipment to be employed during Work of this Contract.

Certificates

020950E01 B. Certification of Containment Installation

1. Prior to working within each containment, submit a letter signed and sealed by the containment design engineer, stating that the containment system has been assembled as shown on the approved, signed and sealed drawings.

2. If the containment is not installed in accordance with the design drawings, issue supplemental calculations for the new design for Engineer review and approval in accordance with the original submittal requirements.

Construction and Installation Procedures

020950G01 The plan for staging, installing, moving, and removing the containment; and the methods of attachment that will be used. Make attachment points to specific, substantial framing members only, as approved by the Engineer. Design the containment in order for it to be disassembled and secured within one hour of notification, such as under inclement weather conditions. Design it in such a manner that it is capable of being disassembled during high wind conditions of at least 40 mph.

020950G02 Include the methods of access that will be provided to work areas inside containment, locations of safety lines, and locations of containment entryways

020950G03 The methods and procedures that will be used for cleaning and securing the containment at the end of each work day, and the cleaning undertaken prior to dropping or relocating the containment.
Controls that will be exercised to prevent excessive sagging during cable installation (e.g., temporary cradles) to ensure the protection of traffic.

Plans for maintaining roadway lighting and signage, navigational and aviation lighting, as applicable.

Plans for the collection and removal of debris from the surface of water when working over streams, rivers, lakes, and other bodies of water.

The methods and procedures that will be used to control spills or releases of dust or debris into the environment.

The plan for monitoring the soundness of the containment during weekends, holidays, or extended shut downs. In the case of extended shut downs, conduct an inspection of the containment, platform, and its components a minimum of once every two weeks. Provide the procedures for mobilizing crews to the site to initiate the emergency demobilization plan in the event of inclement weather, and the plans for the immediate removal of snow and ice from the containment structure.

Provide the plan for monitoring weather and wind conditions, including the procedures that will be followed to communicate impending inclement weather to the field Supervisor/foreman and Engineer through the use of mobile phones, and the faxing of weather information to the Engineer when deciding whether or not to lower containments.

Provide the plan for monitoring of weather conditions during weekends, holidays, or other shut down periods.

Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Emergency Containment Demobilization Plan: Provide a detailed plan for dropping the containment within 1 hour of the notification of inclement weather, such as sustained wind speeds of 40 mph or greater, or heavy snow.

Include the methods and procedures that will be followed to assure that:

a. All equipment and tools are secured,

b. The containment is cleaned of loose dust and debris,

c. All containment system roof and wall enclosure elements that could contribute to adding wind load to the bridge structure are removed or lowered (excluding containment framing), and

d. Snow and ice are routinely removed from the containment
020950G13 Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Lead (Toxic Metal) Health and Safety Compliance Program. Submit the following plans, programs, and information addressing worker health and safety from exposure to lead and other toxic metals. Note that this program is in addition to other OSHA hazard communication and health and safety requirements including scaffolding, electrical safety and general construction safety requirements of OSHA. Provide a written, project specific Lead (Toxic Metal) Health and Safety Compliance Program under the direction of, and signed and sealed by, a Certified Industrial Hygienist (CIH). Identify the methods of compliance that will be used to reduce worker exposures to toxic metals including engineering and waste practice controls.

020950G14 Include the methods and procedures that will be followed for complying with this Section and any OSHA standards published for the toxic metals present in the paint (e.g., 29 CFR 1926.62 for lead, 29 CFR 1926.1127 for cadmium, and 29 CFR 1926.1118 for inorganic arsenic). When toxic metals are present in the paint for which OSHA has not developed a comprehensive health and safety standard, include statements that the workers will not be exposed above the PEL established for the metal as identified in 29 CFR 1926.55. Rely on respiratory protection only after feasible engineering and work practice controls have been first implemented to reduce airborne exposures.

020950G15 Revise and update the program as needed and at least every six months during the portion(s) of the Work which involve the disturbance of toxic metals. Verify that the CIH signs off on all six-month reviews and revisions.

020950G16 Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Plan for Establishing Restricted Zones. Submit a plan for the establishment of restricted zones around equipment and operations that may generate emissions of dust or debris containing lead or other toxic metals. Include the methods that will be used for instrument monitoring and designating the restricted zones.

020950G17 Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Environmental Compliance Plan. Submit an Environmental Compliance Plan which establishes programs for the monitoring activities that will be undertaken under the Contract:

1. Assessments of Visible Emissions and Releases. A written program for the observation of visible emissions during the performance of the Work, and inspections for releases or spills of dust and debris that become deposited on surrounding equipment, property, soil, water, and sediment. Include the frequency and methods of observation and inspection that will be made, areas or work activities that will be observed, and the frequency and nature of clean up that will be undertaken. Include the name(s) and qualifications of the personnel conducting the observations and inspections.

2. Ground (Soil) Evaluations. A written program for the inspection of the ground and soil prior to commencement of the Work and upon completion to assure that the ground has not been impacted by the Work.
3. Water/Sediment Evaluations  A written program for the inspection of the water and sediment prior to commencement of the Work and upon completion to assure that the water and sediment have not been impacted by the Work.

4. Final Cleaning/Clearance Evaluations  A written program identifying the procedures and methods that will be used to conduct final clean up, and final visual cleanliness inspections and evaluations.

5. Include a statement that the Contractor will undertake all clean up and remediation necessary to return the soil, water, and sediment to pre job conditions in the event that sampling and analysis conducted by the Authority show that contamination has occurred, at no additional cost to the Authority.

If recycled steel grit abrasives will be used, advise the facilities that the lead paint waste must be handled and stabilized as if it tested hazardous. Provide the proposed means of stabilization that will be used by the facility to comply with the requirements of this Section.

10. Waste Handling Plan  A written program that addresses the proper handling and disposal of all waste. Include the procedures and equipment that will be used for:

   a. the collection of waste water, paint, spent abrasive and paint chips and other debris, and its transportation to the storage area identified by the Engineer or on the Contract Drawings;

   b. the collection of representative samples of waste for testing;

   c. the testing and analysis procedures that will be used;

   d. the determination of hazardous waste and non hazardous waste streams, as defined in 40 CFR 261.2;

   e. the site handling, storage, packing, and labeling of the waste.

Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Contingency Plan and Emergency Procedures

1. Submit a Contingency Plan and Emergency Procedures to respond to fires, explosions, or any unplanned sudden or non sudden releases of hazardous waste or hazardous waste constituents to air, soil, or surface water at the Work site.

2. The plan must describe arrangements agreed to by local police departments, fire departments, hospitals, and state and local emergency response teams.
3. The plan must list names, addresses, and phone numbers of all persons qualified to act as emergency coordinators; and includes a list of all emergency equipment at the Work site (fire extinguishers, spill control equipment, communications and alarm systems and decontamination equipment).

4. The plan must include an evacuation plan for workers to describe signals to be used to begin evacuation routes, and alternate evacuation routes.

5. Submit evidence that a copy of the plan has been submitted to all local police departments, fire departments, hospitals, and State and local emergency response teams that may be called upon to provide emergency services.

020950G21 Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: CONSTRUCTION START UP A. Containment Lowering, Removal, and Relocation Unless directed otherwise by the Engineer, prior to beginning any paint removal operations, demonstrate:

1. The lowering and removal, within one hour, of those elements of the containment system which contribute wind loads to the bridge, and that the lowering and removal can be performed under high wind conditions of at least 40 mph.

2. The removal, within one hour, of those elements of the containment system which are above the roadways, railways and navigation channel or waterways.

3. Confirm the results of the demonstration in writing and provide to the Engineer prior to the commencement of paint removal operations.

020950G22 Temporary Heating Units If the use of temporary heating units was not anticipated at the time of the initial submittals, notify the Engineer at least one week in advance of use of heating units. Submit, for approval, information on fuel to be used and the safety measures to be employed for heater use and fuel storage.

Calculations

020950H01 Data, calculations, and assumptions used for the design of the containment and ventilation system and the imposed loads on the existing structure, signed by Professional Engineer(s) licensed in the States of New York and New Jersey. Include the design air flows within containment, and the locations and sizes of air inlets and exhaust ducts and dust collectors. Include calculations for static pressure losses through the system.

Qualifications

020950K01 Provide certifications of the entity who will be performing Lead Abatement Work in accordance with the New Jersey Lead Hazard Evaluation and Abatement Code for Superstructures and Commercial Buildings, at NJAC 5.17 2.1.
Provide evidence of confined space training for workers who will be entering, supervising and attending confined spaces.

Provide the name, address, telephone number, and contact person and copy of AIHA certification of the laboratory that will be used for the worker and restricted zone exposure monitoring required under this Section.

Provide the name, address, telephone number, and contact person of the laboratory that will be used for the analysis of waste samples as required by this section.

Provide evidence that the analytical laboratory proposed for TCLP testing and waste analysis (i.e. solid and liquid) is experienced to perform full TCLP and waste analysis for all parameters as specified.

Acoustics Firm: submit the name, address, telephone number, and contact person of the acoustics firm that will be employed. Include the names of the employee(s) who will be performing the acoustical design and consulting services under this Contract. Provide the name(s) and telephone number(s) of previous project owners for whom the acoustics firm has provided similar services.

Certified Industrial Hygienist: provide the name, experience, and qualifications of the CIH who will be reviewing, approving and sealing the site specific Lead Health and Safety Compliance Program.

Provide written confirmation that the supervisors and workers who will be installing the containment system have successfully completed at least one contract of similar size and complexity within two years preceding the Authority's acceptance of the Contractor's Proposal. In the case of abrasive blast cleaning, the project must have involved the use of a containment system equivalent to SSPC Class 1A with negative air pressure.

Provide certifications of supervisors and workers who will be performing Work in the State of New Jersey under New Jersey Lead abatement Supervisor and Worker Programs.

Competent Person: Provide written confirmation that the person or persons designated as the OSHA competent person meets the requirements for "Competent Person" as stated in 1.05D "Qualifications and Experience".

Containment Design Engineers: Provide written confirmation of the license and experience of the Professional Engineers as stated in 1.06 C "Qualifications and Experience".

Include the name of the competent person who will be making routine inspections of Work activities to ensure compliance with the program, and the frequency of inspections that will be made.
Verify that any subcontractors working for the Contractor are included in the program or in a separate program which meets the requirements of this Section. If subcontractors are operating under a separate program, include the program(s) with the submittals.

Outside Laundry  Provide the name, address, and qualifications of the launderer, if one will be used, for the cleaning of reusable clothing. Provide a letter from the laundry indicating that it is permitted to handle clothing contaminated with lead and/or the other toxic metals of concern. Provide a copy of a letter to the laundry informing it that the clothing from the Work is contaminated with lead or other toxic metals and that the laundry must have procedures in effect to handle such clothing.

Personal Protective Equipment for Engineer Use:  Acknowledge that all protective clothing and equipment, laundering or disposal, and hygiene facilities will be provided for up to four Engineer Representatives.

The names, addresses, qualifications, and contact person for the proposed transporter(s) of hazardous waste, non-hazardous waste, and waste water.

Evidence that each transporter has current registration approved by NYSDEC and NJDEP, as applicable. Hazardous waste haulers are required to have a 6 NYCRR, Part 364, Waste Transporter Permit.

Ensure that hazardous waste haulers are required to possess a spill prevention, countermeasures, and containment plan (SPCC). Provide evidence of such a plan.

If it is proposed that the transportation pass through other states, provide evidence that the transporter complies with the applicable transportation regulations of the respective states.

The name, address, telephone number and contact person for each waste disposal facility proposed for use in the Contract, including but not limited to hazardous, non-hazardous, and waste water.

Evidence that each disposal facility has current registrations and permits for the operation of such facilities, or written approval from the state (and by the USEPA or other local agency, if applicable) in which it operates.

Evidence that each disposal facility maintains current state Pollution Discharge Elimination System Permits, if applicable.

If recycled steel grit abrasives will be used, advise the facilities that the lead paint waste must be handled and stabilized as if it tested hazardous. Provide the proposed means of stabilization that will be used by the facility to comply with the requirements of this Section.
If it is proposed that a secondary smelter will be used for the recycling of the waste, provide evidence that the smelter holds a valid EPA and consignment waste approval for the treatment of the hazardous materials present in the waste that will be generated (e.g., D008 in the case of lead containing waste).

Submit a letter from each of the proposed hazardous waste recycling or disposal facilities, stating that the facility can accept this type of waste, is authorized to accept the waste under the laws of the State of residence; has the required capability to treat and dispose of the materials; and will provide or assure the ultimate disposal method indicated on the Uniform Hazardous Waste Manifest.

Submit a letter from the proposed waste water disposal facility, indicating that the facility has the capability to handle and properly dispose of the waste water.

Submit the original letters signed by a legally authorized representative of each facility.

Submit evidence that during the last twelve (12) months, each proposed disposal facility has not incurred:

a. more than five (5) Notice of Violation (NOVs) related to accepting unpermitted haulers, or accepting waste containing contamination above the facility's permit limits;
b. more than three (3) NOVs related to poor housekeeping, such as spills of chemicals or petroleum products that could contaminate soil and ground water; and
c. an Administrative Consent Order (ACO) related to ground water remediation

Non hazardous Waste Disposal Facility Qualifications, Experience, and Permits
Provide the name, address, telephone number, contact person, and permit for each waste landfill that will accept the non hazardous waste generated by the Contractor.

Record Documents

1. Bills of Lading: Provide bills of lading for the disposal of all non hazardous municipal/construction waste within one week of the date of shipment.

2. Waste water: Provide written documentation of the receipt of disposal of all waste water within one week of the date of shipment.

Acoustical Tests: submit three copies of all acoustical test results to the Engineer within two calendar days of testing.

Inspection Reports

Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS:CONSTRUCTION PHASE A. Maintain and make available for Engineer review, a daily (in New Jersey) and weekly (in New York) inspection log of hazardous waste storage.
Waste Manifests: Submit to the Engineer one copy of

1. Executed and signed manifests for each load of waste material transported from the Work site. Provide the manifest to the Engineer within one day of shipment.

2. Executed waste manifest form signed by a responsible party of the disposal facility. Provide the form within one day of receipt. If the copy is not received within 35 days from the date of shipment, contact the Engineer, and assist as directed, in efforts to locate the shipment, and in the completion of the EPA Exception Reports (if the signed manifest is not received within 45 days of the date of shipment).

3. Certificate of final disposal for each manifest or certificate of recycling for recycled material. Provide the certification within one day of receipt.

Containment scaffolding inspection log: maintain, and make available for review by the Engineer, a daily log of the inspections of scaffolding, platforms, and wire ropes in accordance with the OSHA requirements. Conduct the inspections each shift, and after any occurrence which could affect the structural integrity of the scaffolding or wire suspension ropes.

Contact Information

Provide contact names and phone numbers of contractor personnel responsible for monitoring weather, inspecting the containment and performing emergency demobilization in the event of inclement weather.

Include the name of the competent person who will be making routine inspections of Work activities to ensure compliance with the program, and the frequency of inspections that will be made.

Submit the following in accordance with the requirements of “Shop Drawings, Catalog Cuts and Samples” of Division 1 – GENERAL PROVISIONS: Hazardous Waste and Waste Water Disposal Facility Qualifications, Experience, and Permits. Provide the name, address, telephone number and contact person for each waste disposal facility proposed for use in the Contract, including but not limited to hazardous, non-hazardous, and waste water.

If the Contractor proposes to discharge waste water directly into the sewer system, provide a written permit or written documentation from the local sewer district which provides approval of such activities.

Non hazardous Waste Disposal Facility Qualifications, Experience, and Permits Provide the name, address, telephone number, contact person, and permit for each waste landfill that will accept the non-hazardous waste generated by the Contractor.
Closeout Submittals

020950R01 Construction Site Clean up: Prior to issuance of Certificate of Final Completion, provide the Engineer with a letter report presenting the results of the inspections conducted to verify the final cleanliness of the construction site, surrounding property, waterways, equipment, buildings, and structures. Provide the final clearance report within 10 days of the final inspection.

Information

020950S01 Weather Conditions: submit to the Engineer, one copy of each FAX weather transmission containing the wind velocity information used to decide whether or not the containment enclosure(s) should be lowered.

020950S02 Medical Surveillance Summary:

1. Provide the Engineer with letter reports signed by a CIH which summarize employee medical surveillance results that are indicative of worker exposures to (or which demonstrate proper protection from) toxic metals. In the case of lead, summarize the blood lead and ZPP results, indicate any observed trends, and identify worker removal provisions that were invoked based on the results. Provide reports to the Engineer within 15 days of each testing period.

2. Provide summary reports of test results prior to exposing workers to project activities, periodic surveillance results, and results upon completion of site exposures. Provide the Engineer with an original signed copy of each report within 5 calendar days after receipt of the test results, but no later than 10 days after sampling.

020950S03 Personnel and Restricted Zone Air Monitoring report all employee and restricted zone air monitoring exposure results to the Engineer verbally within one day of receipt, and in writing within one week thereafter.

020950S04 Restricted Zone Log: Maintain and make available for Engineer inspection, permanently bound log(s) for the signatures of all individuals entering and leaving restricted zones.

020950S05 Visible Emissions and Releases:

1. Maintain and make available for Engineer inspection a permanently bound log for the documentation of daily inspections and the documentation of unusual incidents or releases.

2. Provide the Engineer with an immediate verbal report each time that Work has been halted due to unacceptable visible emissions or releases. Include the cleanup activities invoked, and the corrective action taken to avoid a recurrence. If the release represents a reportable quantity, identify the amount of material (e.g., lead) released and the notifications that were made. Provide a written report within 2 days of the incident.
3. Summarize the results of all visible emissions assessments in a monthly report. Provide monthly report to the Engineer within 15 days of the last workday of the previous month.

Permits

020950T01  Provide evidence that each disposal facility has current registrations and permits for the operation of such facilities, or written approval from the state (and by the USEPA or other local agency, if applicable) in which it operates.

020950T02  Provide evidence that each disposal facility maintains current state Pollution Discharge Elimination System Permits, if applicable.

020950T03  If the Contractor proposes to discharge waste water directly into the sewer system, provide a written permit or written documentation from the local sewer district which provides approval of such activities.

END OF APPENDIX "A"
NOT USED
SECTION 020951

ASBESTOS/LEAD CONTAINING MATERIALS REMOVAL AND DISPOSAL FOR
PORT AUTHORITY OF NEW YORK AND NEW JERSEY

APPENDIX "A"

SUBMITTALS

Submit the following in accordance with the requirements of "Shop Drawings, Catalog Cuts and
Samples" of Division 1 - GENERAL PROVISIONS:

Shop Drawings

020951A01 Detailed site-specific Drawings prepared and signed by a "Certified Project
Designer" which shall include, but not be limited to, the following: containment,
decontamination system enclosure, clean room, designated pathways, washroom, and
any engineering controls.

Product Data

020951D01 List of all materials and equipment to be used

020951D02 Material Safety Data Sheets and a copy of the product labels for all chemicals to be
used for Work of this Section.

Construction and Installation Procedures

020951G01 Outline of Respiratory Protection Program for Employees conforming with current
regulations - The outline shall bear the signature and approval of a CIH.

020951G02 A construction Critical Path Method (CPM) or Bar Graph Schedule stating critical
dates of the job including start of mobilization, the preparation, removal, and
reactivation of each work area, and completion of deactivation.

020951G03 Any changes in schedule or staffing shall be submitted in writing to the Engineer 48
hours prior to implementation, or as directed by the Engineer

Calculations

020951H01 Negative Air Unit Calculations

020951H02 Drawings, design details and calculations for temporary "Support Structure(s)",
signed and sealed by a Professional Engineer (P.E.) licensed in the State in which the
Work of this Section is to be performed. Following installation of "Support
Structure(s)", submit P.E. signed inspection report verifying compliance with design.
Qualifications

020951K01 Copy of valid Asbestos and Lead Contractor's License

020951K02 Information on Competent Person (i.e.: resume) showing:
1. Three-years project supervision experience.
2. Copy of valid Asbestos and Lead Abatement Supervisor certificate.

020951K03 Asbestos Handlers certificates for the proposed staff.

020951K04 Information (i.e.: resume) on the "Certified Project Designer" the Contractor plans to utilize showing:
Three-years asbestos project design experience.
Copy of valid Asbestos Project Designer certificate

020951K05 Information (i.e.: resume) on the Certified Industrial Hygienist (CIH) the Contractor plans to utilize showing:
Three-years asbestos and lead related experience.
Copy of valid American Board Industrial Hygiene certificate.

020951K06 Information on the Environmental Laboratory the Contractor plans to utilize, including:
Proof of participation in the American Industrial Hygiene Association's Proficiency Analytical Testing Program [PAT].

020951K07 List of Subcontractors Contractor plans to utilize. Submit all their appropriate qualifications as per Section 020951, Part 1 (1.04)(A)(1)(a) and (f) herein.

020951K08 Name of Asbestos/Lead Waste Transporter Contractor plans to utilize -- the entity providing transportation services shall be approved by the Authority prior to the commencement of Work of this Section. Provide documentation showing, for each State in which transportation is to occur, the following:
Copies of Transporter's Permits, Licenses and/or Certificates as required by state agencies to operate.
Name and title of Transporter's contact person.
Business, mobile and pager telephone numbers.
U.S. DOT statement of reportable accidents and reportable environmental incidents as per 49 CFR 171.15 and 171.16

Record Documents

020951M01 letter reports signed by a CIH which summarize employee medical surveillance results that are indicative of worker exposures to (or which demonstrate proper protection from) toxic metals. In the case of lead, summarize the blood Lead and ZPP results, indicate any observed trends, and identify worker removal provisions that were invoked based on the results. Provide reports to the Engineer within 15 days of each testing period.
020951M02  Summary reports of test results prior to exposing workers to project activities, periodic surveillance results, and results upon completion of site exposures. Provide the Engineer with an original signed copy of each report within 5 calendar days after receipt of the test results, but no later than 10 days after sampling.

020951M03  Records signed by a physician documenting worker medical examinations with chest X-rays and pulmonary function tests. The form from Appendix D of OSHA CFR 1926.1101 Title 29 or equal shall be used. These records shall be kept on file by the Contractor for the duration of employment, plus 30 years.

Contact Information

020951P01  Project Specific Chain of Command -- Show on Chain of Command form(s) office, beeper, mobile and home telephone numbers of persons having the authority to dispatch personnel to the Project location and commit such persons to the tasks as directed by the Engineer. At a minimum include numbers for Project Supervisor, Competent Person and CIH.

Closeout Submittals

020951R01  Copies of the Final Report as stipulated in Section 020951(3.05) herein

Information

020951S01  "Work Area" and "Work Site" procedures

020951S02  Fire Prevention and First Aid Procedures.

020951S03  Work site communication with police, fire department, Facility Operations and the Engineer.

020951S04  Engineering Controls (i.e.: work area enclosure; decontamination enclosure system layout and location; work area boundaries; etc.).

020951S05  "Emergency Egress" location(s).

020951S06  Requirements for electric power, water supply and drainage.

020951S07  Requirements for storage and staging location(s)

020951S08  A staffing schedule stating number of workers per shift, name and number of supervisor(s) per shift, hours per shift, shifts per day, and total days to be worked.

Permits

020951T01  1. Name of landfill Contractor plans to utilize. Contractor shall obtain approval from the Authority for utilization of proposed facility prior to commencement of Work of this Section and submit the following documentation for the proposed facility:
2. Municipal permits and/or licenses required to operate.
3. State permits and/or licenses required to operate.
4. Federal permits and/or licenses required to operate.
5. Name, title and telephone number of Landfill's contact person.

Copies of project-specific variances obtained by the Contractor for Work of this Section.

END OF APPENDIX "A"
SECTION 020951

ASBESTOS/LEAD CONTAINING MATERIALS REMOVAL AND DISPOSAL FOR PORT AUTHORITY OF NEW YORK AND NEW JERSEY

APPENDIX "B"

JOB SPECIFIC REQUIREMENTS

A. Description

1. This Section specifies removal of asbestos material from the "Work Area(s)" (shown on the Contract Drawings) listed below:
   a. Steel structures covered by non-friable asbestos-containing coatings at the underdeck of the Lower Level of the George Washington Bridge (GWB). These include but are not limited to:
      • Floor beam
      • Lateral bracing
      • Underdeck stay-in-place forms
      • Stringers and stringer supports
      • Diaphragm

B. Asbestos Type(s)

Test results of asbestos-containing material (above 1% by weight) to be removed indicate that such material contains the following type(s) of asbestos:

<table>
<thead>
<tr>
<th>Asbestos-Containing Material</th>
<th>Asbestos Type</th>
<th>Approx. % by Volume of Asbestos in Asbestos-Bearing Material</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paint</td>
<td>Anthophyllite</td>
<td>Ranging from 1.1% to 7.5%</td>
</tr>
</tbody>
</table>

C. Items in "Work Area" to be Removed

Traveler Track beam.

D. Items Remaining in "Work Area" to be Protected

a. **Existing structural elements.** Existing structural elements shall be protected to prevent damage during construction.
b. Temporary conduits. Protect the temporary conduits containing the medium voltage and fiber optic cables against damage from construction operations for removal and disposal of the existing temporary work platform and installation of the new median upgrade components.

c. Anchorage Utilities. Three 3" diameter metal conduits in front of stringers S5 through S11 at the east end of Span 9 running along the Anchorage wall.

E. Utilities for Work of this Section

a. Drainage. Drainage is not available at the "Work Site". Provide a closed piping or hose system and filter through 5.0 micron filters, drum collect and dispose of as stipulated in "Water Disposal Procedures" herein. In the event of asbestos contamination of temporary materials, clean and decontaminate by wet cleaning and/or HEPA vacuuming in the "Work Area" or dispose of as ACM waste.

F. Utilities and Services in Work Area to be Shut Down and to Remain in Service

Utilities to Remain In Service:
- Existing utilities from the existing cable dehumidification system
- Three 3" diameter metal conduits in front of stringers S5 through S11 at the east end of Span 9 running along the Anchorage wall.
- Center median utilities

G. "Work Site Security/Fire Watch"

Provide Security/Fire Watch inside containment areas if containment is erected and unattended.

H. "Work Area" Procedures

The contractor shall comply with the applicable provisions of Specification 020950 – Containment, Worker and Environmental Protection, the project specific NYSDOL Variance, and all other applicable worker health and safety regulations. For this project, each asbestos regulated abatement work area will be defined as the immediate work area with extension to next floor beam from both side between the platform and underside of the bridge deck.

a. Work Platform. A temporary work platform will be installed under the lower level of the GWB for the full length of the structure. The bottom of the temporary platform will extend a maximum of 3 feet, 9 inches below the bottom of the existing floor beams.
b. **Containment.** Enclosure and ventilation filtration of the work area shall conform with construction details as in a Class A Containment System For Lead Paint Removal. An internal single layer of at least 10 mil impermeable polyethylene shall also be provided on the walls and floor of the enclosure and sealed in accordance with 12 NYCRR 56, Subpart 7.11(e). The area inside the enclosure with internal single layer will be considered to be the asbestos project regulated abatement work area. Follow the conditions of the asbestos variance.

c. **Decontamination System.** remote decontamination system(s) shall be utilized. The decontamination system(s) shall be located as close to the work area as possible. **Signs.** The work area shall be cordoned off with asbestos warning tapes to restrict access to unauthorized personnel.

I. "Water Disposal" Procedures

Waste water shall be added to asbestos lead waste for appropriate disposal. Do not re-use waste water.

J. "Sealing Asbestos-Containing Contact Surfaces"

Not applicable.

K. Removal of "Work Area Containment and Protection of Items that Remained in the Work Area"

Remove "Work Area" containment and discard as asbestos contaminated material.

L. Re-establishment of Utilities and Services

Re-establish utilities and services that were disconnected and install new filters in air moving system(s) affected by the Work of this section.

M. Re-establishment of Items and Objects in the Work Area

Relocate to their original locations (and re-secure as required) items and objects that were cleaned and removed from the "Work Area" prior to commencement of abatement activities.

N. Replacement of Insulation and Fireproofing

There is no insulation and/or fireproofing to be replaced under this Contract.

END OF APPENDIX "B"
SECTION 020951

ASBESTOS/LEAD CONTAINING MATERIALS REMOVAL AND DISPOSAL FOR PORT AUTHORITY OF NEW YORK AND NEW JERSEY

APPENDIX "C"

SEE SAMPLE ASBESTOS VARIANCE - APPENDIX 1 - PERMITS

END OF APPENDIX "C"
DIVISION 03
SECTION 037349
CONCRETE CRACK REPAIR

PART 1. GENERAL

1.01 SUMMARY

This Section specifies the requirements for the repair of concrete cracks by the following methods:

A. Routing and Sealing.
B. Pressure Injection.
C. Gravity Application.
D. Membrane Surface Sealing.
E. Penetrating Surface Sealing.

1.02 PERFORMANCE AND ENVIRONMENTAL REQUIREMENTS

A. General

1. All work under this Section shall be performed in strict accordance with the environmental requirements and instruction provided by the manufacturer of the specified product.

2. All repair materials shall be installed within the range of ambient temperatures and humidity and within the range of surface temperatures and moisture of concrete surface specified by the manufacturer of the repair material.

3. Furnish all labor, materials and equipment required to assist the Engineer in performing inspection and testing. Make scaffolding and other equipment available as necessary to permit access to all portions of the installation.

B. Penetrating Surface Sealing

1. Penetrating Surface Sealer shall not be applied to surface when the wind is in excess of 10 mph.

2. The penetrating surface sealing materials shall not be installed if rain is forecast within 12 hours of application and if rain or water cleaning has occurred within 12 hours of application.

1.03 QUALITY ASSURANCE

A. General

1. The entity performing the Work under this Section shall have a minimum of five years experience and shall have successfully completed at least two projects within the past three years involving quantities and complexities equal to those required under this Section.
2. The Contractor shall obtain a letter signed by a duly authorized representative for the manufacturer of each repair material stating that the entity performing the repair of concrete cracks by any of the methods in Section 1.01 shown on the Contract Drawings has equipment appropriate for the tasks and the training and experience to properly perform the work under this Section.

3. Initially, at locations determined by the Engineer, the Contractor shall perform one test repair installation for each of the methods in 1.01 shown on the Contract Drawings to demonstrate his ability in performing the Work in strict compliance with the requirements of this Section and to the satisfaction of both the Engineer and the manufacturer's representative, as per 1.03 A.5. The Contractor shall submit the plan for each test to the Engineer for approval. The sample test installation shall be performed in the same manner as proposed for production Work. The production Work shall be performed after approval of the test installation(s).

4. Where results from test repair installations or from 1.03 B.1 and 1.03 C.1 are found to be unacceptable, the Contractor shall propose a method for correcting all unacceptable Work, correct the Work to the satisfaction of the Engineer and take those measures necessary to assure that all subsequent repair Work will be acceptable, all at no additional cost to the Authority. Measures shall include any or all of the following: modification of equipment, changing repair materials, or employment of more competent personnel.

5. The Contractor shall arrange for the presence of a duly authorized representative of the manufacturer of the repair material, during the first two days performance of the concrete crack repair Work, who shall ensure that the Contractor's work force has the appropriate equipment, training, and experience to properly perform the Work in strict accordance with the manufacturer's specifications and instructions. As ordered by the Engineer, the duly authorized representative may be present beyond the first two days of the Work. The payment of the additional days shall be paid at the net cost, thereof, provided that cause for additional days are not due to Contractor's poor performance.

6. All materials and equipment including extra (backup) equipment shall be at the work site and shown to be in proper calibration and working order to the satisfaction of the Engineer, before commencing with crack repairs.

B. Pressure Injection

1. In repairs involving pressure injection of cracks, the Engineer will take core samples of two inches in diameter along the path of the injected crack for examination and testing. The number of core samples per each length of crack, longer than 20 feet long, shall be that yielded by dividing the entire length of the crack by 20 feet and rounding to the nearest whole number. The minimum number of core samples per each length of crack, shorter than 20 feet long, shall be one. For acceptance the cores shall show evidence that at least 90 percent of the depth of the cracks have been filled by the injected resin, unless noted otherwise on the Contract Drawings. Core holes shall be patched by the Contractor in an approved method and finished to match the adjacent surfaces to the satisfaction of the Engineer. The Engineer may take additional cores for testing, if and when he deems necessary.
C. Penetrating Surface Sealing

1. In repairs involving the method of Penetrating Surface Sealing, the Engineer will take core samples of two inches in diameter, one core for every 500 square feet of surface repaired. For acceptance the cores shall show evidence of 0.1 inch minimum surface penetration and 85% reduction in Water absorption, per ASTM C 642 entitled "Test Method for Specific Gravity Absorption and Voids in Hardened Concrete". Core holes shall be patched by the Contractor in an approved method and finished to match adjacent surfaces to the satisfaction of the Engineer.

1.04 DELIVERY STORAGE, AND HANDLING

A. Deliver all materials in the manufacturers sealed original containers bearing the manufacturer's name and product identification, and batch or lot number clearly identified, in a manner to prevent damage by breakage, water or moisture.

B. Store all repair material on platforms and cover it as required to protect it from the elements.

C. All materials shall be used during their manufacturer's recommended shelf life, but not after one year from the date of manufacture.

D. The Engineer will sample all materials on site and test them for conformance to manufacturer's specifications, at least once during the work.

1.05 SUBMITTALS

For submittals see Appendix "A".

PART 2. PRODUCTS

2.01 MATERIALS

A. General

1. The method(s) of concrete crack repair are shown on the Contract Drawings. For each repair method, the Contractor shall select and use a corresponding product from Appendix "B", List of Approved Products. No substitution(s) will be allowed.

2. All crack repair material components shall be supplied by the same manufacturer.

3. Solvents used for cleaning shall be approved by the product's manufacturer and shall be non-chlorinated.

B. Pressure Injection

1. Injection material components shall be completely reactive with each other and shall not be thinned.

2.02 ACCESSORIES

A. Pressure Injection

1. The equipment to be used for pressure injection shall be in strict accordance with the injection material manufacturer's instructions.

2. The pressure injection equipment shall be capable of achieving pumping pressures consistent with the recommendations of the product's manufacturer and of mixing reactive components of injection material at a constant volume ratio within a tolerance of 5 percent.
3. Pressure pot systems and hand-held caulking guns, or grease guns, will not be permitted as pressure injection equipment, unless otherwise approved by the Engineer.

4. Injection ports shall be either surface mounted or set in drilled holes as shown on the Contract Drawings. Where drilled holes are called for, holes shall be drilled using drills fitted with a hollow drill bit, swivel chuck, and vacuum to insure that port holes are free of pulverized concrete powder. Rotary hammer drills shall not be used.

PART 3. EXECUTION

3.01 EXAMINATION

Prior to commencing with the Work, the cracks to be repaired shall be thoroughly examined and the complete path mapped on the exterior concrete surface.

3.02 PREPARATION

A. General

1. All loose concrete material in the vicinity of the crack shall be removed and the crack path shall be cleaned of dirt, laitance and other contaminants in accordance with the surface preparation in the manufacturer's specifications. In addition, where shown on the Contract Drawings, clean the surface and the cracks by solvent cleaning, washing and/or flushing.

2. Concrete surfaces and routed cracks which are designated to be sealed shall be cleaned by abrasive blasting and then by air blowing in order to remove substances which may interfere with adhesion of the sealer materials.

3. The Contractor shall coordinate cleaning, vacuuming, wetting, drying and surface preparation. Vacuum the concrete surfaces and all cracks after cleaning to remove all residue, dirt, sand and grit.

4. Protect adjacent existing finished surfaces from damage or marring of finishes as approved by the Engineer.

5. All residue and debris resulting from the Contractor's Work shall be placed in labeled containers supplied by the Contractor and shall be removed from the site and properly disposed of by the Contractor.

B. Pressure Injection

1. On concrete crack repairs performed by the method of pressure injection, locate entry ports along the path of the crack at each end and at intermediate locations spaced in accordance with the recommendations of the manufacturer of the material or as otherwise shown on the Contract Drawings.

2. Where ports are set in drilled holes, sites for round injection ports shall be drilled to a hole diameter and depth sufficient to assure a snug fit of the port. The drill hole shall be deep enough to allow a small reservoir below the bottom of the port that shall be set into the hole a minimum of one-half inch below the surface. All dust shall be thoroughly removed after the drilling operation.

3. Pressure injection ports and the entire path of the crack shall be sealed with the crack surface sealer material. The surface sealer material shall be allowed to cure in accordance with the manufacturer's recommendations prior to commencing with pressure injection.
C. Gravity Application

1. For crack repairs using low viscosity materials applied by the gravity application, the Contractor shall provide a continuous dam along both sides of the crack using silica sand or other approved means to confine the fluid repair material above the cracks for a height of 1/4 inch, unless otherwise shown on the Contract Drawings. While the repair material is tacky, remove the silica sand dams and any excess repair material residue by a spatula or similar tool. Removal of any excess residue by grinding will not be permitted. The final floor surface shall be finished flush with no ridges.

3.03 APPLICATION

A. General

1. The Contractor shall be required to have present, a manufacturer's technical representative, as per 1.03 A.5, to ascertain that each different type of repair is being performed correctly and successfully.

B. Pressure Injection

1. The reactive components of the repair material shall be mixed at a constant ratio in accordance with the manufacturer's recommendations just prior to injection.

2. Prior to commencing with the pressure injection, the equipment shall be activated and approximately eight ounces of mixed injection material shall be deposited into a container to insure that the equipment is working properly.

3. The pressure injection of the repair material shall begin at the entry port at the lowest elevation. Injection shall continue at the first port until the material begins to flow out of the port at the next highest elevation. If the injection process forces water out of the port, the injection shall continue until the material flows from the higher port. The first port shall then be plugged or sealed and pressure injection started at the second port until the material flows again from the next highest port. This sequence shall be repeated until the entire set of ports in the crack or void have flowed with the material and have been sealed.

4. When the repair material supply in the injection equipment is about to be exhausted, it shall be replenished without discontinuity of flow or change in mixing ratio.

5. In the event of leakage from the sealed crack surface, the injection process will be stopped until the leak is sealed. Any work stoppage of more than fifteen minutes will require cleaning of the mixing chamber and other equipment with mixed repair material.

6. Injection pressure shall be adjusted to avoid excessive stress build-up in the concrete and further propagation of the cracks. Pressure shall be increased gradually until the resin flows from the adjacent port.

7. After the pressure injection is complete, allow the repair material to cure fully in accordance with the manufacturer's recommendations. Drill out and/or remove ports and surface sealer and finish the surface to be flush with and to match with the adjacent existing finish. A power grinder shall be used to finish the surface unless otherwise shown on the Contract Drawings.
C. Penetrating Surface Sealing
   1. Horizontal surfaces repaired by the method of Penetrating Surface Sealing shall be
      thoroughly soaked with the sealer and the application shall continue till the surface
      ponds for a minimum period of five seconds, for alcohol-based sealers. On the
      vertical surfaces, the application shall continue until the sealers run six inches past
      the point of application after thoroughly soaking the entire surface. All surface
      sealers shall be placed in two complete applications.

D. Gravity Application
   1. For gravity feed of cracks allow the repair material to run into the crack then reapply.
      Repeat up to three applications or until the material remains flush with the floor
      surface.

PART 4. PAYMENT

4.01 NET COST WORK

The Contractor will be reimbursed for the work specified in 1.03 A.5 at the "Net Cost" for
such work. "Net Cost" shall be computed in the same manner as is compensation for Extra
Work, including any percentage addition to cost as set forth in the clause of the Contract
entitled "Compensation for Extra Work". Performance of such Net Cost Work shall be as
directed by the Engineer and subject to all provisions of the Contract relating to performance
of Extra Work. Compensation for said Net Cost Work shall not be charged against the total
amount of compensation authorized for Extra Work.

END OF SECTION
SECTION 037349
CONCRETE CRACK REPAIR

APPENDIX "A"

SUBMITTALS

Submit the following in accordance with the requirements of "Shop Drawings, Catalog Cuts and Samples" of Division 1 - GENERAL PROVISIONS:

Catalog Cuts

037349B01  Catalog Cuts for equipment used for installation of repair materials

037349B02  List of all materials to be used for crack repairs, including complete manufacturer's certification and recommendations including execution and application procedures for the repair materials to be used in each of the repair method of Section 1.01, in accordance with Appendix "B".

Samples

037349C01  The Contractor's plan for sample test for the Engineer's approval in accordance with 1.03 A.3.

Certificates

037349E01  Letter from the manufacturer in accordance with 1.03 A.2.

Construction and Installation Procedures

037349G01  Method of patching core holes, including proposed materials, as required in 1.03 B.1, 1.03 C.1, and method of finishing the concrete surface as required in 3.03 B.7.

Qualifications

037349K01  Evidence of the experience of the entity performing the Work as required in 1.03 A.1 including the names and addresses of previous clients to be used as references.

037349K02  The qualifications and experience of personnel who constitute the work force performing the Work, defined in 1.03 A.5, to the satisfaction of the Engineer.

037349K03  The names, qualifications and experience of the duly authorized representatives of the manufacturers who will be present during the crack repair Work, in accordance with 1.03 A.5.

END OF APPENDIX "A"
DIVISION 14

SECTION 148320

MAINTENANCE TRAVELERS

PART 1. GENERAL

1.01 SUMMARY

A. This Section specifies the requirements for the maintenance travelers.

B. Unless otherwise shown on the Contract Drawings, or unless otherwise specified in other Sections of these Specifications, the requirements specified in this Section are applicable to all maintenance traveler Work. Additional requirements applicable to individual Sections of these Specifications are specified in those Sections or are shown on the Contract Drawings.

1.02 REFERENCES

The following is listing of the publications referenced in this Section:

American Association of State Highway and Transportation Officials (AASHTO)
LRFD Bridge Construction Specifications with latest revisions
LRFD Bridge Design Specifications with latest revisions
LRFD Movable Bridge Design Specifications with latest revisions

American Society of Mechanical Engineers (ASME)
B31.1 Power Piping

American Society for Testing and Materials (ASTM International)
A6 General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
A27 Mild to Medium Strength Carbon-Steel Castings for General Application
A29 Steel Bars, Carbon and Alloy, Hot-Wrought and Cold-Finished, General Requirements for
A36 Structural Steel
A53 Pipe, Steel, Black and Hot-Dipped, Zinc-Coated Welded and Seamless
A108 Steel Bars, Carbon, Cold Finished, Standard Quality
A276 Stainless Steel Bars and Shapes
A312 Seamless and Welded Austenitic Stainless Steel Pipes
A325 High-Strength Bolts for Structural Steel Joints, including Suitable Nuts and Plain Hardened Washers.
A366 Steel, Carbon, Cold-Rolled Sheet Commercial Quality
A449 Quenched and Tempered Steel Bolts and Studs
A563 Carbon and Alloy Steel Nuts
A564  Standard Specification for Hot-Rolled and Cold-Finished Age-Hardening Stainless Steel Bars and Shapes
A572  High-Strength Low-Alloy Columbian-Vanadium Structural Steel
A668  Steel Forgings, Carbon and Alloy for General Industrial Use
A609  Practice for Castings Carbon, Low-Alloy and Martensitic Stainless Steel, Ultrasonic Examination Thereof
A705  Age Hardening Stainless Steel Forgings
A709  Structural Steel for Bridges
B22   Bronze Castings for Bridges and Turntables
B36   Brass Plate, Sheet, Strip, and Rolled Bar

E164  Standard Practice of Ultrasonic Contact Examination of Weldments
F436  Hardened Steel Washers
F468  Nonferrous Bolts, Hexcap Screws, and Studs for General Use

American National Standards Institute (ANSI)
A85   Bores and Keyways for Flexible Couplings
B1.1  Unified In. Screw Threads
B2.1  Pipe Threads (Except Dryseal)
B4.1  Preferred Limits and Fits for Cylindrical Parts
B16.11 Forged Steel Fittings, Socket Welding and Threaded
B17.1  Keys and Keyseats
B18.2.1 Square and Hex Bolts and Screws
B18.2.2 Square and Hex Nuts
B18.3  Socket Cap, Shoulder and Set Screws
B18.8.1 Clevis Pins and Cotter Pins
B18.21.1 Lock Washers
B18.22.1 Plain Washers
B46.1  Surface Texture
B88   Seamless Copper Water Tube

American Welding Society (AWS)
D1.1  Structural Steel Welding Code

Electrical Generating Systems Association (EGSA)

100 Series  Power Generation Components Standards
101 Series  Power Generation Systems Standards

Institute of Electrical and Electronic Engineers (IEEE)

C37.20.2  Switchgear Assemblies
Standard 446  IEEE Recommended Practice for Emergency and Standby Power Systems for Commercial and Industrial Applications

Military Specifications

MIL-F-3541  Fittings, Lubrication
MIL-S-22499 Commercial Hard, High Brass

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Addendum No. 1
National Electric Manufacturers Association (NEMA)

SG-5 Power Switchgear Assemblies

National Engineers Contractor Association (NECA)

/EGSA 404 Standard for installing Generator Sets (ANSI)


407-2002 Recommended Practice for Installing and Maintaining Panelboards (ANSI)

409-2002 Recommended Practice for Installing and Maintaining Dry-Type Transformers (ANSI)

/IESNA 502-1999 Recommended Practice for Installing Industrial Lighting Systems (ANSI)

101-2001 Standard for Installing Steel Conduit (Rigid, IMC, EMT)

National Fire Protection Association (NFPA)

110 Level 1 requirements

National Electrical Code (NEC) latest revision

National Institute of Standards and Technology (NIST)

Other Codes and Standards

State and local Codes as they apply

EPA and CARB Emissions for Non-Road Mobile Applications.


United States Coast Guard – Bridge Lighting and Other Signals, 33 CFR § 118.150

1.03 DESIGN AND PERFORMANCE REQUIREMENTS

Design and performance requirements shall be in conformance with Section 051200 – Structural Steel.

1.04 QUALITY ASSURANCE & QUALITY CONTROL

A. Quality Assurance and Quality Control shall be in accordance with Section 051200 – Structural Steel.

B. Mock-ups

1. When specified on the Contract Drawings and/or in the Specifications, the Contractor shall prepare steel mock-ups, to demonstrate the fabrication procedure and verify the inspectability of each weld within the assembly.

2. The completed steel mock-up shall be examined visually and by the nondestructive testing methods that are required for production. In addition, destructive testing may be required as directed by the Engineer. Approval of the fabrication and erection procedure shall be contingent on satisfactory results from the mock-up examination and destructive tests (where applicable).
3. Should the Engineer deem the mock up unsatisfactory, the Contractor shall revise and resubmit the fabrication/erection Procedure to correct the deficiency identified by the mock-up. A new mock-up, or partial mock-up, as determined by the Engineer, will be required after approval of the revised fabrication/erection procedure.

4. Mock-ups shall not be part of the permanent structure and shall become the property of the Contractor

C. QUALIFICATIONS

1. STRUCTURAL
   a. Qualifications shall be in accordance with Section 051200 – Structural Steel.

2. MECHANICAL
   a. A single, qualified control system vendor is required for the manufacturing and/or furnishing and assembly of all apparatus and equipment comprising the traveler control systems, including, but not limited to, drives, motors, brakes, limit switches, motor controls, control cabinets, special control panels, programmable controllers, interfacing equipment, laptop hardware for local troubleshooting, and other apparatus required to provide a complete functioning system. All assembled control panels and console shall be UL listed.
   b. The control system vendor is required to have experience in providing electrical control systems for maintenance travelers, overhead travelling cranes or movable bridge control systems including AC vector motor drives and programmable logic controllers. Identify a minimum of five projects for which the system vendor has furnished complete systems, including solid-state drive motor control and programmable controller logic within the past 10 years.
   c. The following applies to the control system vendor:
      (1) Assume complete system responsibility for the integrated functioning of all components to furnish and install a satisfactory assembled system operating in accordance with specified requirements.
      (2) Assume responsibility for the detailed schematics and fabrication of the total control systems to ensure compatibility of equipment and suitability for the intended system functioning.
      (3) Assume responsibility for developing the program for the Programmable Logic Controller (PLC) based on the functional specification for operation of the travelers.
      (4) Assume responsibility for developing and integrating HMI operator display and diagnostic screens.
      (5) Provide supervisory assistance in the installation of equipment to ensure maximum reliability and ease of maintenance.
      (6) During testing of the electrical systems, it may be found that deviations from the specifications are required for optimum traveler operation. Include all hardware and software required for these modifications in the control system at no additional cost to Authority.
      (7) Provide a field service staff having the capability of providing services for field coordination of construction and final adjustments to the drive system. Upon final acceptance of the travelers, provide on-call warranty service for a period of 1 year. Field staff shall be capable of responding to an emergency within 6 hours.
d. Provide written certification of compliance with specified requirements for the control system. The certification shall be subject to approval by the Engineer.

1.05 SHIPPING

A. STRUCTURAL

1. Shipping shall be in accordance with Section 051200 – Structural Steel.

1.06 DELIVERY, STORAGE AND HANDLING

A. STRUCTURAL

1. Delivery, storage and handling shall be in accordance with Section 051200 – Structural Steel.

B. MECHANICAL

1. Machinery parts shall be cleaned of dirt, chips, grit and all other injurious materials prior to shipping and shall be given a coat of corrosion-inhibiting preservative.

2. Finished metal surfaces and unpainted metal surfaces that would be damaged by corrosion shall be coated as soon as practicable after finishing with a rust-inhibiting preservative. Excepting unfinished metal surfaces inside of gear reducers, this coating shall be removed from operation and from all surfaces prior to painting after erection.

3. Any interface between stainless steel or aluminum and steel shall receive a coat of zinc-chromate primer prior to assembly.

4. Shims shall be coated prior to shipment with a rust-inhibiting preservative, and before erection, this coating shall be removed from the shims that are used.

5. Machinery parts shall be completely protected from weather, dirt and all other injurious conditions during manufacture, shipment, and while awaiting erection.

6. Shaft journals that are shipped disassembled from their bearings shall be protected during shipment and before erection by a packing of oil-soaked rags secured in place by burlap and covered with heavy metal thimbles or heavy timber lagging securely attached. Every precaution shall be taken to ensure that the bearing surfaces are not damaged and that all parts arrive at their destination in satisfactory condition.

7. Assembled units shall be mounted on skids or otherwise crated for protection during handling and shipment.

1.07 WARRANTY

The Contractor shall provide a one-year warranty on all travelers including structural, mechanical and electrical equipment that operate the travelers. The warranty period shall cover equipment defects or failures, failing of the paint system (peeling of the paint, appearance of the rust through the paint) in material and workmanship over this period including parts and labor cost.

The Warranty period shall commence following issuance by the Engineer of the Certificate of Final Completion for the fully functioning maintenance travelers in accordance with the requirements of Contract GWB-244.112.
PART 2. PRODUCTS

2.01 OPERATIONAL REQUIREMENTS

A. DESCRIPTION OF OPERATION

1. General Description

   The independently controlled traveler platforms shall be as shown on the Contract Drawings. For each traveler, the forward direction shall be the direction moving away from the tower docking platform and reverse shall be the direction returning to the docking platform. Operation of the traveler shall be from a control console located at mid platform. Traveler motion shall be controlled via a spring return to center joystick with a dead-man enable pushbutton located on the top of the joystick. The joystick shall be positioned so that the direction of travel is the same as the direction the joystick is moved. An Operator Control (HMI) shall be located on the control console which will display traveler status, configuration, and diagnostics. There shall be push-pull emergency stops located at the control console and each of the four corners of the platform. There shall be three speeds of operation, normal = 60 fpm, half = 30 fpm, and creep/jog = 6 fpm.

   The sides of the traveler are considered the north and south portions below the north and south sides of the George Washington Bridge. The travelers move approximately east or west along the alignment of the bridge.

2. Modes of Operation

   The traveler shall operate in two basic modes:

   a. Normal Mode – Automated joystick controlled move at selected speed in the direction the joystick is moved.

   b. Skew Correction Mode – Operator controlled move at creep speed of only one side of the traveler to correct skew.

   (1) Normal Modes

   In this mode, the operation of the traveler shall be controlled automatically at the speed and direction selected by the joystick. The spring return to center joystick has three positions in each direction for jog speed, half speed, and normal speed. When approaching the ends of travel, the system shall slow the traveler down to creep speed when the slowdown limit switch is activated and stop the traveler when the end of travel switch is reached. The traveler motion shall be stopped at any time by returning the joystick to center, releasing the joystick enable pushbutton on the top of the joystick, by pushing an emergency stop, or if a fault occurs. Traveler platform skew shall be automatically controlled using closed loop feedback integrated into the variable frequency motor control system.
(2) Skew Correction Mode

The skew correction control feature shall allow the operator to move only one side of the traveler at a time at creep speed to correct skew if necessary. Motion will only be allowed in the direction which will correct skew when the skew limits are exceeded. There are four pushbuttons on the control console for skew correction operation, a pair for north forward and reverse and a pair for south forward and reverse. The pushbuttons allow jogging one side or the other and are only active when in skew correction mode selected from the HMI. Skew control is not active when moving in skew correction mode. Skew correction mode moves are limited to a short time to prevent moving to far or over correcting the skew. All normal mode interlocks are active in skew correction mode except as noted.

3. System Selection

The traveler control system shall consist of two redundant control systems, a normal system and a backup system. Each system shall have a PLC, I/O, and HMI to control the system. The I/O shall be wired in parallel so that both systems receive all the same input signals and either system can control the outputs based on which system is selected. The backup system shall have a separate ring network and communicates to the drives via I/O instead of the network so that the system can operate with a loss of any of the network switches. The default system shall be the normal system but if a problem occurs in the normal system that cannot be cleared the operator can select the backup system and continue to operate the traveler.

a. Operator selects which control system is in control via the SYSTEM SELECTION SWITCH located on the control console. For the default normal system, the operator turns the switch to NORMAL and for the backup system the operator turns the switch to BACKUP. Indicator lights located beside the switch indicate which system is in control.

4. Move Prerequisites

The following conditions shall be met before a move can be performed. Note: Operator shall make sure no unauthorized personnel are on the traveler platform and that personnel on the platform are aware that a move is about to start and aware of the dangers.

a. Selected Control System - Normal or Backup PLC is functional with no faults.
b. Overloads not tripped.
c. Drives not faulted.
d. Circuit Breakers not tripped.
e. Emergency Brake HPU is not faulted.
f. All E-STOP operators are released and emergency stop system is reset.
g. Travel limits in their proper state.
h. Scissors lifts are in down position.
i. Skew within shutdown limit.
j. No lasting alarms on the HMI screen.
5. Prior to Move Sequence
   a. Operator turns the control power on by turning CONTROL POWER KEY SWITCH located on the control console to ON. The emergency stop system is reset by the on signal of this switch and if all emergency stops are released the CONTROL POWER ON light will illuminate. If an emergency stop is pressed it will indicate which one on the HMI screen. To reset the emergency stop circuit, the CONTROL POWER KEY SWITCH must be turned to off and then back to on.
   b. Holding Brake HPU motor turns on.
   c. Holding brakes are released and verified released via brake mounted limit switches.
   d. "THE TRAVELER IS NOW READY TO MOVE", light shall illuminate.

6. Normal Move Sequence
   a. Operator verifies the move prerequisites are met.
   b. Normal move mode is selected via the HMI.
   c. Operator moves the JOYSTICK located on the control console in the direction of desired travel and in the position of the desired speed, JOG, HALF, or NORMAL. At the same time the operator will press the JOYSTICK ENABLE pushbutton located on the top of the joystick.
   d. The warning horn will sound for 15 seconds. The warning strobes will activate. The warning strobes delay off after a move is complete.
   e. Motor brakes are released and verified on both sides.
   f. Motor drives at the four corners are enabled to run at the desired speed. One master drive per side receives the speed command and the others receive a torque command based on the master drive torque. Torque sharing shall occur between all active drives on a given side of the traveler to within a tolerance of 5%. The skew control loop will adjust motor speed as necessary to maintain skew at close to zero while in motion.
   g. Skew control is enabled.
   h. The traveler ramps up to the desired speed and runs at that speed. (Note: system shall be configured to ramp to or from full speed in ten seconds). Skew control is active during the acceleration ramp.
   i. If the JOYSTICK is released to center or the JOYSTICK ENABLE pushbutton is released the motion will begin to ramp to a stop. Skew control is active during deceleration.
   j. Once motion ramps to a stop, the drives on both sides are disabled and the motor brakes on both sides are set and verified set.
   k. If the end of travel slowdown is reached on either side before motion is stopped by the joystick, then the traveler will ramp to creep speed on both sides.
   l. As long as the JOYSTICK is still commanding motion, then motion will continue at creep speed until the end of travel limits are reached. Skew control will remain in effect during the slow down sequence and while moving at creep speed.
   m. Both sides will stop based on activation of either end of travel limit switch.
   n. Once the motion ramps to stop, the drives are disabled and the brakes are set and verified set.
Once both sides are stopped and the brakes are set, an off delay timer starts which times out the warning strobe light after 30 seconds.

The operator can release the JOYSTICK and JOYSTICK ENABLE pushbutton.

7. Interruption During Move

a. An emergency stop at any location shall drop control power and all motion shall be stopped. Without control power all drives will be disabled and all brakes shall be set.

b. If the Anti-Collision sensor (Main span travelers only) indicates far proximity of the other main span traveler, reduce the speed on both sides to creep speed.

c. If the Anti-Collision sensor (Main span travelers only) indicates near proximity of the other main span traveler, then both sides shall ramp to stop just as if the joystick were to be released during a normal move.

d. If the skew shutdown limit is reached (skew of greater than 2 degrees) all drives on both sides shall quick stop and the brakes on both sides shall set.

e. If a skew warning limit is reached (skew greater than 1 degree but less than skew shutdown limit) the speed shall be limited to half speed. This allows the skew control to correct the skew before it gets worse. There shall be a dead band around this setpoint so the speed does not oscillate.

f. Travel motor brakes shall have an internal limit switch which indicates the set state of the brake. If any brake set switch is detected while the brake is commanded to release while in motion, a motor brake fault shall be triggered. The fault will be displayed on the HMI screen and shall indicate specifically which brake switch has not been detected. The system shall stop motion with a normal stop (drives are allowed to decelerate) and the operator will have to acknowledge the fault before continuing. Once the fault has been investigated, the operator can re-start sequence after clearing the fault or bypassing the brake. A faulted brake may be bypassed via the HMI screen and operation can be restarted. Up to one motor brake per corner may be bypassed. A motor brake must be manually bypassed before it is bypassed on the HMI.

g. The hydraulically released spring set holding brakes have set and release sensors to indicate the brakes position. If the brake sensors detect a fault while the traveler is moving, a fault shall be displayed on the HMI screen indicating specifically which brake switch is faulted. The system shall stop motion with a normal stop (drives shall be allowed to decelerate) and the operator shall have to acknowledge the fault before continuing. Once the fault has been investigated, the operator may re-start the sequence after clearing the fault. Holding brakes cannot be bypassed.

h. If a drive fault occurs, all motions shall stop. If the drive fault is re-settable, the operator can reset the drive fault via the HMI reset button. A faulted drive may be bypassed via the HMI screen and operation can be restarted. Up to one drive per corner may be bypassed.

i. If an over-travel switch is activated while in motion, the traveler shall quick stop and all brakes are set.

j. If a Regen fault occurs while in motion the drives shall be disabled (No deceleration) and all brakes are set.

k. If a communications network failure occurs and communications to a critical device such as a remote IO rack is lost, all motions shall be stopped. The condition must be resolved before normal operation can be resumed.
I. Any shutdown alarm not mentioned above shall stop motion as a normal stop or quick stop as determined during an operational safety review.

8. Once Motion is Complete  
   a. Operator turns control power off by turning CONTROL POWER KEY SWITCH located on the control console to OFF. The CONTROL POWER ON light will turn off. Operator removes the key.

9. Skew Correction Move Prerequisites  
   a. The skew correction move prerequisites are the same as the normal move prerequisites with the following exceptions.  
      (1) Skew correction mode must be selected via the HMI.  
      (2) If skew shutdown limits have been exceeded, then motion is allowed only in the direction that will reduce skew.

10. Prior to Skew Correction Move Sequence  
    a. The operations prior to a skew correction move are the same as defined for a normal move except the skew shutdown limits shall only prevent motion in the direction that would worsen the skew.

11. Skew Correction Move Sequence  
    a. Operator verifies the move prerequisites are met.  
    b. Only one side can be moved at a time.  
    c. Depending on which side and which direction the operator wants to move the traveler, the operator presses one of the skew correction operation pushbuttons located on the control console. The options are NORTH FORWARD, NORTH REVERSE, SOUTH FORWARD, and SOUTH REVERSE. The pushbuttons work like a jog button so motion occurs when the button is pressed. Operator presses one of the pushbuttons.
    d. The warning horn shall sound for 15 seconds and the warning strobes shall activate. The warning strobes delay off after a move is complete.
    e. Motor brakes are released and verified on the side selected to move.
    f. Motor drives on the side selected are enabled to run at jog speed in the direction selected. One master drive per side receives the speed command and the others receive the torque command on the master drive torque.
    g. The traveler side selected ramps up to jog speed and runs at that speed.
    h. Once the skew correction pushbutton is released, end of travel is reached, or skew shutdown limit for direction selected is reached, the motion shall begin to ramp to a stop.
    i. Once motion ramps to a stop the drives on the selected side are disabled and the motor brakes on that side are set and verified set.
    j. Once the selected side is stopped and the brakes are set, an off delay starts and when it times out the warning strobe is turned off.

12. Types of Stops  
The system shall have three types of stops, an emergency stop, a normal stop, and a quick stop.
a. Emergency Stop

A safety controller shall control the emergency stops. Each emergency stop shall be an individual input to the safety controller. The locations of emergency stops are as follows:

(1) Control Console
(2) One on each corner of the platform located on the Drive Enclosure or PLC Enclosure.
(3) Two Safety Gates located on the traveler landing platform side.
(4) Two over-travel limits, one on each side on the tower side of the platform.
(5) Software Emergency stop permissive signal from the PLC which must remain on during operation. If the permissive signal turns off an emergency stop is triggered. This is used to allow the PLC to stop motion if there is a loss of control of any one side such as a master drive fault, so that the other side stops the same as the uncontrolled side.

When an emergency stop occurs the control power turns off and all drives lose the enable and turn off. All brakes are set.

b. Normal Stop

During a normal stop the drives must ramp to a stop and then the motor brakes are set. This is the normal stopping condition and is used when neither a quick stop nor emergency stop is required.

c. Quick Stop

A quick stop is a controlled stop that brings the motors to zero speed quickly while still controlling the deceleration using the drives. When the motors are at zero the motor brakes will set. This mode is used for fault conditions that require a more rapid stop to prevent skew such as the loss of all skew sensors.

13. Bypassing Faults

The system shall have the ability to bypass certain faults to allow operation to continue. Faults that can be bypassed are listed below:

a. Motor brake fault.

When a motor brake is commanded to release and the set switch does not indicate it released, a brake fault shall occur. If it is found the brake is not working or the brake switch is bad, then the brake can be bypassed via the HMI after the brake is manually released. A limit of one brake per corner can be bypassed. Each time the system control power is turned on the brakes that are bypassed will be cleared and will have to be bypassed again by the operator. Clearing the bypassed brakes each time should help to prevent continued operation with brakes bypassed.

b. Drive fault.

When a drive is faulted and the fault cannot be cleared, the faulted drive may be bypassed via the HMI to allow the operation to continue. A limit of one drive per corner can be bypassed. Each time the system control power is turned on the drives that are bypassed will be cleared and will have to be bypassed again by the operator. Clearing the bypassed drives each time should help to prevent continued operation with drives bypassed. A master drive cannot be bypassed. If the drive that is faulted is the master drive for the side, then a new drive shall be selected to be the master drive for that side via the HMI. Once a new master drive is selected then the faulted drive can be bypassed.
c. Skew sensor fault.

The system has redundant skew sensors. If one is faulted or known to be reading incorrectly, then it may be bypassed by selecting the other skew sensor to be in control via the HMI. If both skew sensors are faulted, then no motion is allowed. If the difference between the two redundant skew sensors is more than 0.05 degrees, then a skew sensor fault will occur. Once it is determined which sensor is reading incorrectly the bad sensor / reading may be bypassed.

B. Operator Interface

1. HMI Screens

a. The operator interface (HMI) shall be based on the Allen-Bradley FactoryTalk View ME software or approved equal. The HMI communicates with the PLC, located in the control console, via Ethernet. This system shall have a complete redundant backup system and therefore have an HMI for each system. Each system normal and backup shall have an HMI but they are to operate the same. The backup system shall use a ring network so that it may operate with the loss of any network switch. In cases where a network switch is failed the backup system may not be able to communicate to the drive to get some of the detailed diagnostic information but the system shall remain operable.

b. The graphic shall match the physical location as viewed by the operator such that if the operator is facing East to view the screen the devices on the screen that are located to the North will be on the left side of the screen. The operator will face East to view the screens on platforms 1 and 3 and will face West to view the screens on platforms 2 and 4.

c. Main Screen

The main screen shall be the first screen the operator is presented, when the system is powered up for the first time. The operator can move to any other screen from this main screen by selecting the appropriate button located on the screen. The main screen is the pivot point for all other screens. Since the main screen cannot contain every status in the system it may provide summary status such as Drives OK for each Quadrant rather than the individual status of each drive. Detailed status shall be furnished on more detailed screens.

The following items shall be presented on the main screen:

(1) System in Control Normal or Backup
(2) Emergency Stop Status of each emergency stop.
(3) PLC Status
(4) Network Status
(5) Drive Status for each Quadrant (Drives OK or Faulted)
(6) Brake Status for each Quadrant (Set, Released, or Faulted)
(7) Holding Brake HPU Status
(8) Holding Brake Status for each Brake (Set, Released, or Faulted)
(9) Platform Skew Status (Each Skew Sensor Reading and skew limits status)
(10) Travel Limits Status (Slowdown, End of Travel, Over-Travel)
(11) Scissor Lift Lowered Sensor Status for each scissor lift
(12) Anti-Collision Sensor Status (Slowdown, Stop) Main Span travelers Only.
(13) Commanded Run Speed based on Joystick or Manual control pushbuttons.
(14) Status showing if normal or skew correction mode is selected.
(15) Ability to select normal mode or skew correction mode. Skew correction mode shall be password protected.
(16) Navigation to all other major screens
d. Motors and Brakes Screen
   The motors and brakes screen aids in the troubleshooting of motor or brake faults that may occur.
   The following items shall be presented on the motors and brakes screen:
   (1) Graphic of traveler showing motors and brakes locations.
   (2) Table showing status of all motors and brakes
   (3) Ability to bypass motor brakes. (Number of brakes bypassed on each quadrant is limited)
   (4) Navigation to all other major screens.
e. Drives Screen
   The drives screen shall show the status of each drive, and use the information presented for troubleshooting. Due to the number of drives, this screen maybe split into one screen per side which will show all sixteen drives on the given side. Navigation to each side shall be via a main drives screen showing a summary of all drives.
   The following items shall be presented on the drives screen for all drives:
   (1) Drive Running
   (2) Drive Ready
   (3) Drive Operating At or Above Current Limit
   (4) Drive Torque
   (5) Drive Selected as the Master
   (6) Ability to select which drive is master one per side can be via pop-up screen.
   (7) Ability to bypass faulted drives.
   (8) Drive Fault Code and text description of the code for all drives. I.E. Fault Code 4 “AC Undervoltage”
   (9) Drive Fault Reset pushbutton
   (10) Navigation to all other major screens.
f. Alarm Summary Screen
   The alarm summary screen shall list all current unacknowledged faults so that the operator can view this screen to determine the fault and its severity. The operator has the option to acknowledge the fault and continue or acknowledge the fault and stop the operation.

   Each fault shall be individually acknowledged.

   The following items shall be presented on the alarm summary screen:
   (1) List of all alarms.
   (2) Alarm Acknowledge
   (3) Alarm Reset
(4) Navigation to all other major screens.

g. Alarm History Screen
The alarm history screen shall list all alarms in the alarm history log so that the operator can view this screen to determine the fault history. All alarms shall be historically logged.

The following items shall be presented on the alarm summary screen:
(1) List of all historical alarms.
(2) Navigation to all other major screens.

h. Configuration Screen
The configuration screen shall provide a means to configure the system.

The following items are presented on the configuration screen:
(1) Motor Brake Bypass Status and selection.
(2) Master Drive Selection per side, and Drive Bypass selection.
(3) Skew Sensor status and sensor in control selection.
(5) Navigation to all other major screens.

i. Network Status Screen
The network status screen shall provide the operator with a graphic view of the communications network and display the connection status of all network devices to aid in troubleshooting the communications network. The normal system and backup system have different network topologies and therefore this screen is not the same for both systems.

j. Trending Screens
The trending screens shall provide the operator with trends of various data. All trend data shall be historically logged.

Trending and historical logging of key values shall be furnished. Key values include at a minimum:
(1) Traveler Skew during a move (Each Skew Sensor)
(2) Traveler Skew Speed Adjustment during a move
(3) Traveler Commanded Speed during a move
(4) Individual Drive Commanded Values such as Speed, Torque
(5) Individual Drive Actual Values such as Speed, Torque, Current

2. Control Console
The control console, located at mid platform, shall allow the operator full command of the traveler. From the console, the operator shall be able to automatically or manually control the traveler. Below is a description of each pushbutton, dial, and light found on the console.

a. POWER ON
This indicator light shall show the status of the control power. It will illuminate when the control power is on.
b. CONTROL POWER OFF / ON SELECTOR SWITCH
   This maintained keyed selector switch shall allow the operator to select whether
   the control power is on or off.

c. LAMP TEST PUSHBUTTON
   This pushbutton when pressed shall illuminate all indicator lights on the console.

d. SYSTEM SELECTION NORMAL / BACKUP SELECTOR SWITCH
   This maintained selector switch shall allow the operator to select which system is
   in control the normal system or backup system.

e. NORMAL SELECTED
   This indicator light shall illuminate when the normal control system is selected.

f. BACKUP SELECTED
   This indicator light shall illuminate when the backup control system is selected.

g. JOYSTICK
   The spring return to center joystick shall be used to move the traveler normally.
   The direction is determined by which direction the joystick is moved. The speed
   is selected by how far the joystick is moved. There are three detente positions
   each direction and the center position. The center position is stopped. The three
   positions in each direction are Jog Speed, Half Speed, and Normal Speed. The
   joystick has a enable pushbutton on the top which acts as a dead-man switch and
   it must be pressed to allow motion.

h. EMERGENCY STOP
   This large red mushroom head push-pull button shall drop out the control power
   and stop all motions. This emergency stop pushbutton should only be used under
   emergency conditions.

i. FAULT
   This indicator light shall illuminate when there is a fault in the system. It shall
   flash when a fault first appears and then stay on steady after the fault is
   acknowledged on the HMI if the fault still remains.

j. SKEW CORRECTION OPERATION NORTH FORWARD
   This momentary pushbutton shall allow the operator to move only the north side
   in the forward direction when in skew correction mode as selected via the HMI.

k. SKEW CORRECTION OPERATION NORTH REVERSE
   This momentary pushbutton shall allow the operator to move only the north side
   in the reverse direction when in skew correction mode as selected via the HMI.

l. SKEW CORRECTION OPERATION SOUTH FORWARD
   This momentary pushbutton shall allow the operator to move only the south side
   in the forward direction when in skew correction mode as selected via the HMI.

m. SKEW CORRECTION OPERATION SOUTH REVERSE
   This momentary pushbutton shall allow the operator to move only the south side
   in the reverse direction when in skew correction mode as selected via the HMI.

n. NAVIGATION LIGHTS OFF / AUTO / ON SELECTOR SWITCH (Main Span
   Travelers only)
   This three position maintained selector switch shall allow the operator to select
   the mode for the navigation lights. When off is selected the navigation lights are
off. When on is selected the navigation lights are turned on. When Auto is
selected the navigation lights turn on when not parked at the tower park position.

o. NORMAL SYSTEM HMI
The HMI on the left is the normal system HMI which is described more in the
screen sections.

p. BACKUP SYSTEM HMI
The HMI on the right is the backup system HMI which is described more in the
screen sections.

3. Diagnostics
Provide diagnostics to aid troubleshooting as part of the system. The PLC shall
perform diagnostics on the PLC components and equipment connected to it as I/O or
via the communications network. Diagnostic information and alarms shall be
displayed on the HMI displays.

Diagnostics shall be furnished as follows:

a. Built in PLC diagnostics information such as module faults, loss of
communication to remote I/O, loss of communications between devices create
alarms.

b. Drive fault codes shall be monitored by the PLC and displayed on the HMI. The
drive fault codes for each drive shall be displayed with descriptions for the most
common fault codes on the HMI’s.

c. All hardwired interlocks shall have individual feedback to the PLC to provide
alarms and status indication for the HMI’s.

d. There shall be no hardwired series circuits. Each device shall have a separate
input to allow for individual alarms to be displayed.

e. Trending and historical logging of key values shall be furnished and installed.

f. Current system alarms as well as historical logging of alarms shall be furnished
and installed.

g. Emergency stop status for all emergency stops shall be displayed on the HMI’s.
It shall be simple to determine which emergency stop condition or button caused
the emergency stop by viewing the HMI screen and alarms.

h. Status of all Limit Switches shall be displayed on the HMI’s.

i. Status of all Motors and Motor Brakes shall be displayed on the HMI’s.

j. Status of all Holding Brakes shall be displayed on the HMI’s.

k. Status and output of all sensors shall be displayed on the HMI’s.

C. General Requirements

1. Redundancy
The control system shall be furnished and installed to increase system redundancy so
the traveler operation is not jeopardized by failures of one or several components.

a. The control system shall be a completely redundant control system, one for
normal operation and one for backup operation. Each system shall have
redundant PLC’s, I/O, HMI’s, and network. The backup system shall use a
different network topology than the normal system so that it can operate with the
loss of any network switch.
b. The Control System shall use a redundant skew feedback device - one on each side of the traveler. The operator shall receive an alarm when the redundant skew sensors devices disagree or when one of them fails. The operator can then bypass the failed or incorrect skew sensor device to continue operation. If both skew sensors are failed, then operation shall be prevented.

c. Due to the number of motor brakes (sixteen per side); the system shall be operable with the loss of a up to one brake per quadrant. A failed motor brake can be manually released and bypassed so the system can remain operational.

d. Due to the number of motors and drives (sixteen per side); the system shall be operable with the loss of a up to one motor or drive per quadrant. A failed motor or drive can be bypassed so the system can remain operational. If a master drive or motor fails, then another motor or drive on the same side can be selected to be the master and the failed motor or drive can then be bypassed.

2. Safety Controller

A safety controller shall be used for the emergency stop circuits. All emergency stops pushbuttons and signals shall be individual safety inputs so that when an emergency stop condition occurs it will be easily determined which signal caused it.

The safety controller shall be connected to the network only for reading the status of the individual safety devices so that the emergency stop condition can be displayed on the HMI for diagnostics purposes.

3. Skew Control

The control of skew, i.e. the difference in travel between the North Side and the South Side of each traveler, shall be handled by the PLC. The skew shall be detected via linear displacement transducers that read the rotation of the pivot bearing. Rotation of the pivot bearing will occur if the platform skews with respect to the track beams due to variation in distance traveled of one side of the traveler with respect to the other. A skew of 1 degree will translate into approximately 0.21 in. on the linear sensor and that translates into 17.7 in. of platform skew between the north and south sides. There shall be redundant skew sensors and the system shall compare the two sensors and alarm if they disagree by more than 0.05 degrees. A failed sensor shall be able to be bypassed by selecting the other sensor to be in control via the HMI.

The system shall actively control the skew by applying a skew offset to the drive speed slowing the faster traveler side down and speeding up the slow traveler side to maintain a zero skew. If the skew dwells at greater than 1 degree for more than 30 seconds, then both panels shall decelerate to half speed. If the skew reaches 2 degrees then all panels shall stop instantly. The drive speed skew offset shall be limited to a field determined amount to prevent over correcting. When the skew offset is applied to the drive speed, the resulting drive speed shall be limited to prevent reversing direction or exceeding maximum speed. The algorithm which controls skew shall also be capable of adjusting speed of one side of the traveler versus the other side during acceleration and deceleration periods in order to maintain close to zero skew during acceleration and deceleration. To accomplish skew control during acceleration and deceleration the PLC shall control the acceleration and deceleration.
4. Master / Follower Load Sharing
Each side of the traveler shall have sixteen motors and drives, with the motor load on a given side shared between the active motors by using a master / follower torque sharing system. One drive per side is selected to be the master drive and it will receive a speed command when running. The remaining drives shall be followers and shall operate to follow the master drives torque. As the followers work to match the master drives torque, the load between the master and followers shall equalize. Motor speed run away in the follower drives shall be prevented and detected if wheels slip occurs. The torque sharing system shall be capable of sharing torque between motors on a given side to within 10% of the average within no more than 0.5 seconds after motion is initiated. The drive manufacturer shall demonstrate in a testing lab prior to installation that the drives are capable of detecting actual torque within an accuracy of 5% and that the system of sixteen drives and the PLC maintains torque between the sixteen motors within 10%.

The drives shall be capable of controlling torque via flux vector control without motor speed feedback encoders.

The system cannot operate if the master drive fails therefore the system shall be able to change which drive is the master drive via the HMI. If the master drive fails, the master can be changed and the failed master (now a follower) can be bypassed.

The number of drives that can be bypassed is up to one per quadrant.

5. Open Non-Proprietary Design
The control system shall be non-proprietary and have the ability to be maintained by more than one qualified maintenance vendor.

Ways that the control system will be open and non-proprietary include:

a. The use of PLC and drive manufactures that have been installed at a minimum of fifty industrial facilities to ensure there are available qualified maintenance vendors that will be familiar with the system hardware components and the programming software.

b. All application programs will be un-protected (not password protected or locked) so that any maintenance vendor may view the programs for troubleshooting and maintenance.

c. The Authority will own the application programs for its own use. Proprietary application software shall not be used or if it is used, rights to use and maintain the software will be granted to The Authority and their representatives. This only includes application software not off the shelf software such as HMI development or PLC development software.
2.02 MATERIALS

A. STRUCTURAL

1. GENERAL

a. Materials shall be furnished and installed in accordance with Section 051200.

b. All traveler, docking platform and trackbeam steel shall be considered Fracture Critical, Tension Component and shall meet the requirements ASTM A572, ASTM A6 Supplementary Requirement S5 and Section 051200.

c. All traveler access steel shall be considered Non-Fracture Critical, Tension Component and shall meet the requirements of ASTM A572.

B. MECHANICAL

1. GENERAL

a. Materials and equipment shall be essentially the standard catalogued products of manufacturers regularly engaged in production of such materials or equipment and shall be manufacturer's latest standard design that complies with the specification requirements. Materials and equipment shall essentially duplicate items that have been in satisfactory commercial or industrial use at least two (2) years prior to bid opening. Where two or more units of the same class of equipment are required, these units shall be products of a single manufacturer; however, the component parts of the system need not be the products of the same manufacturer. Each major component of equipment shall have the manufacturer's name and address and the model and serial number on a nameplate, securely affixed in a conspicuous place. The nameplate of the distributing agent will not be acceptable. Nameplates shall not be painted.

b. Where installation procedures or any part thereof are required to be in accordance with the recommendations of the manufacturer of the material being installed, printed copies of these recommendations shall be furnished to the Engineer prior to installation. Installation of the item will not be allowed to proceed until the recommendations are received. Failure to furnish these recommendations can be cause for rejection of the material.

2. CASTINGS AND FORGINGS

a. All castings shall be free of cracks, cold shuts, shrink holes, blowholes and porosity.

b. All castings shall be cleaned free of loose scale and sand, fins, seams, gates, risers, and other irregularities.

c. All unfinished edges of castings shall be neatly cast with rounded corners, and all inside angles shall have ample fillets.

d. All castings that have solid sections four (4) in. thick or greater shall be ultrasonically tested in accordance with ASTM A609, Method A, Quality Level 3. Castings that do not pass this test may be rejected. Test results, whether positive or negative, shall be submitted to the Engineer.

e. Carbon Steel and Alloy Steel Forgings shall meet the requirements of ASTM A668 unless as otherwise approved by the Engineer. Supplementary requirements as outlined in the ASTM specifications may be required upon the request of the Engineer.
f. Stainless Steel Forgings shall meet the requirements of ASTM A705 unless as otherwise approved by the Engineer. Supplementary requirements as outlined in the ASTM specifications may be required upon the request of the Engineer.

g. No repairs will be permitted on any casting or forging unless approved by the Engineer regardless of the ASTM Specification. The repair procedure shall be described fully, and inspection requirements established prior to repair.

3. SHAFTING AND PINS

a. All forged shafts shall be reduced to size from a single bloom or ingot until perfect homogeneity is secured. The blooms or ingots, from which shafts or pins are to be made, shall have a cross-sectional area at least three times that required after finishing. No forging shall be done at less than a red heat. Forged rounds for shafts and pins shall be true, straight and free from defects.

b. All shafts and pins shall be accurately finished, round, smooth, and straight and, when turned to different diameters, shall have rounded fillets at the shoulders.

c. All shafts shall conform to tolerances in ASTM A29 unless otherwise indicated. Turned, ground and polished shafting straightness tolerances shall be 0.002 in. per foot for shafts up to and including 1½ in. in diameter and 0.003 in. per foot for shafts over 1½ in. in diameter.

d. Each end of all shafts, when finished to the required lengths, shall have a 60-degree lathe center, with clearance hole, at the exact center of the shaft. Shafts that are bored with an inspection hole shall have the ends prepared for the attachment of a centering device equivalent to the lathe center. All such devices shall be furnished as part of the work. Turned, ground and polished shafts need not have this requirement.

e. Where shown on the drawings, stepped shafts shall have fillets blended in smoothly to adjacent surfaces without tool marks or scratches. Unless otherwise required herein or on the drawings to have a finer finish, all shaft surfaces shall have an ANSI maximum roughness of 63 microinches. Finishes for mating with commercial components such as hubs, bearings and seals shall be per the manufacturer recommendation.

f. All cold-finished shafting shall be steel of the type and grade shown on the Contract Drawings and shall be tested for its mechanical properties, and a test certificate shall be furnished to the Engineer. Each cold-finished shaft shall be free from camber and shall run without vibration, noise, or chatter at all speeds up to and including the maximum rated speed.

g. All hubs mounted on the ends of cold-finished shafts shall have the fit specified herein or on the drawings. To obtain the required fit between hub and shaft, the Contractor shall furnish the cold-finished shaft 1/16 in. larger than the nominal diameter specified and shall turn the ends to the required dimension for the hub. The Contractor may, at his option, furnish any cold-finished shaft of one diameter end to end; but such shaft shall have tolerances selected from the normal manufacturing range to provide the specified fit. The selected tolerances shall be shown on the shop drawings.

h. Turned, ground and polished commercial shafting of the grade specified shall be used where shown on the drawings.
4. FASTENERS

a. All bolts for connecting machinery parts to each other or to supporting members shall be as shown on the Contract Drawings or specified otherwise and conform to one of the following types:

b. Finished body, high-strength bolts.
c. Cap screws, hex and socket head type.
d. Finished body high-strength bolts shall meet the requirements of ASTM A449. High-strength bolts shall have finished bodies and regular hexagonal heads. Holes for high-strength bolts shall be not more than 0.01 in. larger than the actual diameter of individual bolts. Drilled and or reamed holes shall match the tolerances for each bolt. The clearance shall be checked with 0.011-in. wire. The hole shall be considered too large if the wire can be inserted in the hole together with the bolt. Wherever possible, high-strength bolts connecting machinery components to structural elements or to other machinery components comprised of different thicknesses shall be installed such that the bolt head is adjacent to the connected element with the least thickness.

c. All elements connected by bolts shall be drilled or reamed assembled to assure accurate alignment of the hole and accurate clearance over the entire length of the bolt within the specified limit. Hand held reamers are not considered accurate enough and the Contractor shall assume that a reaming jig shall be used to keep the bolt hole cylindrical. This jig shall be of structural steel, fixed to the drill and secured to the work preventing the reamer shaft from deviating. Holes shall be checked with a bolt hole micrometer to assume uniform diameter.

f. The dimensions of all bolt heads, nuts, castle nuts and hexagonal head cap screws shall be in accordance with ANSI Standard B18.2, Square and Hexagon Bolts and Nuts.

g. ASTM A449 bolts shall have finished bodies and regular hex heads.
h. The dimensions of socket-head cap screws, socket flathead cap screws, and socket-set screws shall conform to ANSI Standard B18.3. The screws shall be made of heat-treated alloy steel, cadmium-plated and furnished with a self-locking nylon pellet embedded in the threaded section. Unless otherwise called for on the drawings or specified herein, set screws shall be of the headless safety type, shall have threads of coarse thread series, and shall have cup points. Set screws shall neither be used to transmit torsion nor as the fastening or stop for any equipment that contributes to the stability or operation of the traveler.

i. Threads for bolts, nuts and cap screws shall conform to the coarse thread series and shall have a Class 2 tolerance for bolts and nuts or Class 2A tolerance for bolts and Class 2B tolerance for nuts in accordance with the ANSI Standard B1.1, Unified In. Screw Threads.

j. Bolt holes through unfinished surfaces shall be spot faced for the head and nut, perpendicular with the axis of the hole.

k. Unless otherwise called for, all bolt holes in machinery parts or connecting these parts to the supporting steel work shall be subdrilled at least 1/32-in. smaller in diameter than the bolt diameter and shall be reamed assembled for the proper fit at assembly or at erection with the steel work after the parts are correctly assembled and aligned.

l. Holes in shims and fills for machinery parts shall be 1/16-in. larger in diameter than the bolt diameter.
m. Positive locks of an approved type shall be furnished for all nuts, except those on ASTM A449 bolts. If double nuts are used, they shall be used for all connections requiring occasional opening or adjustment. If lock washers are used for securing, they shall be made of tempered steel and shall conform to the SAE regular dimensions. The material shall meet the SAE tests for temper and toughness.

n. High-strength bolts shall be installed with a hardened plain washer meeting ASTM F436 at each end.

o. Wherever possible, high strength bolts connecting machinery parts to structural parts or other machinery parts shall be inserted through the thinner element into the thicker element.

p. All cotters shall conform to the SAE standard dimensions and shall be made of half-round stainless steel wire, ASTM A276, Type 316.

q. All fasteners shall be of United States manufacture and shall be clearly marked with the manufacturer's designation.

r. Fasteners that require tapped holes, shall be detailed with a minimum thread engagement of 1 ½ times the nominal body diameter when possible. A 1/8in. counterbore shall be provided in the base material. Suitable thread relief shall be provided to allow the proper tensioning of the fasteners.

s. All fasteners shall be provided with a means to lock the fastener to prevent them from loosening. A thread locking compound shall be used in the case where lock washers, double nuts, cotter pins or high tension cannot be utilized. The thread locking compound shall be equal to Loctite No. 242 "removable threadlocker".

5. KEYS AND KEYWAYS

a. Keys and keyways shall conform to the dimensions and tolerances for square and flat keys of ANSI Standard B17.1, Keys and Keyseats, unless otherwise specified. All keys shall be effectively held in place, preferably by setting them into closed-end keyways milled into the shaft. The ends of all such keys shall be rounded to a half circle equal to the width of the key. Keyways shall have a radius in the inside corners and keys shall be chamfered. Keyways shall not extend into any bearing. If two keys are used in a hub, they shall be located 120 degrees apart and in line with wheel arms where practicable.

b. Unless otherwise specified herein or in the drawings, keys shall be machined from carbon steel forgings, ASTM A668, Class K.

6. BEARINGS

a. Anti-friction bearings have been selected for minimum B-10 life of 40,000 hours as shown on the Contract Drawings.

7. SEALS AND O-RINGS

a. Seals shall be set to retain lubricant and exclude water and debris.

b. All mating surfaces of seals and o-rings shall be finish machined in accordance with manufacturer recommendations.
8. BUSHINGS
   a. All journal-bearing areas on shafts and pins shall be accurately machined and
      polished, with no trace of tool marks or scratches on the journal surface or
      adjoining shoulder fillets. Burnishing of the shaft journal areas and adjoining
      shoulder fillets will be acceptable in lieu of polishing provided that the
      burnishing is done with a Stellite roller or equal, finished to a mirror surface.
      Journal diameters shall be finished to the limits of an ANSI B4.1 Class RC6
      running fit.
   b. The journal-bearings for the equalizer pin, upper gimbal joint, and lower gimbal
      joint shall be a special bronze bushing with low friction coating on the
      sliding/rotating and thrust surface. Acceptable Manufacturers are listed below. Due
      to the slight variances between manufacturers, the final details and materials for the
      bearings and pins may also be adjusted subject to approval of the Engineer. The
      installation of bearings shall be as per manufacturers recommendations. All such
      variations and adjustments of details and materials for the bearings and axles
      shall be considered part of the Project and at no additional cost.
      
      (1) Self-lubricating / Maintenance-free bushing manufacturers or approved
          equal:
              (2) Lubrite Technologies, Meadville, PA
              (3) RBC Bearings Inc., Oxford, CT
              (4) Thordon Bearings Inc., Burlington, Ontario, Canada

9. ENCLOSED GEAR REDUCERS
   a. Speed reducers shall be standard models from one manufacturer, with ratios,
      dimensions, construction details and AGMA ratings as shown on the Contract
      Drawings. Ratings shall be based on a service factor of 1.15.
   b. Each unit shall have means for filling and draining the case, - and a sight gauge
      to show the oil level. Each unit shall be furnished with a moisture trap breather.
   c. Lubrication of the gears and bearings shall be automatic when the unit is in
      operation.
   d. It is preferable that a bath lubrication system be utilized. In a bath lubrication
      system, all components in the reducer which require lubrication are partially
      submerged in the oil bath.
   e. When the configuration of gears and bearings prevent bath lubrication, a splash
      lubrication system should be used. Splash lubrication systems shall continuously
      lubricate all gears and bearings properly. Oil feed troughs may be used to supply
      oil to bearings, and gears which are above the bath. Splash lubrication systems
      shall be designed such that equal lubrication is supplied to each internal
      component for both directions of operation.
   f. Helical gearing shall conform to ANSI/AGMA Standards 2001-B88. Bevel
      gearing shall conform to ANSI/AGMA Standards 2003-A86.
   g. Internal drawings showing each gear reducer component with part numbers shall
      be provided to the Engineer.
   h. Moisture-trap breathers shall be located above maximum oil levels in all
      positions of the reducer during operation, and its piping shall enter the unit at the
      highest point possible. Breathers shall not be mounted in bearing caps.
   i. Oil drains shall be located at the lowest point and be located as to facilitate
      draining and filling without spillage.
j. Gear reducers shall have provisions for oil expansion due to churning and temperature change.

k. On shaft extensions, bearing shaft ring seals shall be mechanical type oil seals which compensate for wear. Dual lip spring loaded seals are preferred. Seal systems shall be so designed to assure leak free operation for 10 year minimum.

l. Reducers shall have nameplates giving the rated horsepower, rating, speed and service factor in accordance with applicable AGMA standards.

10. DAMPING STRUTS

a. Pressure cylinders and end caps of all dampers are machined from alloy steel billet, internally threaded, and through hardened. Damper cylinders shall be rated and proof tested to a minimum burst pressure of 2.0 times maximum operating pressure. No failure prone tie rods, welds, castings or gaskets shall be used.

b. All piston rods are machined from type 17-4 PH stainless steel billet, through hardened, hand polished to a mirror-like 2 micro-in. surface finish, and Teflon® impregnated by a proprietary process.

c. All dynamic pressure seals shall be machined from billets of structural polymer.

d. Operating fluid shall be environmentally safe.

e. Dampers shall be built to be maintenance free. Without the need of reservoirs, external plumbing, fluid level indicators, accumulators, or periodic fluid changes.

11. BUFFERS

a. Travelers shall incorporate hydraulic buffers to absorb energy in the event the traveler control system fails to properly slow the traveler down at the end of travel. The system will be designed to stop just short of the buffer strikes under normal operation.

12. HOLDING BRAKES

a. Holding brakes shall be heavy industrial style spring set hydraulically released caliper type disc brakes which simultaneously clamp on both the upper and lower surfaces of the lower flange of the track beams with industrial brake friction material.

b. The brakes shall act as parking brakes and are not intended to stop traveler motion under normal stopping conditions or during emergency stopping conditions. The hydraulic systems which hold the brakes open during traveler motion shall incorporate slow setting orifices which will delay brake setting for a minimum of 10 seconds and a maximum of 20 seconds during normal setting operation and after an emergency stop where electrical power is completely removed from the system. The hydraulic systems shall be designed to hold the brakes open continuously.

c. The holding brake system shall be rated for an ambient temperature range of 0°F to 100°F without the need to change hydraulic fluid from summer to winter. The system shall be designed for year around outdoor use. Brake hardware shall be fabricated from corrosion resistant materials such as stainless steel or brass to the greatest extent practical. Pin joints shall include lubrication fittings unless maintenance free type bushings are used. The system shall be designed for long life based on intermittent use.
d. The hydraulic fluid shall be environmentally safe type fluid. The brake supplier shall submit the type of fluid recommended for use with their brakes. The brake supplier shall include precautions in their design against fluid leakage to the greatest extent practical. The precautions shall include at a minimum the following:

1. Double wall hydraulic fluid reservoir or drip pan capable of holding full volume of fluid
2. Control logic to detect a loss of pressure in the system and shut down the pump(s)
3. Robust sealing system compatible with fluid type used
4. Use of hydraulic fittings which minimize leaks
5. Industry standard field installation which minimizes risk of leakage. Particular care shall be taken where hoses are used to transition across joints where relative movement may occur such as at the gimbal joints. The hoses shall be properly supported and be routed to allow flexibility without placing stress on the fittings.

e. Brake assemblies shall maintain a minimum clearance of at least 3/16 in. from the top and bottom surface of the track beam bottom flange in the released position. The assembly shall maintain a fixed clearance of at least ½ in. with the edge of the lower flange of the track beam. When the brakes are released, no part of the brakes shall be permitted to encroach within these clearances.

f. Each brake shall have a holding capacity of at least 4,000 lbs. Two brakes shall be installed on each bogie for a total of four on each track beam and eight on each traveler. Minimum static holding capacity of 16,000 lbs required per track beam, 32 kips total per traveler, under wet/dry rusty surface conditions.

g. Brake frames shall each be constructed to resist a minimum force of 10,000 lbs oriented normal to the trackbeam due to damping strut reaction under maximum wind conditions.

h. Each holding brake shall include a minimum of one limit switch to indicate brake released position.

i. Each traveler shall include a hydraulic unit at each end to normally release the four brakes located at that end of the traveler. Each of the two units shall have capacity to release all eight brakes should one unit fail. The two units shall be hydraulically connected with a shutoff valve between to allow either unit to release all eight brakes if necessary.

j. The hydraulic units shall be fully enclosed, fabricated from corrosion resistant materials and be designed for outdoor use. The enclosures shall meet the requirements of NEMA 4X to the greatest extent practical. All electrical and hydraulic penetrations shall be made through the bottom of the enclosure and shall be sealed watertight. Hydraulic connectors shall be integrated into the enclosure so external tubing or hose connections will be made external to the enclosure. Clearance holes or slots intended for tubing to pass through the enclosure wall(s) are unacceptable. Each enclosure shall include a thermostat controlled anti-condensation heater unless a reservoir heater is included. If ventilation and/or cooling is required, the venting shall be made in such a way to prevent water ingress into the enclosure due to wind driven rain. External ducting may be required to prevent ingress of water.
k. Holding brake supplier shall specify the pressure rating of the system, considering pressure losses in the fluid conduits between the hydraulic unit and the brakes under the full operational temperature range. Brake supplier shall submit calculated pressure drop in fluid conduits at both extremes of temperature range for approval.

l. All field tubing shall be specified according to AASHTO requirements for the pressure rating of the brake hydraulic system. Minimum tube size shall be 0.625in. OD with wall thickness to meet AASHTO and ASME B31.1 code requirement for the pressure rating of the system. All field fittings, valves and hose fittings shall be stainless steel compatible with the tubing material.

m. All hoses shall meet the requirements of AASHTO/ASME for the pressure rating of the system.

13. HUBS AND BORES
   a. The hubs of all gears, wheels and couplings shall be finished on both faces and polished where the hub face performs the function of a collar to prevent shaft movement. The hubs shall be bored concentric with the rims of gears and wheels or with the outside of couplings. All hubs shall have an ANSI Class FN2 medium shrink fit on the shafts, unless otherwise specified.

14. SHIMS
   a. All machinery shims required for leveling and alignment of equipment shall be brass, neatly trimmed to the dimension of the assembled parts and drilled for all bolts that pass through the shims. In general a nominal ½in. shim pack shall consist of sheets of thickness of ⅛in., ⅛in., ⅛in., ⅛in., ⅛in., ⅛in., ⅛in., ⅛in., (2)-0.005in. and (2) 0.003in. Additional shims of smaller thickness and or tampered shims shall be provided as necessary to obtain the proper alignment of mechanical components. Shims shall be ASTM B36 C21000. Shims greater than ½ in. shall include one solid plate of thickness equal to ½ in. less than total shim thickness.

15. WELDING
   a. Welding required for machinery components shall be done in accordance with the requirements for welding structural steel listed in Part 2 – Structural Steel. Stress relieving by heat per AWS D1.1 shall be required for all weldments used as machinery components. All welds used to fabricate machinery shall be completely tested by ultrasonic inspection (ASTM E164-74) per AWS D1.1, Section 6, Part C. All machining shall be performed after welding and stress relieving.

16. LUBRICATION
   a. Grease fittings for a pressure system of lubrication shall be for surfaces requiring external lubrication unless otherwise shown on the Contract Drawings. Not more than two sizes of fittings shall be used. Giant button head grease fittings (Alemite Part No. 1823-1 or approved equal) shall be used wherever possible, and the smaller size shall be used for motor bearings and other small devices. Pressure fittings shall be rated at a minimum of 10,000 psi. Fittings shall contain a steel check valve that will receive grease and close against backpressure.

   b. Giant Head fittings shall be connected directly into the bushings by ¼ in. minimum size, extra strong, threaded steel pipe and forged threaded fittings. The smaller fittings shall be connected with ¼ in. pipe where pipe extensions are required or by the size pipe thread furnished with the device to be lubricated.
c. Pipe extensions shall be provided to facilitate access for lubrication but shall be kept as short as practical and shall be rigidly supported at the fittings and at intermediate points.

d. Immediately after the completion of fabrication, all grease fittings shall be plugged until components are installed and regular lubrication is started. The plugs will then be replaced with the proper grease fittings.

e. The Contractor shall furnish lubrication charts and the component manufacturer's lubrication literature for every machinery component that requires lubrication.

The charts shall consist of:

(1) A schematic diagram of all machinery showing the location of lubrication fittings and other points of mechanical and electrical equipment that require lubrication of any kind. These diagrams shall indicate the type of lubrication to be used at each point, the method of application at each point and the frequency of lubrication at each point.

(2) A table chart listing each machinery component that requires lubrication, the minimum lubrication frequency, the minimum lubrication change frequency instructions, standards, guidelines and a history of most recent service. Each chart shall be made from a fade resistant and weather proof material and permanently mounted on the traveler platform as directed by the Engineer. The schematic chart shall be sealed in permanent plastic covers. A second set of charts shall be furnished to the Engineer as a reference set.

f. Maintenance and lubrication manuals for each machinery component shall be kept in a location as directed by the Engineer.

g. An amount of each of the required lubricants shall be furnished to perform maintenance for (1) year from issuance of Certificate of Final Completion by the Contractor. The lubricants shall be stored in a location as directed by the Engineer.

h. The lubricant for each type of machinery component shall be kept separately in clearly marked containers. All measures shall be taken to prevent lubricant contamination.

i. During installation, the Contractor shall lubricate all rotating and sliding parts of the machinery and fill all gear reducers with lubricants indicated on the approved charts.

17. LUBRICANTS

a. Enclosed GearReducers

(1) Enclosed gear reducer lubricant shall meet the requirements of the American Gear Manufacturers Association (AGMA) Standard 250.04 "Lubrication of Industrial Enclosed Gear Drives".

(2) The lubricant shall be manufactured by a reputable and knowledgeable supplier of lubrication for use in each application by the lubricant manufacturer.

(3) The lubricant shall be recommended for use by the reducer manufacturer.

(4) The lubricant should contain oxidation inhibitors, rust inhibitors, anti-foaming agents and anti wear additives.

(5) Enclosed Gear Reducer Lubricant specification to be used in conjunction with AGMA Standard 250.04.
(6) The maintenance of the lubricant, method of application and re-lubrication intervals, shall be recommended by both the reducer manufacturer and the lubricant manufacturer, and meet the requirements of the AGMA Standard 250.04 unless otherwise stated herein.

b. Roller Bearings

(1) Roller bearing lubricant shall be per bearing manufacturer’s recommendation

(2) The roller bearing lubricant, the maintenance of the lubricant, method of application and re-lubrication intervals shall be recommended or approved by the bearing manufacturer unless otherwise stated herein.

18. EQUALIZER, TROLLEY, HANGER AND SWIVEL ASSEMBLIES

a. Steel Plates - All plates for equalizer, trolley and hanger components shall be considered Fracture Critical, Tension Component and shall meet the requirements ASTM A572, ASTM A6 Supplementary Requirement S5 and Specification Section 051200.

b. Steel Tubing – All tubes shall meet the requirements of ASTM A519 Standard Specification for Seamless Carbon and Alloy Steel Mechanical Tubing unless otherwise noted.

19. SPARE PARTS AND ADDITIONAL LUBRICANTS

a. In addition to the spare parts described under other items the following spare parts and additional lubricant shall be provided:

(1) Trolley Assembly, including drive wheels, bearings and shaft, (4)

(2) Bearing seals, (8) of each type.

(3) Enclosed gear motor drive including motor and brake, (2) RH, (2) LH

(4) Drive Trolley guide roller assemblies (complete), (16)

(5) Damper strut, (2)

(6) Enclosed gear reducer gear oil, per Section 3.05 Materials, item N – Lubricants

(7) Roller bearing lubricant, per Section 3.05 Materials, item N – Lubricants

(8) Sleeve bearing lubricant, per Section 3.05 Materials, item N – Lubricants

(9) Brake hydraulic oil, per Section 3.05 Materials, item N – Lubricants

20. SCISSOR LIFT VEHICLE

a. The scissor lift vehicle shall be custom manufactured or modified commercially available personnel lift, and OSHA compliant.

b. The scissor lift shall not exceed 4,000 pounds gross weight.

c. The scissor lift shall be electrically operated, and battery powered. Charger shall be 20A Automatic.

d. The scissor lift shall be collapsible to a height 5ft-3in. with the handrails collapsed and contain an extendable kick out platform of 3 ft nominal length

e. The scissor lift shall be capable of maximum working height of at least 20ft, and a minimum work capacity of 500-pounds, with 250-pound work capacity on the kick out platform.

f. The scissor lift shall be outdoor rated, include a protective cover when not in use, include spring-loaded gate, include flashing amber beacon, include lifting lugs, and biodegradable hydraulic oil.
2. **PROVISION FOR EXISTING EQUIPMENT**
   a. All work required to connect existing equipment to remain to traveler electrical equipment furnished and installed as part of the Work shall be included under this item. This includes obtaining information on existing components, protection of equipment during construction, removal and reinstallation of components if necessary, and testing of all equipment to verify proper operation. All wiring insulation shall be rated for the equipment it is being connected to. All other necessary conduit and wiring shall be covered under their respective items.

3. **CONDUCTOR BAR**
   a. The Conductor Bar shall be furnished in accordance with Section 260514 Conductor Bars. In addition to the requirements of Section 260514, provide the services of the conductor bars manufacturers technical representative for the following on-site services:
      
      (1) Training of installation personnel before the start of the installation to provide introduction to the conductor rail system including the description of the single components and installation steps and use of the specific installation tools.
      
      (2) Oversight at each stage of the conductor bar installation.
      
      (3) Commissioning of the conductor bar installation before startup including:
          
          (a.) Check of the general conditions and the operational performance of the conductor rail system
          
          (b.) Checking the condition of the conductor rails
          
          (c.) Checking the condition of the contact surface
          
          (d.) Checking any pollution/corrosion of the rails
          
          (e.) Inspection of the single rail components
          
          (f.) Checking of the collector assemblies
          
          (g.) Checking for wear and tear of the components
          
          (h.) Checking the location, alignment, contact pressure and the wiring
          
          (i.) Checking of joints and any transfer points and drive-in/-out zones
          
          (j.) Check of the maximum distance between the two corresponding elements in vertical, horizontal, and angular direction
          
          (k.) Inspection of the accessories and attachments
          
          (l.) As an option for the inspector, taking shots with cameras mounted on the moving consumer (e.g. trolley) to take pictures of the system in operation, as needed
          
          (m.) Creation of final report
          
          (n.) Detailed report about the carried-out work, measurements, recommendations and necessary remedial actions to take
          
          (o.) Detailed analysis of any video taken of the system

4. Train up to ten (10) Authority maintenance personnel with regard to maintenance procedures specifically for the GWB conductor bar systems for one day at the construction site including typical faults and troubleshooting
5. DRIVE MOTORS
   a. The drive motors shall be vector duty gearmotors with integral disk brakes. The motors shall be assembled with the gearboxes as indicated on the Mechanical System Contract Drawings and Specifications by a single vendor.
   b. The gearmotors shall be 2 hp, 4 pole, three phase, 480 VAC 60 Hz high efficiency motors. They shall be rated for use with inverter drives and shall be furnish and installed with internal space heaters and thermostats.
   c. The motor shall be rated for above deck applications with following options:
      (1) Encapsulated stator
      (2) Internal Corrosion Protection
      (3) Drain Plug
      (4) OS4 Surface Protection
      (5) Stainless steel nameplate with specification number
   d. The motors shall be supplied with an integrated mechanical brake. The brake shall be rated for 100% to 125% of full load motor torque. The brake shall be a spring set electromagnetic disk brake with a DC coil that releases electrically. Due to its operating principle, the brake shall be applied if the power fails. The brake shall be supplied with a manual release with automatic reset. The brake shall be controlled by a brake controller that is installed in the motor wiring compartment.
   e. All motors shall be Marine Duty manufactured to the following standards:
      (1) IEEE Marine Standards No. 45.
      (2) American Bureau of Shipping (A.B.S.)
      (3) U.S. Coast Guard 259.
      (4) International Electrotechnical Commission (IEC)
      (5) Navy 9Y
   f. Drive Motors shall utilize the following:
      (1) Hollow shaft design
      (2) 2 output oil seal
      (3) Nirosa type breather valve
      (4) Stainless steel design thread adapter
      (5) Bullseye oil sight glass
      (6) IP66 enclosure
      (7) 1.15 Service Factor
   g. The motors shall be manufactured by:
      (1) SEW, Bridgeport, NJ
      (2) Marathon, Wausau, WI
      (3) Reuland, Industry, CA
      (4) Baldor, Fort Smith, AR
      (5) Or as approved by the Engineer
6. VECTOR MOTOR DRIVES

a. The drives shall be properly sized based on the full load ampere rating of the motors and shall allow for 150% overload for 60 seconds. The catalog numbers and ratings of the drives listed on the Contract Drawings are approximate and shall be confirmed with the drive motor approved shop drawings. The correctly sized drive, meeting all the requirements, shall be furnish and installed at no additional cost to the Authority.

b. Vector drives shall be four quadrant drives and shall be capable to run in speed and torque mode with adjustable torque limits in all four quadrants without the need for motor speed feedback encoders.

c. To minimize electrical and acoustical noise, and to eliminate low speed cogging, a minimum switching frequency of 20 kHz shall be used. The drive shall not "cog" at any frequencies with a 1,000:1 speed regulation. There shall be no sudden frequency shifts and associated acoustical noise shifts as the output frequency is varied between 0 and 60Hz.

d. The drive’s input displacement power factor shall be 0.98 or better over the entire operating frequency and load range. Efficiency shall be measured 96% minimum at rated load. The Contractor shall provide manufacturers typical test results or calculations with submittal to verify efficiency and power factor.

e. The drives shall be furnished and installed with input reactors as specified by the drive manufacturer.

f. Select IEEE 519 compliant vector drives to limit harmonic distortion at the power distribution point of service, including line notching and transients. Take the necessary steps to limit Total Harmonic Distortion (THD) to the prescribed limits of the utility company. Total Harmonic Current Distortion (THDc) measured at the power input terminals of VFD shall not exceed 20 percent at 50 percent or higher load. Submit with VFD system voltage and current THD calculations at the point of service for the particular drive system for approval.

g. Output reactors shall be supplied as required per drive and motor manufacturer recommendations.

h. The vector drives shall have, but not be limited to the following features:

1. Manufacturer provided Ethernet communications module to allow transfer of all commands and operational data/faults to the PLC network

2. High speed analog inputs

3. Allow for smooth and instantaneous connection into rotating loads, regardless of commanded direction, without the need for any speed feedback.

4. Provide a torque proving circuit to ensure proper control of the load when transferring control between the drive and a mechanical brake.

5. Slip Compensation to provide a minimum 0.5% speed regulation without feedback hardware.

6. Solid state output ground fault protection shall be provided.
(7) Adaptive electronic motor overload protection shall be provided which shall protect both the motor and the drives at all frequencies. This overload shall be UL approved. Electronic thermal overload circuits which only protect the motor at full speed shall not be acceptable. The drive shall sense the load and speed and shall recalibrate the thermal trip curve to insure low speed motor protection. The initial trip point shall be adjustable from at least 40% of the drive continuous rating to account for motor magnetizing current.

(8) Configure the drives for minimum 6-pulse operation to effectively reduce harmonic distortion content by using front end filtering

(9) Input surge protection

(10) Input and output phase loss detection

(11) Output short circuit protection

(12) Four programmable digital inputs for Forward, Reverse, Fault Reset and Master/Follower Selection.

(13) Two programmable digital dry contact outputs for Drive Fault, Drive Ready/Drive Running/Drive At Speed.

(14) Programmable current limit.

(15) Remote drive reset contact.

(16) Capability to provide torque sharing with up to 15 other drives.

i. The ‘Drive Trouble’ fault condition shall cause the drives to shut off and shall be annunciated to the PLC control system through the Ethernet connection. All faults shall be transmitted to the PLC. The conditions that shall cause a drive shutdown fault are as follows:

(1) Blown fuse.

(2) Instantaneous overcurrent trip.

(3) DC bus overvoltage.

(4) DC bus undervoltage.

(5) Excessive ambient drive heat sink over temperature.

(6) External fault input.

(7) Internally diagnosed, control failure.

(8) Motor thermal overload.

(9) Drive thermal overload.

j. The drives shall employ modular PC board design for ease of troubleshooting. All connectors shall be polarized type and clearly marked on both the connector and PC board to ensure proper connection.

k. On each drive cabinet, furnish and install one (1) door-mounted LCD Human Interface module station which can connect to any drive for troubleshooting with the following minimum features:

(1) Remote versions for panel mount application

(2) Large and easy to read 7-line x 21-character backlit display

(3) Alternate function keys for shortcuts to common tasks

(4) “Calculator-like” number pad for fast and easy data entry

(5) Control keys for local start, stop, speed, and direction
1. All drive functions shall be programmable from the door-mounted keypad. The keypad shall be equipped with EEPROM and be removable so that the parameters can be downloaded into another drive.

m. The vector motor drives shall be:
   (1) Allen-Bradley Powerflex 70, Milwaukee, WI
   (2) Siemens, Washington, DC
   (3) Emerson, St. Louis, MO
   (4) Or equal as approved by the Engineer

7. **LINE REGENERATION UNIT**
   a. The line regeneration unit shall be used to dissipate regenerative braking currents due to braking or an overhauling load, returning the regenerated energy back to the input AC line. The unit shall be rated for operation with a 480 VAC, 3 Phase line voltage. The unit shall have a current rating at least 25% greater than the combined rated overload condition of the drives connected to it. During a braking event, as the DC bus rises above the AC line peak, the unit redirects current from the DC bus into the AC line to limit the rise in bus voltage and prevent overvoltage faults. While regenerating the unit will automatically fold back in an overcurrent condition or shut down if unsafe conditions are detected. The unit shall be furnished and installed with a digital display to indicate:
      (1) DC Bus Voltage
      (2) DC Regen Current
      (3) Regen Power
      (4) Total Unit On-time Fault Records stores 50 most recent fault states (Last one record is stored with LED Indicators)
      (5) Feedback Undervoltage
      (6) Overtemperature
      (7) DC Overvoltage
      (8) Differential Overvoltage
      (9) Sync Loss
      (10) IGBT Driver
      (11) Phase Overcurrent
      (12) Phase Loss
      (13) DC Undervoltage
      (14) Precharge Failure
      (15) Frequency Detect Failure Energy
      (16) Energy Regenerated since user reset
   b. The line regeneration shall be the Bonitron M3645 Line regeneration unit or approved equal.

8. **PROGRAMMABLE LOGIC CONTROLLER SYSTEM (PLC)**
   a. Traveler control logic functions shall be performed by a PLC system, which shall control operation of the travelers in accordance with the system functioning specified herein and the control logic shown on the Contract Drawings.
b. The PLC shall be an Allen Bradley (AB), Milwaukee, WI, 1769 CompactLogix brand PLC with components, hardware and remote input/output drops or approved equal by Modicon, Andover, MA. or Siemens, Washington, DC. The PLC shall be of modular construction, provide high-speed peer-to-peer networking, and be programmable with ladder logic.

c. The PLC system shall consist of a normal PLC system and a backup PLC system.

d. Modules are defined herein as devices that plug into a chassis and are keyed to allow installation in only one direction. The design shall prohibit upside down insertion of the modules as well as safeguard against the insertion of a module into the wrong slot or chassis via an electronic method for identifying a module. Electronic keying performs an electronic check to ensure that the physical module is consistent with what was configured. The PLC shall have the ability to be updated electronically to interface with new modules.

e. All hardware of the PLC system shall be capable of operating at an ambient temperature range of 0 to 60 degrees C (32 to 140 degrees F), with an ambient temperature rating for storage of -40 to +85 degrees C (-40 to +185 degrees F). The PLC hardware shall function continuously in the relative humidity range of 5% to 95% with no condensation. The PLC system shall be designed and tested to operate in a high electrical noise environment.

f. The PLC shall have the capability of addressing up to 48 nodes. It shall also have the ability to communicate with up to 256 connections that contain I/O. Each input and output module shall be self-contained and housed within a chassis. The PLC shall include as an optional feature the capability of addressing remote input and output modules on EtherNet/IP or equivalent.

g. The PLC shall use multiple independent, asynchronous scans. These concurrent scans shall be designated for processing of input and output information, program logic, and background processing of other controller functions. Input and output devices located in the same backplane (local I/O) as the CPU will produce at the rate of the configured RPI (Requested Packet Interval), and for discrete input modules enabled for Change of State (COS), at the time any point changes state.

h. The PLC shall have the ability to communicate with multiple remote I/O racks or devices configured with multiple I/O modules. Networks that allow remote I/O include EtherNet/IP or equivalent. It shall be possible to communicate with remote I/O racks or other PACs via fiber optic cable by inserting fiber optic converters into the links. The fiber link shall support distances up to 82,000 cable feet (25km). Redundant fiber optic cabling shall be an option.

i. The PLC shall have the ability to support data communications networks in the same chassis by using Ethernet/IP

j. The PLC shall have one dedicated Universal Serial Bus port communicating at 12mb/sec. The USB port is a device only programming port. USB-3 ports shall be usable for programming and data monitoring purposes.
Controller Hardware

(a.) The CPU shall be a self-contained unit and will provide control program execution and support remote or local programming. This device will also supply I/O scanning and inter-controller and peripheral communication functions. The operating system firmware shall be contained in non-volatile memory. An option shall be possible to store both the user program and system firmware in a removable non-volatile memory for backup/restore purposes. The operating system firmware can be updated via a separate software update tool to allow for easy field updates. The controllers shall allow the operating system to be updated using a suitably configured removable non-volatile memory card. The controller shall contain a minimum of 5 Mbytes of user memory and shipped with minimum of 2GB SD card.

(b.) The CPU within the system shall perform internal diagnostic checking and give visual indication to the user by illuminating a “green” (OK) indicator when no fault is detected and a “red” indicator (Blinking or Solid) when a fault is detected or by way of a display screen scrolling an error code and message. The front panel on the Controller shall include color LED indicators or 4-digit display showing the following status information:

i. Program or Run mode of the controller
ii. The fault status of the controller.
iii. I/O status
iv. Secure Digital (SD) activity
v. Force LED

(c.) The front panel of the Controller shall include a mounted keyswitch. The key shall select the following Controller modes: RUN – No control logic edits possible, program always executing; PROGRAM – Programming allowed, program execution disabled; and REMOTE – Programming terminal can make edits and change controller mode, including test mode, whereby the logic executes and inputs are monitored, but edits are not permanently active unless assembled. The front panel of the Controller shall include a USB port, to support upload and download, online edits, firmware upgrades, and bridging to other modules in the same chassis.

(d.) All system modules, local and remote chassis shall be designed to provide for free airflow convection cooling. No internal fans or other means of cooling, except heat sinks, shall be permitted. All system modules including the controller may be removed from the chassis or inserted in to the chassis while power is being supplied to the chassis without faulting the controller or damaging the modules. This is known as Removal and Insertion Under Power (RIUP). Alternately a software configurable option shall exist to fault the controller.

Power Supplies

(a.) The PLC shall operate in compliance with an electrical service of 18-32 VDC (24VDC nominal).
(b.) A redundant 24V DC power supplies shall have the capability of supplying power to the CPU and local input/output modules. Redundant 24V DC power supplies shall provide power to remotely located racks. The power supply shall automatically shut down the PLC system whenever its output power is detected as exceeding 125% of its rated power. The power supply shall monitor the incoming line voltage for proper levels. The system shall function properly within the range of 18 to 32 VDC. The power supply shall provide surge protection, isolation, and outage carry-over of up to 40ms @ 24VDC. Design features of the PLC power supply shall include a diagnostic indicator mounted in a position to be easily viewed by the user. This indicator shall provide the operator with the status of the DC power applied to the backplane. In addition, a means of disabling power to the CPU shall be possible from a power disconnect switch mounted in a position easily accessible by the operator. At the time of power-up, the power supply shall inhibit operation of the controller and I/O modules until the DC voltages of the backplane are within specifications. In addition to the electronic protection described above the power supply shall offer a failsafe fuse.

(3) Program Creation and Storage

(a.) Memory state shall be selectable to allow for the most economical match to the intended application. It shall be possible to upgrade to a controller with a larger memory size simply by saving the program, upgrading the controller and downloading the program to the new system without having to make any program changes.

(b.) The controller shall write all variable data to internal nonvolatile memory storage (Flash) during the power down cycle. The controller shall provide the capability to use commercially available, removable nonvolatile memory storage. The card shall be available from the supplier as an industrial rated device suitable for use in the same environment as the controller.

(c.) The controller shall have the ability to store the user program, controller firmware and firmware for all other modules residing in the same chassis to the removable nonvolatile memory card. Additionally, when memory is restored a user selectable option to be restored in Run mode or Program mode shall be provided. The controller shall have the capability to ensure, that modules in the chassis are flashed using the firmware files stored on the removable nonvolatile memory card, to the correct revision level for the project. The removable nonvolatile memory card shall support a Windows file system allowing multiple files to be stored on the card. The user can manually trigger the controller to save or load from the card and also configure the controller to load from the card on power up. The operator should be able to backup volatile memory, including data and program logic onto a personal computer storage device.

(d.) All user memory in the controller not used for program storage shall be allocable from main memory for the purpose of data storage. The PLC system shall be capable of storing 4 data types:

i. Predefined
ii. User-defined
iii. Module-defined
iv. Add-on defined

(4) Predefined data types shall include the following: alarm, axis, bool, cam, cam-profile, control, coordinate system, counter, etc. User defined data shall be limited to structures. Each structure shall contain one or more data definitions called members. Object includes a structure for each I/O module and system or module specific information (hidden from user). Add-on defined data type shall include the Local and Parameter tags of the add-on instruction and not include the logic. Any data can be displayed in ASCII, Binary, Octal, Hexadecimal, or Decimal radices. Function-specific data types such as PID, Axis, Axis Group or Message shall have dedicated displays available annotating the meaning of specific control bits and words within them and allowing for selective control where appropriate.

(5) If instructions or entire rungs are intentionally deleted from an existing logic program, the remaining program shall be automatically repositioned to fill this void. Whenever contacts or entire rungs are intentionally inserted into an existing program, the original program shall automatically be repositioned to accommodate the enlarged program. All rung comments shall maintain their original links.

(6) The number of times a normally open (N.O.) and/or normally closed (N.C.) contact of an internal output can be programmed shall be limited only by the memory state to store these instructions. The number of times a timer or counter can be programmed shall be limited only by the memory state to store these instructions. Controller programs shall have immediate access to the sub elements of control structures by address and sub element mnemonic, such as timer accumulator value, timer done bit, or PID Process Variable value.

k. Interfacing and Peripherals

(1) The programming software shall be on a Windows 10 laptop. The laptop shall have the capability to be remotely located and connected via Ethernet or fiber optics for remote access.

(2) The Programmable Controller system shall be able to interface with a data terminal via USB @ 12mb/s to generate hard copy messages. The system shall have the capability to interface to a CD-ROM, DVD, USB flash drive and/or a hard disk for loading a user program into, or recording the contents of, the controller's memory. It shall be possible to load or record the entire contents of memory.

l. Communication Interfaces

(1) The PLC shall have communication interface modules for Ethernet/IP and any other communication protocol needed for the operation of the system.

(2) The Ethernet/IP interface shall support the following:
   (a.) Standard TCP/IP communications
   (b.) Standard Ethernet media (10base2, 10base5, 10baseT, 100baseT, fiber)
   (c.) CSMA/CD access method
   (d.) Subnet masking
   (e.) Standard repeaters, bridges, routers, host computers, peer PLCs.
   (f.) RJ-45
   (g.) BootP client
(h.) Manual configuration using RSLogix5000, RSLinx, or BootP/DHCP Servers.
(i.) Programmable controller messaging to peer controllers and laptops
(j.) I/O Control
(k.) Device Level Ring (DLR)
(l.) CIP Motion (Motion over Ethernet/ IP)

m. Programming

(1) The programming format shall be IEC 1131-3 compliant Ladder Diagram (LD), Function Block Diagram (FBD), Sequential Function Chart (SFC), and Structured Text (ST) languages. The controller shall organize user applications as Tasks, which can be specified as continuous, periodic, or event based.

(2) Periodic tasks shall run via an interrupt at a user-defined interval in one microsecond increments from 1 millisecond to 2000 seconds. The interrupt mechanism of periodic and event tasks shall adhere to the IEC 1131-3 definition of pre-emptive multitasking. The controller shall be able to accommodate a maximum of 32 individual tasks of which one can be continuous. The periodic and event tasks shall have an associated, user assignable priority from one to fifteen (one being the highest priority), which specifies that task’s relative execution priority in the multitasking hierarchy. The event task can be triggered by hardware events (an input point) or software events (event instruction). Each task shall have a user settable watchdog timeout which is unique to that task. Each task can include a maximum of 100 programs, which can be prioritized for execution within the task. Each program can include routines programmed in LD, FBD, SFC, or ST languages. One of the routines can be specified as the main routine and one can be specified as an optional fault routine. All routines shall be capable of being edited when on-line. The number of routines which can be contained in a program is limited only by memory.

(3) Variables within the controller shall be referenced as unique, default or user defined tags. Tag naming convention shall adhere to specifications in IEC 1131-2. Tags may be created off-line, on-line and at the same time the routine logic is entered. The system shall have the capability to store user tags names in the controller. Tags shall be available to all tasks in the controller (Controller Scoped) or limited in scope to the routines within a single program (Program Scoped) as defined by the user. Any tag shall have the ability to be aliased by another tag, which is defined and has meaning to the user. The ability to program control logic via tags of the PLC shall exist.

(4) It shall be possible to program ladder diagram rungs with the following restrictions:

(a.) Series instruction count limited only by user memory
(b.) Branch extensions limited only by user memory
(c.) Branch nesting to six levels
(5) The capability shall exist to interleave input and output instruction types on the same contiguous rung in the ladder diagram rungs. The capability shall exist to change a contact from normally open to normally closed, add instructions, change referenced tags, etc. It shall not be necessary to delete and reprogram the entire ladder diagram rung. It shall be possible to insert ladder diagram rungs anywhere in the program, even between existing rungs, insofar as there is sufficient memory to accommodate these additions. A single program command or instruction shall suffice to delete an individual ladder diagram rung from memory. It shall not be necessary to delete the rung contact by contact. A clock/calendar feature shall be included within the CPU. Access to the time and date shall be from the programming terminal or user program.

(6) Latch functions shall be internal and programmable. The system shall have the capability to address software timers and software counters in any combination and quantity up to the limit of available memory. All management of these instructions into memory shall be handled by the CPU. Instructions shall permit programming timers in the "ON" or "OFF" delay modes. Timer programming shall also include the capability to interrupt timing without resetting the timers. Counters shall be programmable using up-increment and down-increment. Timer instructions shall have a time base of 1.0 milliseconds. The timing range of each timer shall be from 0 to 2,147,483,648 increments. It shall be possible to program and display separately the timer's preset and accumulated values.

(7) The PLC shall use a signed double integer format ranging from -2,147,483,648 to +2,147,483,648 for data storage of the counter preset and accumulated values. The PLC shall store data in the following formats:

(a) Boolean values (0 or 1).
(b) Short Integer Numbers ranging from -128 to +127.
(c) Integer Numbers ranging from -32,768 to +32,767.
(d) Double Integer Numbers ranging from -2,147,483,648 to +2,147,483,647.
(e) Floating Point Numbers consisting of eight significant digits. For numbers larger than eight digits, the CPU shall convert the number into exponential form with a range of plus/minus 1.1754944 E -38 to plus/minus 3.402823 E +38.
(f) Long Integer Numbers consisting of 64 bits.

(8) The capability shall exist to organize data in the form of User Defined Data Structures. All aforementioned data types, as well as others, can be used in such structures along with embedded arrays and other User Defined Structures.
(9) The PLC shall have support for integer and floating point signed math functions consisting of addition, subtraction, multiplication, division, square root, negation, modulus, and absolute value. Trigonometric instructions supported shall include Sine, Cosine, Tangent, Inverse Sine, Inverse Cosine, and Inverse Tangent. These instructions shall fully support floating-point math. Additional floating-point instructions supported shall include Log 10, Natural Log, and Exponential. It shall be possible to complete complex, combined calculations in a single instruction, such as flow totalizing or equations of the format ((A+(B-C) *D)/E).

(10) File function instructions supported shall also include Sort, Average and Standard Deviation. Value arrays shall be limited in size only by the amount of available memory. Arrays shall be configurable with one, two or three dimensions. The CPU shall support indexed addressing of array elements. Array element manipulation instructions such "array copy" (COP), "array copy with data integrity" (CSP) and "array fill" (FLL), "array to array" (MOV), "element to array" (FAL), "array to element" (FAL), and "first in-first out" (FIFO) shall be supported by the system. The four function and math instructions and instructions for performing "logical OR", "logical AND", "exclusive OR", and comparison instructions such as "less than", "greater than", and "equal to" shall be included within the system. All instructions shall execute on either single words or array elements.

(11) For any module specifically associated with the PLC, it shall be possible to configure operation and query the current status of all channels through controller scoped tags without any programming.

(12) The system shall contain instructions, which shall construct word shift registers (SRI, SRO, and SLI). Additional instructions shall be provided to construct synchronous bit shift registers (BSR and BSL).

(13) The PLC shall have an embedded motion planner capable of doing coarse motion planning for up to 100 axes. This planner shall be the highest priority task of the controller.

(14) The PLC shall have a ladder diagram instruction interface to the motion planner which allows the user to request that the motion planner create and execute a specific motion profile. The profile can be changed dynamically through the ladder diagram program.

(15) The PLC shall have the ability to provide a master system clock and the 1588 PTP v2 CIP Sync object to allow time synchronization and transport and routing of a system clock to the control system and motion axes in a local chassis or on an Ethernet/IP network.

(16) It shall be a function of the CPU to automatically manage all data types. For example, if a word stored in an Integer tag is transferred into a Floating-Point tag, the CPU shall convert the integer value into floating point prior to executing the transfer.
(17) In applications requiring repeatable logic it shall be possible to place such logic in a subroutine section. Instructions which call the subroutine and return to the main program shall be included within the system. It shall be possible to program several subroutines and define each subroutine by a unique program file designator. The controller shall support nesting of subroutines up to available stack at the moment of the call. It shall be possible to pass selected values (parameters) to a subroutine before its execution. The number of these parameters is limited only by available memory. This allows the subroutine to perform mathematical or logical operations on the data and return the results to the main program upon completion. These subroutines will be accessed by jump-to-subroutine instructions.

(18) The system shall have the capability to enter rung comments above ladder diagram rungs. These comments may be entered at the same time the ladder logic is entered. The program shall be fully commented.

(19) The capability shall exist for adding, removing, or modifying logic during program execution in routines of LD, FBD, SFC, and ST languages. When changes to logic are made or new logic is added it shall be possible to test the edits of such logic before removal of the prior logic occurs. It shall be possible to manually set (force) either on or off all hardwired discrete input or output points from the programming panel. It shall also be possible to manually set (force) an analog input or output to a user specified value. Removal of these forced I/O points shall be achieved either individually or totally through selected keystrokes. The programming terminal shall be able to display forced I/O points.

(20) A means to program a fault recovery routine shall exist. When a major system fault (Controller Fault) occurs in the system, the controller fault recovery routine shall be executed and then the system shall determine if the fault has been eliminated. If the fault is eliminated, program execution resumes. If the fault still exists, the system shall shut down. The capability shall exist for each program to have its own fault routine for program fault recovery. Each having the same features as the controller-based fault routine. An instruction shall be available to give the control program diagnostic information, state control, and sequencing of a process simultaneously, while allowing the capability of user-friendly state programming techniques.

(21) An instruction shall be supported to incorporate closed loop control systems. The "proportional", "integral", and "derivative" elements shall be accessible to the user in order to tune a closed loop system. This instruction shall fully support floating-point math.

(22) The system shall support both bit and word level diagnostic instructions.

(23) To facilitate conditional event detection programming, output instructions shall include "one shot" instructions, which may be triggered on either low-to-high (rising) or high-to-low (falling) rung conditions. To facilitate debugging, an "always false" instruction shall exist which may be utilized to temporarily inhibit the execution of control logic.

(24) The controller shall support Master Control Reset (Relay) type functionality to selectively disable sections of logic.

(25) The controller shall include direct support of FOR-NEXT loop constructions.
(26) Controller files will have the ability to be exported and edited in L5k, (text) format or XML format.

9. SAFETY CONTROLLER SYSTEM

a. The safety controller system shall be a standalone, software configurable system consisting of a CPU module, I/O modules and a gateway module to communicate with the PLC system.

b. The safety controller system shall have the following ratings:

(1) SAFETY-RELATED PARAMETERS
   (a.) Safety integrity level SIL3 (IEC 61508) SILCL3 (EN 62061)
   (b.) Category 4 (EN ISO 13849)
   (c.) Performance level PL e (EN ISO 13849)
   (d.) PFHD (mean probability of a dangerous failure per hour) 1.69 x 10^-9 (EN ISO 13849), 0.4 x 10^-9 (EN ISO 13849) 1
   (e.) TM (mission time) 20 years (EN ISO 13849)

(2) ELECTRICAL DATA
   (a.) Protection class III (EN 61140)
   (b.) Type of voltage supply PELV or SELV 1)
   (c.) Supply voltage VS 24 V DC (16.8 V DC ... 30 V DC)
   (d.) Internal power consumption ≤ 2.5 W
   (e.) Overvoltage category II (EN 61131-2)
   (f.) Switch-on time ≤ 18 s

(3) AMBIENT DATA
   (a.) Enclosure rating IP20 (EN 60529)
   (b.) Ambient operating temperature −25 °C ... +55 °C
   (c.) Storage temperature −25 °C ... +70 °C
   (d.) Air humidity 10 % ... 95 %, Non-condensing

c. The I/O modules shall have the following electrical ratings:

(1) ELECTRICAL DATA
   (a.) Protection class III (EN 61140)
   (b.) Internal power consumption ≤ 2 W 1)
   (c.) Inputs
   (d.) Input voltage HIGH 13 V DC ... 30 V DC
   (e.) Input voltage LOW −5 V DC ... 5 V DC
   (f.) Input current HIGH 2.4 mA ... 3.8 mA
   (g.) Input current LOW −2.5 mA ... 2.1 mA
   (h.) Test outputs
   (i.) Voltage supply Via network
   (j.) Type of output PNP semiconductors, short-circuit protected
   (k.) Test pulse generator 2
   (l.) Output voltage HIGH 15 V DC ... 30 V DC
   (m.) Output current ≤ 120 mA 2)

d. The relay modules shall have the following electrical ratings:
(1) ELECTRICAL DATA

(a.) Protection class III (EN 61140)
(b.) Power consumption \( \leq 1.6 \text{ W} \)
(c.) Internal power consumption \( \leq 1.6 \text{ W} \)
(d.) Overvoltage category II (EN 61131-2)
(e.) Type of output Potential-free NO contacts, positively guided
(f.) Switching voltage 5 V AC/DC ... 253 V AC/DC
(g.) Current-carrying capacity per OSSD 10 mA ... 6 A
(h.) Signalling current contacts
(i.) Type of output NO contact, connected to internal 24 V DC, positively guided, current-limited
(j.) Output voltage 16 V DC ... 30 V DC
(k.) Output current \( \leq 75 \text{ mA} \)
(l.) Contactor monitoring contacts
(m.) Type of output Potential-free NC contacts, positively guided
(n.) Switching voltage 5 V AC/DC ... 253 V AC/DC
(o.) Current-carrying capacity per OSSD 10 mA ... 6 A

1. The gateway shall have the following communications features:

(1) INTERFACES

(a.) Fieldbus, industrial network EtherNet/IP™
(b.) Integrated Ethernet switch 3-port layer-2 managed switch with Auto-MDI-X for automatic detection of crossed Ethernet cable
(c.) Data transmission rate 10 Mbit/s, 10Base-T, 100 Mbit/s, 100Base-T, autosensing
(d.) Connection type 2 x female connector, RJ-45

f. The Safety controllers shall be a Flexi Soft software-programmable safety controller system manufactured by Sick, by Schmersal or Allen Bradley or approved equal.

10. HUMAN MACHINE INTERFACE (HMI)

a. The HMI shall be rated NEMA 4X and have a color display for status information and alarm messages. The HMI shall be equipped with a touch screen.

b. The HMI shall have a real time clock to time and date stamp alarms. It shall communicate via Ethernet and have dual Ethernet ports. The HMI shall be fully programmed by the Control System Vendor, and alarm messages shall be programmed into the HMI memory and displayed on the screen in response to receiving individual bits from the defined bit arrays from the PLC processor. Upon receiving an individual bit from the defined bit array, the HMI shall display the alarm, store the alarm in the internal register, and print the alarm in the order that the alarms are received.

c. The control system vendor shall consult with the equipment designer and the Engineer to determine all critical items to be displayed on the HMI displays when faults occur. Additional requirements can be found in the functional specifications. At a minimum, the following indications shall be displayed:

(1) All traveler control system failures.
(2) All brake failures.
(3) All limit switch failures.
(4) All drive system failures.
(5) All PLC and communications failures.
(6) All traveler overspeed faults.
(7) All position indicator faults.
(8) All uses of bypass functions, type and time (not an alarm but part of the monitoring function).

11. NOISE FILTER

a. The Contractor shall furnish and install one active tracking noise filter on the input of each PLC rack. The noise filter shall be a series connected high frequency noise filter with transient protection. It shall offer hard wired connection to all critical loads and rated for an industrial environment and equipment. It shall reduce mode transient to +/- 2 volts, have a surge capacity of 45,000 amps, provide transient protection in all modes (line to neutral, line to ground, and neutral to ground), have an LED power indication, and be UL approved. The 120VAC MCOV shall be rated 150 VRMS. The line frequency response time shall be less than 0.5 Nano-seconds. The operating temperature shall be -40°F to 115°F at full load. The unit shall be capable of protecting against a peak surge current of 15,000amps in all modes. The noise filter shall be the Isotrol® IC+/LRIC+ Series manufactured by Emerson Electric, St. Louis, MO, or approved equal products as manufactured by Allen-Bradley, Milwaukee, WI or Square D, Andover, MA.

12. LAPTOP COMPUTER

a. A laptop computer shall be provided to allow the PLC and vector drive programs to be modified as required in the future. The laptop computer shall be a Lenovo ThinkPad or approved equal. It shall have the following features at a minimum:

(1) 8th Gen Intel® Core™ i7-8565U Processor (1.80GHz, up to 4.60GHz with Turbo Boost, 4 cores, 8MB Cache)
(2) Windows 10 Pro 64bit English
(3) Intel® UHD Graphics 620 16GB, DDR4 2400MHz Memory
(4) 512GB Solid State Drive
(5) 14.0" FHD 1920 x 1080 Anti-Glare
(6) Internal English Keyboard, Backlit
(7) Intel® Dual-Band Wireless-AC 9560 Wi-Fi + BT 5.0 Wireless Card (2x2)
(8) 60 Whr Express Charge Capable
(9) 3 Years Hardware Warranty with Onsite/In-Home Service after Remote Diagnosis
(10) 65W AC Adapter
(11) USB 3.1, USB 3.1 Type-C (Power Delivery, DisplayPort, Data transfer)
(12) DVD-RW Optical Disk Drive
(13) Nylon Carrying Case
b. The unit shall be an intelligent terminal, functioning both as a programming and a data terminal. It shall permit PLC programming, including loading, editing, and monitoring ladder diagram programs in memory by entering through the keyboard and monitoring on the display. Program instructions shall be in the form of standard symbols similar to those used for electromagnetic control equipment.

c. The laptop shall have the latest editions of Microsoft Office Suite preinstalled, along with software packages required for programming, viewing, and interfacing and any other software tools required for the PLC, HMI, and vector drives. The Contractor shall include all CD-ROM's, manuals and other materials. The Contractor shall provide all licenses and original CD-ROM or Disk copies with the computer for all software installed.

13. MONITORED OPERATIONS
   a. All traveler operations shall be data-logged, recording both operating parameters and faults/errors. The functional specification describes what faults shall be listed. The following parameters at minimum shall be logged:
      (1) Drive motor Kilowatts
      (2) Drive motor RPM
      (3) Skew
      (4) Errors
      (5) Faults
      (6) Any other functions as determined by the engineer
   b. The kilowatt and position data shall be recorded at 10 samples per second, and all faults and errors shall have a time/datestamp at a minimum 1-second resolution. Additional parameters may be added during the shop test and traveler startup — these shall be included as part of this item.

14. PROXIMITY SWITCHES
   a. The proximity sensors shall be inductive proximity switches. They shall be 30 mm tubular, constructed of stainless steel, with a stainless steel face. They shall be shielded, and have a nominal sensing distance of 10 mm. They shall be normally open, with a PVC cable. They shall have an operating voltage of 20 – 250 V AC/DC. They shall be Allen Bradley 871TM-B10N30-A2 or approved equal by Turck, Minneapolis, MN or Eaton, Moon Township, PA.
15. **LINEAR DISPLACEMENT TRANSDUCERS (LDT)**

a. The LDT shall be an accurate, programmable zero & span, auto-tuning, non-contact linear displacement transducer in a rod-style package. The transducer shall utilize magnetostrictive technology to give absolute position, accurate to 0.01% of the programmable sensing distance. It shall be provided with a 4 – 20 mA output. It shall have an input power range of 7 to 30 VDC @ 1 watt. It shall have auto-tuning capability, the ability to sense a magnet other than the standard ring magnet and adjust its signal strength accordingly. It shall have tri-color diagnostic LED Indicator, to gives quick indication on the status of the LDT to help aid in troubleshooting. They shall have programmable zero and span points, and the analog output shall be programable over the entire active stroke length. The active sensing stroke shall be three in. (3.0”). They shall have high vibration resistance to 30 Gs and high shock resistance to 1000 Gs (lab tested). The enclosure rating shall be IP68, IEC 600529, with an operating temperature of -40° to 185° F (-40° to 85° C).

b. The LDT shall be housed in a type 304 Stainless Steel body, barrel, piston, head and clevis mount bracket. They shall be provided with ¼” stainless steel rod ends on both ends of the assemble. The head assembly shall be removable to allow installation of a rod style LDT that will screw into the standard 3/4” - 16 x 1.00 mounting thread. The head shall be provided with a 1/2” NPT conduit port for wiring to the LDT. The head shall be sealed with O-rings. The actuator rod shall be supported by two bearings within the guide tube. The front piston bearing shall contain a wiper assembly to keep contaminants from entering the guide tube. The rear, or movable, bearing assembly shall be manufactured from Rulon®. The transducer magnet is mounted within the rear bearing assembly. The actuator rod shall be provided with a protective boot of neoprene coated nylon. They shall have a -60° F to 250° F operating range with resistance to water and oil.

c. The Contract Drawings were developed using an Ametek 953A LDT and 950 MD mill duty housing. If other sensors such as LDT's manufactured by Honeywell, MTS Sensors or others are used, coordination will be required at no additional cost to the Authority and is subject to approval by the Engineer.

d. The sensor is located in an area where it could be stepped on and damaged if not protected. The Contractor shall furnish and install a removable and welded (painted) steel or stainless-steel cover which shall be bolted and can withstand a paint load of 500# in any direction. The cover shall be bolted to the traveler floor system.

16. **CONTROL APPARATUS AND MISCELLANEOUS EQUIPMENT ON THE TRAVELER PLATFORM**

a. Control apparatus shall conform to the applicable requirements of NEMA Publication No. ICS, latest revision, Industrial Control and Systems, rated as shown on the Contract Drawings or as required and to the following:

   (1) Feeder Fusible Disconnect Switches:

      (a.) Individual feeder disconnect switches shall be quick-make, quick-break gang-operated type utilizing Class R fuse clips if needed. The fused switch shall be rated minimum 42 kAIC at rated voltage. See Contract Drawings for location.

      (2) Circuit Breakers
(a.) All branch circuits from the power buses shall be protected by molded-case circuit breakers mounted on the control panels. All breakers shall have quick-make and quick-break contacts, and the mechanism shall be trip-free and trip indicating. All circuit breakers and motor circuit protectors shall be furnished and installed with at least two form C auxiliary contacts for PLC input and status indication. Frame sizes shall not be less than 100 amperes. The breakers shall be equipped with thermal-magnetic trips or adjustable, instantaneous, magnetic trip units, with trip rating as shown on the Contract Drawings or as required. Molded-case circuit breakers shall meet the requirements of the latest revision of NEMA Publication No. AB1. The service entrance circuit breakers are to be 600 volt rated, frame size as indicated on the Contract Drawings and shall be furnished and installed with electronic trip unit with independently adjustable short time pick-up and time delay, set to trip as per the Contract Drawings. Interrupting capacity shall be no less than 100,000 AIC. Circuit breakers shall be Westinghouse, Pittsburgh, PA, Series C, Type LD with LS trip unit, Type TA or approved equal manufactured by General Electric, Plainville, CT or Square D Company, Andover, MA.

(3) Motor Starters and Magnetic Contactors

(a.) The continuous current rating of contactors and starters shall be adequate for the connected loads, and no starters shall be smaller than NEMA Size 0 unless otherwise noted. All starters shall be full voltage types, 600 VAC, 60 Hertz, rated with 120 VAC operating coils. All contact poles shall be furnished and installed with arc chutes, and contactors rated 150 amperes and above shall be equipped with magnetic blowouts. Select heater elements based on motor full-load running current. Each overload relay shall be furnished and installed with a set of auxiliary form C contacts for PLC interfacing and indication. Reversing contactors shall be electrically and magnetically interlocked.

(4) Service Disconnect Switches

(a.) Unfused safety switches, for use as disconnects, shall be installed where shown on the Contract Drawings. The switches shall be nonfusible, heavy-duty, 600 VAC safety switches in watertight and dust-tight NEMA 4X, 316 stainless-steel enclosures. Each disconnect shall be furnished with two N.O. auxiliary contacts and phenolic nameplate to identify the switch. The rating shall be as required and/or shown on the Contract Drawings.

(5) Overload Relays

(a.) Heater elements are to be selected based on motor full load running current. Each overload relay shall be furnished and installed with two N.O./N.C. auxiliary contacts.

(6) Control Transformers

(a.) Control transformers shall be high voltage regulation type, low temperature rise, rated 480/120VAC. Each transformer shall have copper windings and a cover to prevent accidental contact with the energized components.
(7)  Control Relays
(a.) Auxiliary control relays shall be multi contact magnetic relays with contacts rated at 10 amperes, 600 volts, on a continuous basis, such as Square D, Andover, MA class 8501 type X, Allen Bradley, Milwaukee, WI, Eaton, Moon Township, PA or approved equal.

(8)  Phase Failure and Reversal Relay
(a.) This relay shall prevent operating the traveler in the event of reversed phase sequence, loss of one phase, or low voltage. The phase failure and reversal relay shall be the Square D, Andover, MA Class 8430 Type MPD, Allen Bradley, Milwaukee, WI, Eaton, Moon Township, PA or approved equal.

(9)  Selector Switches and Pushbuttons
(a.) Pushbuttons and control switches shall be heavy-duty, oil-tight, contact blocks operated by glove handle selector knobs, key switches or pushbutton as indicated on the Contract Drawings. Contacts shall be fine silver, capable of interrupting 2.5 amperes at 24 Volts DC. Switches and pushbuttons shall be Square D, Andover, MA class 9001, type K, NEMA 4, Allen Bradley, Milwaukee, WI, Eaton, Moon Township, PA or approved equal.

(10) Master Switch
(a.) The traveler master switch shall be a single axis joystick. The housing shall be cast aluminum with an IP56 rating, corrosion resistant components and marine epoxy paint. It shall be furnished and installed with an 8mm diameter stainless steel handle shaft, and a low-profile handle with mechanical interlock. It shall be rated for a 10 million cycle mechanical operating life and a temperature rating of -25 to +60 degrees C.
(b.) The movement configuration shall be stepped detents 3-0-3 with spring return to center. The switch contacts shall be double pole field replaceable contacts rated 16A at 240 VAC.
(c.) The master switch shall be a JR Merritt, Stratford, CT, NSO-SFA or approved equal by Eaton, Moon Township, PA or Square D, Andover, MA.

(11) Indicating Lights
(a.) Indicating shall be heavy-duty, oil-tight pilot lights with one or two fields as required as per the Contract Drawings. They shall be furnished and installed with LED lamps the color of the lamp lens and shall be rated at 24VDC. Where group testing cannot be accomplished through the PLC the lights shall be furnished and installed with a push to test feature. All lenses shall be glass, with color and marking as shown on the Contract Drawings.
(12) Terminal Blocks

(a.) Terminal blocks for conductors of Size No. 8 AWG and smaller shall be fed through terminal blocks with stud and nut type connection on a DIN rail mounted modular terminal blocks. Barriers shall be not less than 13mm high and 3mm thick and shall be spaced 16mm center-to-center. Straps, studs and nuts shall be of a material for use in highly corrosive atmospheres and shall be rated for 57 amperes for a terminated conductor. The blocks shall provide a withstand voltage rating of 800 volts per IEEE switchgear standards. The terminal blocks shall provide studs and nuts suitable for use with flanged ring wire connectors. Corrosion resistant marking strips shall be provided for conductor identification. At least ten percent spare terminals shall be furnished and installed. Terminal blocks shall be Phoenix Contact, Middletown, PA type RBO 5, Allen Bradley, Milwaukee, WI, Weidmuller, Richmond, VA or approved equal.

(13) Terminal Connectors

(a.) Terminal connectors shall be seamless, heavy duty compression locking fork terminals manufactured from pure electrolytic copper tubing. Terminals shall be tin plated and furnished and installed with a double-thick tongue and insulation grip. Terminals and compression tools shall be approved by the Engineer.

(14) Wire Ferrules Connectors

(a.) Conductors not suitable for locking fork terminals shall be furnished and installed with seamless, heavy-duty insulated wire ferrules terminal lugs. Terminal lugs shall be installed per lug manufacturer recommendations using the proper tools approved by the manufacturer.

(15) Power Distribution Blocks

(a.) Power distribution blocks for all conductors larger than No. 8 AWG, shall be fingersafe, fabricated from copper and approved equal to Ferraz Shawmut FSPDB series, sized as required. Finger-safe fully insulated block shall ensure that no one can touch live parts. They shall be furnished and installed with recessed termination screws and wire openings providing IP20 grade protection and qualify as "finger-safe" per IEC 529, integral DIN rail adaptors allowing for quick and easy installations on 35mm DIN rail, and captive termination screws. Furnish and install end anchors for rigid end stops.
(16) Wire Number Identification

(a.) Permanent wire markers shall be used for wire marking at all splices, terminals and lugs in all cabinets, wire ways and junction boxes. Wire identification shall be professionally and permanently typewritten or heat sensitive markings, in black, on a white field. Markers shall be at least 4.0 mils thick vinyl with a high tack acrylic adhesive. Markers shall be self-laminating and shall incorporate a laminating feature to protect the legend (wire marker identification) with a clear overlay of vinyl. Other wire marker types meeting the general specifications above, applied by professional marking equipment may be considered by the Engineer, when submitted. Sleeve type markers which are sized to fit the wire snugly shall be required to be furnished and installed with adhesive or be of the heat shrinkable type. However, clear vinyl shall be used to protect the legend in all cases. Embossing or painting wire insulation for wire identification shall not be permitted. The Engineer reserves the right to deny the use of any type wire marker he deems to be inferior to the type specified for use.

(b.) Wire numbers shall be permanently attached to the wire within 1.0 in. of termination. All wiring connections at any terminal strips or lugs shall have the numbers facing out for easy troubleshooting.

(17) Nameplates

(a.) Nameplates shall be furnished and installed for all aforementioned devices and shall be made of laminated phenolic plastic with white front and back and black core and shall be not less than 0.1 in. thick. The lettering shall be etched through the front layer to show black engraved letters on a white background. Lettering shall be not less than 0.25 in. high, unless otherwise detailed on the Contract Drawings. Nameplates shall be securely fastened to the equipment with stainless steel screws.

(18) Transient Voltage Surge Suppression:

(a.) The Transient Voltage Surge suppression module shall be an active tracking network (ATN) UL 1283 listed as an EMI/RFI filter. It shall be rated for 300 KA and shall be for a nominal 480 VAC delta electrical system. All components shall be encapsulated to provide a high dielectric and protection from adverse environmental conditions. Large diameter MOVs (Metal Oxide Varistors) shall be provided to protect against high stress transient environments. It shall be furnished and installed with comprehensive monitoring of critical system functions, with real-time audible and visual reporting of unit status, phase loss/ protection loss and transient events (alarm with reset and mute). It shall be furnished and installed with a dual function surge counter provides non-volatile event history recording. It shall be provided dry form C contacts for remote status monitoring, integral disconnect switch and LED monitoring on each phase. The enclosure shall be NEMA Type 4 (IP66) stainless steel enclosure. It shall be listed UL 1449 2nd Edition for surge suppression devices, and UL 1283 complementary.

(b.) The TVSS shall be an Eaton, Moon Township, PA PTE300NN400-SD-D or approved equal by Square D, Andover, MA or Siemens, Washington, DC.
17. RECEPTACLES AND SERVICE LIGHTING

a. All receptacles shall be 20-ampere, 125-volt, three-wire, polarized, duplex, convenience outlets. Where shown on Contract Drawings, the receptacles shall also be ground-fault-indicating type. Each receptacle shall be a heat-resistant melamine body, mounted on the handrail in an outlet box as shown on the Contract Drawing, and shall be furnished and installed with a waterproof cover plate. Receptacles shall be industrial grade as manufactured by Hubbell, Shelton, CT, Arrow Hart, Peachtree City, GA or Leviton, Melville, NY, or approved equal.

b. All lights shall be controlled from tumbler switches as shown on the Contract Drawings. All tumbler switches shall be industrial grade, 20-ampere, 125-volt switches. Switches shall be mounted in waterproof, cast-brass, surface mounted boxes. Switches shall be mounted on the top rail of the handrail. Switches shall be industrial grade switches manufactured by Hubbell, Shelton, CT, Arrow Hart, Peachtree City, GA, Leviton, Melville, NY or approved equal.

c. Service lighting on the traveler platform shall be constructed for use in areas under constant vibration. It shall have shock absorber sleeves to dampen sideways and vertical movements. It shall be mounted 6½ feet above the platform on the platform railing. The lamps shall be LED type with minimum initial lumens of 1900 and shall maintain 70% of light output at 50,000 hours of service. The color temperature shall be 4000K. Fixtures shall be OLFL series as manufactured by Lithonia Lighting, Atlanta, GA, Cree, Durham, NC, Signify, Somerset, NJ or approved equal.

18. TRAVELER CONTROL CONSOLE

a. The control console shall be NEMA 4X type 316 stainless-steel. Spare terminals totaling at least 10 percent of those actually used shall be furnished and installed.

b. The console shall be of neat construction, fabricated from No. 10 gauge sheet-steel. The console tops shall be fabricated of No. 10 gauge, Type 316 stainless-steel sheet with a non-glare satin finish. Removable doors shall be furnished and installed in the front and side panels of the console, pivoted on 90-degree hinges, and secured with flush type, three-point latches. A ¾" mm return lip shall be provided for all openings on the top and front of the console. The console shall be neatly fitted up with close joints, and all rough edges or corners shall be ground off smoothly, and all projecting edges rounded off. All metal hardware shall be of substantial construction and shall have a satin-chrome plate finish. All equipment mounting screws and bolts shall be stainless steel.

c. Two local operator interface displays (HMI) shall be furnished and installed to display system status and diagnostics. Communication to the PLC shall be via ethernet. The operator interfaces shall be a color flat screens with a 15 in. or larger touch screen. Programming configuration software required to modify the screens shall be furnished and installed with the system. The HMI shall be Allen-Bradley, Milwaukee, WI, PanelView 7 Performance, Phoenix Contact, Middletown, PA, Eaton, Moon Township, PA or approved equals.
19. TRAVELER CONTROL CABINETS

a. Control panels enclosed in freestanding cabinets shall be furnished and installed on the traveler platform where shown on the Contract Drawings. All circuit breakers, PLC racks, switches, contactors, relays, regulating equipment, and other apparatus for control of the traveler and its auxiliaries shall be mounted on these enclosed panels. The arrangement and line-up of the individual control cabinets shall be as shown on the Contract Drawings.

b. All equipment in each control cabinet shall be mounted on sheet-steel bases, and each device shall be front-connected, front-wired, and removable from the front. The equipment in all cabinets shall be arranged for ease of access and for safety and convenience of operation. Special care shall be taken to obtain a systematic and neat arrangement of the equipment. Each device shall be suitably named and plainly marked by a laminated nameplate mounted near the device on the panel. Each nameplate shall show an approved descriptive title for the apparatus, together with the device designation appearing on the schematic wiring diagrams.

c. Each control cabinet shall be a NEMA Type 4X type 316 Stainless Steel enclosure constructed of No. 12 gauge sheet-steel and shall be reinforced with steel angles or channels to provide a rigid, freestanding structure. The control cabinets shall be furnished and installed with hinged doors on the front of each panel section. Door panels shall be gasketed and shall be furnished and installed with three-point, vault-type latches. Drive and control panels shall be furnished and installed with air conditioners. All hardware shall be corrosion resistant. Thermostatically controlled strip heaters shall be furnished and installed in each cabinet to prevent build-up of excess moisture. Each panel shall be furnished and installed with suitable interior light fixtures and a duplex receptacle. All enclosures shall be lockable with a key.

d. Each control panel enclosure shall be as shown on the Contract Drawings. If the final cabinet dimensions, as established by the manufacturer, should necessitate rearrangement or modification of the equipment in order to fit in the available space, such rearrangement or modifications shall be made and at no extra cost. The final arrangement of all equipment in the operator house shall be subject to the approval of the Engineer.

e. All contactors, relays, and other devices shall be of required current carrying and interrupting capacity. All apparatus shall be of substantial construction and shall conform to the requirements of NEMA Standards Publications ICS 1 and 2, 2000, for industrial control devices.

f. All wire shall be flame-retardant, ethylene-propylene insulated, switchboard wire, Type SIS. Conductors shall be stranded copper not smaller than No. 14 American Wire Gauge.
20. ENCLOSURE AIR CONDITIONING
   a. The drive cabinet shall be furnished and installed with air conditioners to maintain the internal temperature and humidity to levels acceptable to the drive manufactures. The air conditioners shall be furnished and installed with NEMA 4X enclosures attached to the sides of the equipment enclosures. They shall be designed for side mounting on any enclosure surface where spot cooling or low capacity cooling is required. Closed loop cooling shall ensure clean enclosure air is recirculated without ever mixing with contaminated ambient air. They shall be designed for outdoor, wet conditions. They shall be recognized by UL, cUL, and CE, and comply with IP56, NEMA 3R, 4, and 4X. The refrigerant shall be R134a. They shall be furnished and installed with thermostat controls accessible from inside the conditioned enclosure. Expansion valves shall prevent evaporator freeze up while minimizing heavy inrush currents on large BTU/H units. Air conditioning condensate discharge shall be via 1/4 in. NPT threaded port. They shall provide continuous air circulation from high capacity fans. EMI/RFI suppression shall meet CE. They shall have a provision for door contacts, allowing power down when enclosure door is opened. They shall be furnished and installed with washable aluminum mesh filters.

   b. The enclosure air conditioners shall be sized by the control system vendor based on the heat generating characteristics of his selected drive and PLC equipment. These sizing calculations shall be provided to the engineer for review.

   c. The enclosure air conditioners shall be DTS series by Hammond, Cheektowaga, NY, Kooltronic, Pennington, NJ, Hoffman, Anoka, MN or approved equal.

21. WIRING TROUGH
   a. Wiring trough shall be NEMA 4X, constructed of No. 12 gauge type 316 stainless steel, suitably reinforced with stainless steel angles, and welded continuously at all seams and joints. It shall have a removable, gasketed (oil-resistant) cover on the front side to provide access to the interior. Covers shall be secured by stainless steel screw clamps spaced no more than 8 in. apart.

   b. Intermediate diaphragms of molded phenolic compound, not less than 1/2 in. thick, shall be furnished and installed in the trough. Diaphragms shall be spaced no less than 36 in. apart throughout the trough. The diaphragms shall be bolted to interior, structural steel mounting angles.

22. FLEXIBLE MULTI-CONDUCTOR CABLES
   a. The cables shall conform to ICEA S-68-516 and UL-62.

   b. The conductors shall be extra-flexible stranding (Class K), soft-drawn tinned copper: per ASTM B-3, ASTM B-172, and UL-62 for high flexibility, extended flex-life, reduced copper fatigue and conductor breakage, and resistance to corrosion. The size and quantity of conductors for the flexible cables shall be as shown on the Contract Documents.
c. In each flexible cable, the insulated wires shall be cabled with non-wicking, non-hygroscopic fillers without a separator, which allows pressure-extruded jacket to fill interstices and prohibits conductor displacement during flexing operations. The cables' overall jacket shall be oil and flame-resistant, double-layer, reinforced thermoset rubber jacket, suitable for use indoors and outdoors in abusive flexing applications. Insulation type of single conductors part of the flexible multiconductor assembly shall be thermoset (EPDM) insulation per UL-62 and ICEA S-68-516, colored and printed and suitable for use in extreme flexing applications.

d. Flexible cables shall be furnished and installed with strain relief fittings and basket weave cable grips at each end. Strain relief fittings shall be malleable iron, liquid tight strain relief fittings. The cable grips shall be stainless steel, heavy long, closed wire mesh, and single weave with a double eye support. All mounting hardware shall be stainless steel.

e. All power and control wiring shall be installed in PVC coated RGS conduit.

23. ETHERNET CABLES

a. All Ethernet cabling shall be by means of industrial grade CAT 6 cables. They shall consist of 23 AWG solid bare copper conductors, bonded pair polypropylene insulation, FRPE spline center member, inner PVC jacket, overall shielding (100% coverage), industrial grade sunlight and oil resistant PVC jacket, and with sequential footage marking every two feet.

b. It shall meet the following standards:

(1) Telecommunications Standards: Category 6 - TIA 568.C.2.
(2) UL Verified to Category 6
(3) NEC/(UL) Specification: CMR, CMX-Outdoor.
(4) CEC/C(UL) Specification: CMR.
(5) AWM Specification: UL Style 2104

c. Installation Temperature Range shall be -25°C To +75°C, Operating Temperature Range shall be -40°C To +75°C, and the UL Temperature Rating shall be 75°C. The Ethernet cabling shall be Belden, Richmond, IN 7953A, General Cable, Highland Heights, KY, Mohawk, Calhoun, GA or approved equal.

24. FIBER OPTIC CABLES

a. Fiber optic cable shall be multi-conductor and contain spare unused pairs. All fiber optic cables shall be jacketed for protection and strength. Size of the fiber shall be 62.5 microns. Heavy-duty, direct burial, interlocking armor, waterproof, loose tube, with dielectric central member/double armor mini bundle cable with loose buffer construction.

b. The fiber optic cable shall be Corning, Corning, NY, FREEDM LST Loose Tube, Gel-Free, Interlocking Armored Cable, Product Number 012KSF-T4130DA1, 24 conductor, Belden, Richmond, IN, Mohawk, Calhoun, GA or approved equal. The minimum bending radius shall be 6in.

c. Do not exceed manufacturers recommended pulling tensions. Do not exceed minimum (installed and long-term) bend radius. No splices are permitted throughout the entire length of cable routing between termination points.
d. Prior to installation, carefully inspect the cable reels for protrusions which might cause damage to the cable as it is unreeled. If the cable must be unreeled during installation, the “figure-eight” configuration shall be used to prevent kinking or twisting. The cable should not be coiled in a continuous direction except for lengths of 100 feet or less, or as recommended by the cable manufacturer, whichever is shorter. When “figure-eight” long lengths of cable, care shall be taken to relieve pressure on the cable at the crossover of the eight. Enough cable slack should be left at the termination points to allow the cable to be route through the termination hardware to a polishing/splicing table. The Contractor shall submit a cable placement plan under the shop drawings phase. Cable lubricant shall be done per written manufacturer’s recommendations.

e. Use pulling grips and swivels for cable installation. Use pulling grips to secure the pull line to the strength members of the cable. Use ball bearing swivels to prevent the pull line from imparting a twist to the cable as it is pulled through the duct or conduit. Ensure that sharp edges such as entrance points into the ducts, conduits, and pull boxes, are eliminated through the use of bushings, box end connectors, bell ends, or flex duct.

f. Store splicing slack in the pull boxes in such a manner to prevent damage during later work in the pull box.

g. The cable shall be factory “broken out” and separated from the overall bundle for the last 5-6 feet of length, for connections to the fiber optic communication equipment. All loose fiber optic cables shall have individual jacketing for protection and shall be factory sealed against moisture and water contamination.

h. Field termination of fiber optic cable will not be permitted, unless termination is performed by factory trained technicians, using approved termination tools and equipment for the type of fiber optic cable and terminations required. All terminations and fiber optic cable shall be tested with the proper fiber optic cable transmission test equipment. All tests shall be documented and submitted to the Engineer for approval.

i. All fiber optic cables and spares shall be installed with terminators for easy switching in case of a cable failure.

j. All fiber cables shall be identified and the designation permanently marked on durable fiber tags, or on metal or plastic bands with heat shrunk protective sleeving so that any wire may be traced from terminal to terminal, or as specified. The designations shall correspond with those shown on wiring diagrams.

25. NAVIGATION LIGHTS

a. Navigation lights shall be furnished and installed in accordance with the rules and regulations of the United States Coast Guard 33 CFR 118.150 in locations as shown on the Contract Drawings.

b. For all navigation lights, the doors and lenses shall be gasketed, and each entire unit shall be completely weatherproof, marine duty and vandal resistant. Fittings shall be non-corroding, and the sockets shall be of porcelain mounted on shock absorbers. The housings for all units shall be cast-bronze, and an LED 120-volt lamp with brass base shall be installed in each socket.

c. All navigation lights shall be equipped with bronze junction boxes.
d. The housing shall be of cast bronze and shall be suitable for marine environment. Construction shall be rain-tight and fully gasketed. The light assembly shall be designed for heavy duty, long life service. Design shall provide ready access for lamp service.

e. The lens shall be heat-resistant fresnel glass. Lens sections shall be 180 degrees red. Inside lens diameter shall measure approximately 7 in. Outside lens diameter shall measure approximately 8 in.

f. Lamp fixture head shall be suspended from the swivel on a 2 in. schedule 40 pipe, 2.375 in. outer diameter. Pipe material shall be stainless steel.

g. Each navigation light shall be equipped with a swivel. The swivel design shall provide for all wiring to be completely contained inside the light assembly. Gaskets and o-rings shall be used to provide a weather tight assembly. Swivel shall be of heavy duty construction, cast of the same material as the fixture head. Spindle shall be of stainless steel.

h. Base shall be cast of the same material as the fixture head. Light assembly shall mount via four 1/2in. diameter bolts through the base, provided by installer to suit installation. A junction box shall be furnished and installed at the base of the unit. A cast junction box with gasketed access cover shall be furnished and installed. Junction box shall be of the same material as the fixture assembly and shall match the navigation light base footprint. Orientation of junction box shall be capable of rotation in 90 degree increments.

i. The navigation lights shall be model CM as manufactured by B&B Roadway, McKinney, TX, Pharos Marine Automatic Power, Houston, TX, Tideland Signal, Houston, TX or approved equal.

26. SAFETY GUARDS

a. The traveler platform shall not move if the traveler platform’s access gate is open. Once away from the platform dock, the gate shall be magnetically locked. The gate shall only be unlocked if the end of travel limit switch on the docking side triggered.

b. The traveler platform shall not move if both the scissor lifts’ controls wire have not been plugged into the one of the receptacles on the platform as shown on the contract drawing.
27. CABLE REEL
   a. Spring driven cable reels shall be furnished and installed to power the scissor lifts. The cable reel shall also have controls wires to the limit switches. The cable reel frames shall be welded assemblies painted with a baked polyester finish. All components shall be on the outboard of the frame to allow for component replacement without disassembly. The spring motor shall be a power spring sealed in a disposable housing. The spring motor shall be located outboard on the frame such that replacement does not require the reel to be removed from its frame. The motors shall be readily re-tensioned. The spring motors shall be equipped with an inspection hole to visually check the integrity of the spring while reel is in service. The spring motors shall be protected from damage in the case of the cable being severed. Gears used for reeling longer lengths of cable shall be protected from dust and moisture by a sealed housing, with external grease fitting for lubrication of gears during service without opening the enclosure. Furnish and install a spool lock to facilitate cable changes, allowing cable change while the reel is under full tension. When released, reel shall rewind entire length of cable. The cable reels shall be sealed to NEMA 4 for outdoor use.
   b. Cables shall be no. 10 AWG for power and no. 12 AWG for controls type SOOW cables. Furnish and install a positive, watertight connector at the shaft where the cable enters the spool area. The cable shall feed through the hollow shaft for termination within the slip ring enclosure. Connections are required at one point only. Furnish and install removable slip ring enclosure with an “O” ring seal providing a watertight, dust-tight seal suitable for any type of atmosphere. The enclosure shall be removable for inspection or service by means of the three toggle clamps. The slip ring assembly shall be replaceable as a unit. The cable spools shall allow for even winding with multiple layers. The edges of the steel flanges on cable spool shall be die-formed to eliminate cable pileup in corners.
   c. The cable reels shall be as manufactured by Conductix, Omaha, NE, Gleason Reel, Mayville, WI, Ericson, Willoughby, OH or approved equal.

28. SPARE PARTS
   a. Supply spare parts in accordance with AASHTO requirements and the Contract Drawings. The spare parts supplied for each traveler shall include at a minimum the following:
      (1) Six fuses of each kind and each size installed.
      (2) Two switches of each type provided, and six contact blocks for each type of switch.
      (3) 4 limit switch or proximity switch of each type specified. In addition, a full set of contacts and contacts fingers for each type of limit switch.
      (4) A set of contacts and contact fingers for each unit or fractional unit of five or less of each kind or size installed, including contactors and starters. For units that do not incorporate replaceable contacts, furnish a complete unit with coil.
      (5) One coil for every five or less of each size relay, contactor, and motor starter installed.
      (6) One complete relay timer, time delay relay, contactor, and starter for each unit or fractional unit of five or less of each kind and size installed.
      (7) Two heaters for overload relays of each size installed.
(8) For the navigation lights:
    (a.) 1 each color and type lens.
    (b.) 2 each color and type LED lamp.
    (c.) 6 lens gaskets.
(9) For the PLC system:
    (a.) 1 each of every type PLC input card and PLC output card.
    (b.) In addition, a quantity of 4 discrete input cards and 4 relay contact output cards.
    (c.) 1 PLC chassis power supply module.
(10) Four spare drive with all appurtenances.
    b. Arrange the spare parts in uniform size cartons of substantial construction, with typed and clearly varnished labels to indicate their contents and store them where directed by the Engineer. Provide large spare parts with moisture-proof wrapping. Provide a directory of permanent type, describing the parts. In the directory state the name of each part, the manufacturer's number thereof, and the rating of the device for which the part is a spare. Mark the spare parts to correspond with their respective item numbers as indicated on the elementary wiring diagram.

2.03 FABRICATION

A. STRUCTURAL
   1. Fabrication shall be in accordance with Section 051200 – Structural Steel.

B. MECHANICAL
   1. Fabrication requirements of the equalizer, trolley, hanger and swivel assemblies shall be in accordance with Section 051200 – Structural Steel and Part 2.01B 14 within this section.
   2. Field Welding is not permitted.

2.04 SHOP PAINTING

A. STRUCTURAL
   1. Shop Painting shall be in accordance with Section 051200 – Structural Steel and Section 099100 - Painting.

B. MECHANICAL
   1. All unfinished surfaces of machinery assemblies shall be cleaned and painted in the shop and field as specified under Section 099100 as applicable.
   2. All unfinished surfaces of machinery assemblies shall be cleaned and painted in the shop and field as specified under Section 099100 as applicable.
   3. After completion of the operating tests and acceptance of the assemblies, all accumulated oil, grease, dirt, and other foreign matter shall be washed from exposed machinery surfaces, excepting rubbing or sliding surfaces with benzene or other approved cleaner. The exposed surfaces shall then be given a final finish coat.
   4. The paint for the final finish coat shall be a high-gloss enamel compatible with the intermediate paint coating.
   5. The following shall not be painted:
      a. The grip portion of bushed pins.
b. Stainless Steel.
c. Within ¼ in. of seal running surfaces and exposed portions of seals.
d. Bottom flange of trackbeam where wheels, guide rollers and holding brake pads make contact.
e. Nameplates on all proprietary elements shall be readable, clean and free of all paint coatings before acceptance of the machinery.

PART 3. EXECUTION

3.01 PREPARATION

A. Preparation shall be in accordance with Section 051200 – Structural Steel.

3.02 ASSEMBLY

A. STRUCTURAL

1. Assembly shall be in accordance with Section 051200 – Structural Steel.
2. All parts to be installed shall be thoroughly cleaned. Packing compounds, rust, dirt, grit and other foreign matter shall be removed. Holes and grooves for lubrication shall be cleaned. Enclosed chambers or passages shall be examined to make sure that they are free from damaging materials.
3. Where units or items are shipped as assemblies they shall be inspected prior to installation. Disassembly, cleaning and lubrication will not be required except where necessary to place the assembly in a clean and properly lubricated condition.
4. Pipe wrenches, cold chisels or other tools likely to cause damage to the surfaces of rods, nuts or other parts shall not be used for assembling and tightening parts.
5. Bolts and screws shall be tightened firmly and uniformly but care shall be taken not to over stress the threads.
6. When a half nut is used for locking a full nut, the half nut shall be placed first and followed by the full nut.
7. Threads of all bolts except high strength bolts, nuts and screws shall be lubricated with an approved lubricant before assembly.
8. Threads of corrosion-resisting steel bolts and nuts shall be coated with an approved anti-galling compound. Driving and drifting bolts or keys is not permitted.

B. MECHANICAL

1. All enclosed gear reducers shall be tested by running each reducer at 100% rated RPM for ½ hour in each direction (1 hour total continuous operation) prior to shop assembly with other traveler mechanical components.
2. Traveler Machinery components shall be temporarily shop assembled to verify their correct fit prior to FAT and shipment.
3. Travelers will be shop (Factory Acceptance Testing) tested in accordance with Part 3.05, Testing.

3.03 ERECTION/INSTALLATION

A. STRUCTURAL

1. Erection shall be in accordance with Section 051200 – Structural Steel.
2. Alignment and Setting
a. Coordinate alignment and setting of steel with mechanical, machinery and electrical equipment

b. Each steel element shall be accurately aligned by the use of steel shims or other approved methods so that no binding in any moving parts or distortion of any member occurs before it is fastened in place. The alignment of all parts with respect to each other shall be true within the respective tolerances required. Machines shall be set true to the elevations shown.

c. Align and adjust various members forming part of complete frame or structure before permanently fastening. Before assembly, clean bearing surfaces and other surfaces that will be in permanent contact. Perform necessary adjustments to compensate for discrepancies in elevations and alignment.

d. Level and plumb individual members of structure.

e. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be when completed and in service.

f. Splice members only where indicated on the Drawings.

g. Remove erection bolts on welded, exposed steel; and grind smooth at exposed surfaces.

h. Do not fill holes with plug welds. Install bolts snug tight to fill holes when approved by Authority.

i. Do not use thermal cutting during erection.

3. Coordination:

a. The Contractor shall employ a competent superintendent to supervise all work of installation. This superintendent shall be present at all times during this phase of the work.

b. Coordinate erection activities with the other activities to minimize impact on other work on site and to allow for the most efficient installation of the works.

c. Allow access to the steel and machine work by other trades as required.

4. Surveys

a. Employ a registered professional engineer or surveyor licensed in the state where the work is being performed for the installation, to assure accurate erection of all mechanical systems. Survey elevations & locations of all bearing surfaces, trackbeams, bogies and similar devices before installation proceeds.

5. Notify the Authority in writing of conditions detrimental to proper and timely completion of Work.

6. Do not proceed with installation until unsatisfactory conditions have been corrected in a manner acceptable to the Authority.

B. MECHANICAL

1. Construction and installation shall be coordinated to assure that the machinery components fit the adjacent material furnished under other items.

2. ASTM A449 bolts shall be tensioned to the same bolt tension required for ASTM A325 bolts specified in the New York State Steel Construction Manual.

3. Torques for other grades or bolts shall be proportioned to their strength and shall be indicated on the erection drawings.
4. The machinery shall be erected and adjusted by millwrights competent in the type of work involved. They shall be supplied with all necessary measuring and leveling instruments as may be required.

5. Refer to 3.03A for additional erection requirements.

C. ELECTRICAL

1. GENERAL

a. The Contractor shall document all existing conditions prior to removal of any wiring and or equipment shown and described on all Contract Documents. If the existing conditions are in conflict with any of the Contract Documents shall be brought up to the Authority for review and approval. The conflict shall be submitted in writing describing the conflict and including any backup drawings or sketches to explain the conflict.

b. The control system and its installation shall be in accordance with the NEC, all applicable local codes, and shall conform to AASHTO LRFD Movable Bridge Design Specifications, 2nd Edition, with all Revisions, except as otherwise provided herein.

c. All Work shall be made by workmen skilled in this type of work and under the supervision of an experienced and qualified electrical supervisor. In addition, the Contractor shall provide the services of the control system vendor for supervisory assistance to the electrical contractor as specified herein. All Work shall be executed in a neat and workman-like manner and shall present a neat and mechanical appearance when completed. Upon completion of the Work, the Contractor shall deliver to the Authority a corrected set of Contract Drawings showing in detail all changes on construction from the original Contract Drawings, especially location and sizes of conduits, complete schematic circuit diagrams and the like.

d. The Contractor shall provide written certification of compliance with specified requirements for his control system vendor.

e. The Contractor shall retain the services of a qualified control system vendor who shall have complete system responsibility for the detailed integration of all system components, in order to ensure a complete operating system is furnished and installed in accordance with specified requirements. The control system vendor shall be responsible for ensuring total compatibility of all equipment and devices furnished and installed and shall provide supervisory assistance in the selection, installation and integration of all traveler associated control equipment. Components associated with traveler operations include at a minimum, drive control, limit and safety switches, motor controls, skew control, control console, control cabinets and associated devices. The control system vendor shall comply with all items listed herein.

f. Name and written qualifications of the control system vendor shall be subject to approval of the Authority.

g. The Contractor shall be responsible for coordinating all aspects of equipment installation including matters of construction staging and methods of bringing equipment into the spaces where it is to be installed.

h. Each piece of electrical equipment and apparatus shall have a permanent type corrosion-resisting metal nameplate on which is stamped the name of the manufacturer, the catalog or model number, and the rating or capacity of the equipment or apparatus.
i. All electrical devices, printed circuit boards, including their components, and any other electrical or electronic parts, shall be completely identified in such a way as to be easily procured from a supplier of that device. All prints and drawings of it shall show complete circuitry and identify all components as to their specific use and function in the circuit.

j. All ferrous metal work shall be hot-dip galvanized in accordance with ASTM A123 or ASTM A153, whichever is applicable. If any galvanizing is damaged, the metal work shall be refinished by cleaning and painting, with two coats of approved galvanizing repair paint, or approved zinc spelter paint.

k. Lock washers shall be furnished and installed on all mechanical fastenings. In order to prevent deterioration due to corrosion, all bolts, nuts, studs, washers, pins, terminals, springs, hangers, cap screws, set screws, tap bolts, brackets, and other hardware fastenings and fittings shall be of an approved corrosion-resisting material such as silicon bronze, or stainless steel. Hot-dip galvanizing, per ASTM specification A153, will be considered approved treatment for all non-moving ferrous hardware.

l. Reference to a particular product by manufacturer, trade name, or catalog number establishes the quality standards of material and equipment required for this installation and is not intended to exclude products equal in quality and similar in design.

m. Equipment for which an acceptable manufacturer is not specifically named, or named equipment for which substitution is proposed, shall be manufactured by a company which has had a minimum of ten years of experience in the manufacture of similar equipment and which, in the Authority's opinion, has demonstrated its proficiency in the manufacture of such equipment. All equipment will be subject to the Authority's approval.

2. PLC PROGRAMMING

a. The entity manufacturing the control system shall be fully responsible to generate a complete operating system and develop the PLC program and alarm messages using:
   (1) The functional specifications
   (2) All logic and wiring shown on the Contract Drawings
   (3) Testing requirements

b. The entity manufacturing the control system shall furnish a laptop computer, interconnection cables, power supplies, software, Panel View programming, and PLC programming to accomplish the specified operation of the traveler and it's auxiliaries. Software for the PLC, Panel View, drives, and laptop computer shall be loaded and coordinated by the Contractor to achieve the correct operation of all software.

c. The entity manufacturing the control system shall be fully responsible for developing the PLC, and Panel View software to accomplish the specified operation of the traveler and its associated equipment. The Contractor shall assume software debugging will occur in the shop as well as in the field during start-up and subsequent testing. No additional payment shall be made for software debugging due to logic changes made in the field.

d. The PLC program shall be in accordance with the following items:
   (1) The ladder logic shall be easy to understand and troubleshoot.
(2) The ladder logic shall be fully documented, including rung comments and
address comments, for each rung in the ladder logic.

e. The ladder logic shall be written with regards to the operational sequence of the
traveler, containing separate sections for each of the major equipment areas such as
gates, center locks, etc. with interlocks.

f. The ladder logic shall not utilize or contain the following flaws:

(1) Latched coils: PLC logic shall be based upon real world conditions and reset
when required. When the PLC loses power, and then power is returned, the
PLC will determine the position of the traveler skew and other electrical
equipment, but not expect the traveler to be in the exact same position. If any
equipment was operated manually, the PLC program will determine the new
position of the equipment and operate normally including LDT positioning
system.

(2) Unnecessary internal coils: PLC logic shall be as simplified as possible and
not use multiple relays for a single function. The intent of this is to make the
program easy to troubleshoot and understand.

(3) Improper bypass logic: When bypass switches are utilized the bypass shall
bypass only the required interlocks. The intent of this item is to provide
programming that bypasses the correct interlock and does not remain active
in the logic or bypass other interlocks in the program.

(4) Problems transferring between normal and backup modes of operation: PLC
logic shall allow simple transfer from normal and backup modes without
generating unnecessary alarms or causing failures in the program. The intent
of this item is to provide programming that transfers between normal and
backup mode without problems or inaccurate alarms.

g. All timer settings shall be clearly documented in the program. They shall be
adjusted to match the selected equipment and adjusted during shop and field
testing for proper operation.

h. Add alarm messages and associated alarm ladder logic as required to achieve
robust diagnostics.

i. All application program code developed for the traveler shall become the
property of the owner and shall be provided to the owner with the system.
Locked or protected programs are not allowed.

j. Contractor shall submit a fully documented and cross-referenced copy of the new
PLC program for review and approval.

k. The Panel View alarm panel shall be programmed to timestamp, print, and store
each PLC alarm. The alarms shall be stored in chronological order and the
operator shall be able to scroll through the alarm screen to review alarms. The
alarms shall be stored in the Panel View and identified by a numerical identifier.
When the PLC processor transmits alarm bits to the Panel View, the Panel View
shall display the alarms, print the alarms, and store the alarms in an alarm history
screen.

3. PLC INSTALLATION

a. Magnetic components (contactors, relays, and other electro-mechanical
components) shall be mounted near the top or bottom of the enclosure in an area
segregated from the PLC components. Barriers shall be placed with at least 6-in.
separation between the magnetic area and the PLC.
4. CONTROL CONSOLE
   a. A traveler control console shall be furnished and installed on the traveler as located on the Contract Drawings. On the console shall be mounted all devices for controlling operation of the traveler, and its auxiliaries.
   b. Indicating lights shall be mounted on the control console to show that the various steps in the sequence of operation have taken place so that the operator may proceed to subsequent steps at the proper time. The functions to be indicated and the color of the lenses shall be as shown on the Contract Drawings.
   c. Special care shall be taken throughout the construction to ensure that the stainless-steel console tops and the equipment mounted thereon are completely protected from damage or defacement at all times.
   d. Both the inclined panel and the traveler main control console top are hinged where they meet, so they can be lifted (singly) for easy access to the components mounted through the console top and inclined panel. Handles shall be furnished and installed on the inclined panel and console top for ease in opening them. The inclined panel door shall be held open with cable stops. The console top shall be held open at approximately 60 degrees with leg braces on each side of the door.
   e. The console interior shall be suitably lighted and controlled by a switch mounted near the front doors. One duplex receptacle shall be mounted in the console's interior and two duplex receptacles shall be mounted on the console's exterior (one on each side).
   f. All contact blocks for control switches, pushbuttons, and other control devices shall be mounted within the body of the console. The operators for these devices shall protrude through the console top. The indicating lights for each operation shall be mounted adjacent to the control device governing that operation.
   g. The wiring within the control console shall be insulated switchboard wire conforming to the requirements hereinbefore specified for wiring on the control panels. The wiring shall be arranged systematically so that all circuits can be readily traced. All conductors shall be terminated on easily accessible terminal blocks mounted inside the console at the rear, with crimped locking fork connectors. Wiring shall be identified at equipment terminals by marking the adjacent area with brightly painted numbers to correspond to conductor designations appearing on the Contractor's wiring diagrams.
   h. The control console shall be rated NEMA 4X.

5. CONTROL CABINETS
   a. For each assembled control panel, all outgoing wire, No. 8 AWG or smaller, shall be connected to terminal blocks installed at the sides of the cabinet with crimped locking fork connectors. For each assembled control panel, all internal wire, No. 8 AWG or smaller, shall be terminated with locking fork connectors. The control panels shall also provide sufficient extra terminals to allow connection of all wires coming from limit switches and other devices that go on to the traveler control console and other locations as required, even though these wires do not connect to apparatus on the control panels. Spare terminals totaling at least 10 percent of those actually used shall be provided. Each terminal shall be identified per wire number shown on the Contractor's schematic wiring diagrams.
b. All panel wiring shall be arranged systematically so that circuits can be readily traced. The wiring shall be installed in a network of troughs consisting of horizontal and vertical sections securely bolted to the panels. After installation of the wiring, an insulated, flanged cover shall be snapped over the open side of each trough section.

6. REMOVAL
a. The removal work at the construction site under this subsection shall be done in conformance with all requirements governing the sequencing and scheduling of construction.

b. Any existing conduit encased in concrete, which is to be abandoned, shall be cut back to the concrete surface, threaded and plugged with a steel plug.

c. In general, all apparatus to be removed shall be disconnected by removing existing bolts, nuts and screws, including removal of all brackets, hangers, clamps, fittings and other hardware no longer needed.

d. All existing facilities, apparatus, cables, wiring and other equipment which are to remain shall be protected at all times from damage or defacement caused by the Contractor’s operations. Any such damage or defacement shall be promptly repaired or cleaned to the satisfaction of the Engineer at no additional cost to the Authority. If, in the opinion of the Engineer, the Contractor’s operations require the temporary removal of existing equipment for proper protection, such removal and remounting shall be done at no additional cost to the Authority.

e. Upon completion of the Work, the contractor shall repair all damaged or defaced areas exposed by the removal of equipment, or caused by his operations, in a workmanlike manner satisfactory to the Engineer. Small bolt holes in concrete surfaces shall be filled with epoxy mortar. Holes in the walls, ceilings or floors shall be filled with grout and finished to match the existing surfaces. Any damage to windows, window framing, sash, sills, frames or any other architectural trim shall be repaired, and painted surfaces shall be repainted after being repaired. Any holes in the ground shall be filled with earth topsoil and landscaped to match the existing landscape.

f. All existing materials and equipment removed under this item shall become the property of the Contractor unless otherwise specified and shall be removed from the site and disposed of properly.

7. PAINTING
a. The requirements for painting structural steel also apply to painting electrical equipment, unless otherwise specified.

b. Nameplates on all proprietary elements shall be masked off before painting. They shall be readable, clean and free of all paint coatings before acceptance of the machinery.

c. Shop Painting
   (1) Electrical equipment such as conduits, boxes, supports, and other devices which either have a galvanized finish or are of stainless-steel and equipment such as motors, brakes, control console, and control panel frames and enclosures which normally are given a factory finish shall not be shop painted.

d. Field Painting
(1) Electrical equipment, which is normally given a factory painted finish suitable to the Engineer, need not be field painted. Any touch-ups required shall be as recommended by the manufacturer.

3.04 LUBRICATION

A. MECHANICAL

1. After erection is complete, the Contractor shall make a thorough inspection to ensure that all parts are aligned as closely as practicable without actual operation, and all bolts are properly tightened. All gear housings shall be filled to the proper level, and all rotating and sliding parts shall be supplied with the lubricants called for under the specific machinery items.

2. All lubricants shall be listed on the lubrication charts as specified in the Contract documents. All lubricants, which will be listed on the lubrication charts, shall be approved for use in each proprietary unit by the manufacturer thereof.

3. The Authority, through the Engineer, will approve the manufacturer of all lubricants required.

4. Additional lubricants called for under specific items of the machinery specifications shall be provided.

3.05 COMMISSIONING

A. Commissioning (Cx) is a systematic process of ensuring that all systems, have been installed in the prescribed manner, are functionally checked and capable of being operated and maintained to perform with the design intent and to have documentation to support proper installation and operation.

B. The Contractor shall furnish the services of an independent Commissioning Agent (CXA). The CXA shall provide the Engineer with an unbiased, objective view of the system’s installation, operation and performance. This process does not eliminate or reduce the responsibility of the Contractor to provide a finished product. Commissioning is intended to enhance the quality of each system installation, startup and transfer to beneficial use by the Engineer. The Commissioning process shall be a team effort and encompass, as well as coordinate, the traditionally separate functions of system documentation, system installation, equipment startup, control system calibration, testing, and verification and performance checkouts. The CXA shall work closely with the construction team, cooperating on and coordinating all Cx activities with the Contractor and Engineer. The Cx process shall not reduce the responsibility of the Contractor to comply with the Contract Documents.

C. Meetings

1. Scoping Meeting. Prior to the commencement of Work, the Contractor and the CXA shall schedule, plan and conduct a commissioning scoping meeting.

2. Bi-weekly Meetings. Bi-weekly meetings shall be planned and conducted by the CXA and the Contractor during commissioning period. These meetings shall cover coordination, deficiency resolution and planning issues with the Contractor, appropriate sub-contractors and suppliers, the CXA and the Engineer.

D. The CXA will prepare and verify Pre-Functional Checklists for all commissioned components, equipment, and systems:

1. Red-lined Drawings:
a. The Contractor will verify all equipment, systems, instrumentation, wiring and components are shown correctly on red-lined drawings.

b. Preliminary red-lined drawings must be made available to the CxA for use prior to the start of Functional Performance Testing.

c. Changes, as a result of Functional Testing, must be incorporated into the final as-built drawings, which will be created from the red-lined drawings.

d. The Contractor shall prepare final as-built drawings from red lines.

2. Factory Acceptance Test Documentation:

a. Approved final test documentation must be made available to the CxA for use prior to the start of Functional Performance Testing.

3. Startup and Checkout Documentation:

a. Signed documentation that each system’s component manufacturer’s recommended startup and checkout procedures have been completed shall be made available to the CxA for use prior to the start of Functional Performance Testing.

4. Operation and Maintenance Data:

a. Contractor will provide a copy of O&M literature within 45 days of each submittal acceptance for use during the commissioning process for all commissioned equipment and systems.

b. The CxA will review the O&M literature once for conformance to project requirements.

c. The CxA will receive a copy of the final approved O&M literature once corrections have been made by the Contractor.

E. Demonstration and Training:

1. Contractor shall provide demonstration and training at the construction site for Authority personnel.

2. A complete training plan and schedule shall be submitted by the Contractor to the CxA four weeks (4) prior to any training.

3. A training agenda for each training session shall be submitted to the CxA at least one (1) week prior the training session.

F. Functional performance testing:

1. Using the requirements in the specifications, the CxA shall develop specific test procedures and forms to verify and document proper operation of each piece of equipment and system. The Contractor shall provide assistance to the CxA in developing the procedures. Prior to testing, the CxA shall provide a copy of the test procedures to the Contractor who shall review the tests for feasibility, safety, equipment and warranty protection.

2. Functional performance testing shall document that each system is operating in accordance with the Contract Documents. During the testing process, areas of deficient performance shall be identified. Deficiencies shall be corrected by the Contractor and functional testing shall be re-scheduled. The Contractor shall be responsible for all costs associated with re-testing for functional performance.

3. Each system shall be operated through all modes of operation. Proper responses to such modes and conditions as power failure, equipment failure, etc. shall also be tested.
4. Test Methods. Each function and test shall be performed under conditions that simulate actual conditions as closely as possible. The Contractor shall execute the test and shall provide all materials and system modifications as necessary to execute the test according to the specified conditions. At the completion of the test, the Contractor shall return all equipment and systems affected by these temporary modifications to their pre-test condition.

3.06 TESTING

A. GENERAL

1. The Contractor shall furnish all labor, materials, plant, and equipment and shall do all work necessary, such as adjustments or corrective measures, to properly test and to make fully functional all systems included in the factory, field and final acceptance testing.

2. All test results, parameters, data specified herein to be recorded shall reference the appropriate paragraph number and shall be presented in legible, tabular format, listing associated parameters and conditions. For example, motor current shall reference speed (rpm), direction of travel and grade (going up or down), operation mode, forward or reverse mode, drive control, drive control selector position number, etc.

3. The results of the Normal systems tests shall be presented in a matrix form on an Inspection Report Data Sheet. The proposed format of these sheets shall be submitted to the Engineer for acceptance prior to the actual testing. Any parameter value, which falls beyond the recommended range, would require the readjustment or replacement of the defective device.

4. The table of the test results shall have references to the specific sections of the testing procedure. The precision of the results will depend on the accuracy of recording equipment, the observer and weather conditions. For each stage of testing of the traveler control equipment, the name of the person who will perform the test, instruments used with calibration data, the exact date, time and weather conditions shall be recorded.

5. Some devices such as lamps, console indicator lights, brake function indicator lights, horn, can be tested without performing any traveler operation.

6. The traveler main parameters shall also be observed and visually compared to the control console HMI. Any discrepancy between results should be recorded. A discrepancy between critical measurements shall be resolved prior to continuing the tests.

7. The testing shall be accomplished sequentially, following the traveler operation instructions for normal operation, backup operation and skew correction operation. The major traveler systems shall be monitored while the traveler operates. All monitored parameters shall be kept for future reference, and a printout copy shall be attached to the Operating and Maintenance (O & M) Manual for reference. Another printout copy shall be provided to the Engineer.

8. All meters shall be calibrated per NIST guidelines within 6 months of the testing.

9. The Contractor shall arrange for and conduct all the necessary field tests and provide a testing procedure subject to the approval of the Engineer, to demonstrate that the entire electrical system is in proper working order and in accordance with the Contract Drawings and Specifications.
10. Should the tests show that any piece of equipment, connection or assembly in the judgment of the Engineer, as defective or functions improperly, such adjustments and/or replacements shall be made by the Contractor as to make the installation satisfactory to the Engineer and at no extra cost.

11. During testing of the traveler systems, it may be found that minor deviations from the performance specification are required for optimum traveler operation. All hardware required for these modifications shall be included in the Work at no additional cost to the Authority.

12. The traveler field tests shall confirm each major sub-component acceptance factory tests, and that the subsystem is operational, as well as the complete system. Confirmation of correct operation of sub-components shall be demonstrated through successful operation of the particular component. However, the Contractor is still responsible for the factory acceptance tests in accordance with the Contract Drawings and Specifications. Examples of subsystems are the traveler drive systems, control and power wiring, limit switches and starters.

13. This acceptance test shall show and/or demonstrate that the normal, backup and skew correction control and power systems are operational, trouble free, operating with all interlocks properly functioning, and in compliance with the requirements of the Contract Drawings and Specifications.

14. The traveler acceptance tests are not a substitute each sub-component acceptance factory and field tests. Confirmation of correct operation of sub-components shall be demonstrated through successful operation of the total control system. However, the Contractor is responsible for the factory and field acceptance tests as required by the Contract Drawings and Specifications. The Contractor shall be able to prove that the results of each sub-component tests are in conformance with the Contract Drawings and Specifications. Correct operation of the sub-components, and control circuit wiring connections shall be verified through the successful completion of the entire traveler control and power systems tests using the accepted testing procedure.

15. This testing procedure will evaluate performance and confirm correct and proper operation of all major subsystems and devices including the control desk meters and HMI, control switches and pushbuttons, brakes, drives and motors, etc. Visual inspections and physical measurements of some equipment are required for the purpose of recording valid parameter values. Traveler run printouts shall be provided for each test and kept for the record together with all other recorded data.

16. The Engineer shall be in possession of the final, operating and maintenance (O & M) manuals at least 30 days before acceptance testing may begin. The Contractor shall submit O & M manuals as soon as possible, as several revisions may be required.

17. There shall be 30 consecutive days of nominal traveler operation using the new permanent systems, with a minimum of five (5) successful operations per day, before the Final Acceptance Test may be scheduled.

18. During the Factory Acceptance Testing period, the Contractor shall arrange to have at the site manufacturers technical representatives of all major pieces of equipment or systems. The representatives shall be capable of supervising all adjustments to the equipment; of locating faults or defects and correcting them; and of obtaining from the manufacturers, without delay, new parts or replacements for apparatus which, in the opinion of the Engineer, does not perform satisfactorily.
19. Coordination with The Authority’s Testing and Inspection Personnel:
   a. The Contractor shall have sole responsibility for coordinating the work with
      the Authority to assure that all Quality Assurance/Quality Control procedures
      required by the Contract Documents are properly provided. The Contractor
      shall cooperate fully with the Authority in the performance of their work and
      shall provide the following:
         (1) Information as to time and place of starting shop fabrication and a field
             construction and erection schedule shall be submitted 15 days prior to the
             beginning of the work.
         (2) Site File: At least one copy of each approved shop and field drawing shall be
             kept available in the Contractor's field office and the drawings not bearing
             evidence of approval and release for construction by the Engineer shall not
             be kept on the job. Provide drawings for the work to be performed in the
             shop or field one week prior to the start of work.
         (3) At least one copy of each approved complete submittal covering the
             following: Approved RFIs, Quality Control Program, certification of
             welders, welding procedure specifications (WPSs), Nondestructive Testing
             Procedures, and Nondestructive Testing Personnel to be used in the job.
         (4) Cutting lists, order sheets, material bills and shipping bills.
         (5) Representative sample pieces requested by the Authority for testing, if
             necessary.
         (6) Full and ample means of assistance for testing and inspection of material.
         (7) Proper facilities, including scaffolding, temporary work platforms, etc., for
             inspection of the work in shop and field.

B. FACTORY ACCEPTANCE TESTING (FAT)
   1. Factory Acceptance Testing is the process of testing all mechanical and electrical
      systems specifically for the Project before products and materials are shipped and
      incorporated into the Work to verify performance or compliance with specified
      criteria. The intention of the FAT is to test each fully assembled traveler on
      trackbeams erected at the same spacing they will be erected at the bridge site and at a
      grade which can be varied between 0% and 2.5%. Perform Factory Acceptance
      Testing (FAT) on all machinery prior to shipment from the Contractor’s facility. The
      tests will attempt to simulate working loads that will be encountered by the traveler
      while in normal use.
   2. The Factory Acceptance Test shall be witnessed by the Engineer and the
      Commissioning Agent. Contractor shall notify the Engineer and Commissioning
      Agent 30 days in advance of the scheduling of said tests.
   3. The Contractor shall be responsible to develop complete FAT procedures to be
      submitted to the Engineer and Commissioning Agent for approval. The FAT tests
      and procedures shall include but not be limited to the following:
a. The Contractor shall replicate field conditions such as trackbeam orientation, dummy loads, gap transitions or mechanical interlocking. A minimum of three (3) trackbeam sections shall be erected per traveler lifting girder. For testing purposes only, at least one of the gaps between trackbeams shall be deliberately installed out of plane at the upper limits of the installation tolerances specified within the Contract Drawings and specifications. Minimum gap shall be 9/16 in. longitudinally, 1/32 in. vertically, and 1/32 in. laterally within +/- 1/64 in.. Test equipment and fixtures are to be provided and installed by the Contractor as approved by the Authority in the submitted FAT procedure plan.

b. Prior to FAT All equipment shall be installed, lubricated, adjusted as required.

c. FAT shall not commence until the systems are substantially complete and able to be operated with safety. All system functions shall be operable.

d. All safety equipment including sensors, guards and covers shall be in place during the FAT.

e. Each deficiency or maladjustment disclosed by the FAT shall be immediately resolved and the test repeated until satisfactory results are obtained.

f. All functions of each system shall be tested including the electromechanical drives, skew control, load sharing, brakes, electrical/electronic controls, sensors and all safety equipment.

g. All components of each traveler shall fully tested, including but not limited to: the drives, brakes, locks, interlocks, EOT's, motion sensors, etc.

h. Travelers shall be operated at maximum and minimum speeds. Observe and record the achieved speeds.

i. Operate the E-Stop control at various speeds including full speed full load to ensure effective stopping.

j. The Contractor shall operate and demonstrate functionality of the Skew control system under all anticipated loading conditions including with half rated live load applied to one side of traveler only. Testing shall include starting, stopping and traveling at uniform speeds up or down a 2.5% grade.

k. The Contractor shall install and utilize dummy loads where practical during FAT to demonstrate equipment capacity.

l. The Contractor shall coordinate with the trackbeam flange brake manufacturer to ensure that the proper FAT testing of the brakes.

m. Observe and record the control voltages necessary to achieve maximum velocity with dummy loads for the drives.

n. Observe the quality of motion for each component of the system watching for vibration in motion, irregular motion and jerking on startup.

o. Test Logs: Prepare a test log including descriptions of control operation, control voltages, motor currents, maximum velocities achieved, temperature of motors and pertinent observations concerning adjustments made and difficulties encountered.

p. Operate the equipment at creep speed carefully checking for lost motion, vibration, noise, irregular motion or any other unusual conditions.

q. Observe and record the speeds achieved and the maximum motor current at startup and at full load/full speed.
r. Demonstrate proper operation with combinations of motors removed from the circuit by successively removing one motor and brake from each bogie assembly up to four total.
s. Demonstrate proper load sharing of motors on each pair of bogies on each side of the traveler including with one or two motors and brakes removed from the circuit.
t. The FAT shall be completed not less than 14 days before the scheduled shipping date for the first shipped components.
u. During the FAT the Contractor shall log the number of cycles accumulated during all testing.

C. COMMISSIONING ACCEPTANCE TESTING (CAT)

1. Commissioning Acceptance Testing shall be completed on all the travelers prior to the issuance of a Certificate of Substantial Completion by the Engineer. The testing shall duplicate all operating sequences and methods that will be encountered by the travelers while in normal use.

2. The CxA shall submit complete CAT procedures to be presented to the Authority for approval. The CAT tests and procedures shall include but not be limited to the following:

a. Prior to CAT all equipment shall be installed, lubricated, adjusted as required.
b. CAT shall not commence until Prefunctional Checklists and Functional Testing is approved and the systems are substantially complete and able to be operated safely with all system functions operable.
c. All safety equipment including sensors, guards and covers shall be in place during the CAT.
d. Each deficiency or maladjustment disclosed by the CAT shall be immediately resolved and the test repeated until satisfactory results are obtained.
e. All functions of each system shall be tested including the electromechanical drives, skew control, load sharing, brakes, electrical/electronic controls, sensors and all safety equipment.
f. All components of each traveler shall be fully tested, including at a minimum: the drives, brakes, locks, interlocks, EOT's, and motion sensors.
g. Travelers shall be operated at maximum and minimum speeds. Observe and record the achieved speeds.
h. Operate the E-Stop control at various speeds including full speed full load to ensure effective stopping.
i. The Contractor shall operate and demonstrate functionality of the Skew control system under all modes of operation and speed.
j. The Contractor shall operate each main span traveler to the mid-span position at minimum of 4 runs without any faults in the system. For the NY and NJ approach travelers a minimum of 8 full runs shall be performed without any faults.
k. Observe the quality of motion for each component of the system watching for vibration in motion, irregular motion and jerking on startup.
l. Test Logs: Prepare a test log including descriptions of control operation, control voltages, motor currents, maximum velocities achieved, temperature of motors and pertinent observations concerning adjustments made and difficulties encountered.
m. Operate the equipment at creep speed carefully checking for lost motion, vibration, noise, irregular motion or any other unusual conditions.

n. Observe and record the speeds achieved and the maximum motor current at startup and at full speed.

o. The CAT shall be conducted in the presence of the Authority and Authority's Engineer. CAT shall demonstrate the full performance of the travelers in accordance with the Contract Drawing and Specifications including at a minimum: motions, clearances, loads, velocities, controls, skew control, load sharing between motors, cable management, interlock switches and systems, E-stop systems and other life-safety systems, and all finishes. CAT parameters shall be as detailed in the approved O&M Manual and documented by photos, videos, and notes as applicable. Test sequences of large automated mechanical components may also be documented by an electronic data log of the control system. A record of this control data shall include, at a minimum: position, velocity, acceleration, and amperage.

D. FIELD TESTS

Field tests shall be in accordance with Section 051200 – Structural Steel and as stated in this Section.

3.07 TRAINING, OPERATIONS, AND MAINTENANCE MANUALS

A. DESCRIPTION

1. The Contractor shall provide separate Operating and Maintenance Manuals for the bridge maintenance travelers electrical equipment and operating machinery (referred to herein after as the “manuals”) which shall include acquiring, coordinating, assembling, organizing and editing all information required.

2. The Contractor shall provide the services of technical instructors to supervise the operation of the bridge travelers and train personnel, including training Authority operators, programmers, electronic technicians, electricians, maintenance workers, and other personnel as indicated by the Authority. The Contractor shall furnish complete manuals with necessary instruction sheets, student training aids, books, paper, and booklets to train the personnel in operation and maintenance of the bridge travelers.

3. The Contractor shall coordinate Training with the installation and testing of the bridge travelers.

4. The preparation of the manuals and the training sessions shall be scheduled and coordinated with the traveler testing requirements. 90 days prior to traveler testing the Contractor shall submit a schedule of work for approval. The sequence of work shall include (at minimum):

a. Operating and Maintenance Manuals – Outline
b. Factory Acceptance Testing
c. Operating and Maintenance Manuals – DRAFT
d. Field Testing
e. Operating and Maintenance Manuals – REVISED DRAFT
f. Commission Acceptance Testing
g. Training – Outline
h. Training Manual and Course Materials (Including Schedule)
i. Operating and Maintenance Manuals – FINAL DRAFT
j. Training – Classroom
k. Training – Field
l. Operating and Maintenance Manuals – FINAL As-Built
m. Final Acceptance by Authority

B. MATERIALS

1. GENERAL
   a. All manuals shall be written and compiled by a professional technical writer, who shall be a registered New York and New Jersey Professional Engineer, having knowledge of Mechanical and Electrical equipment similar to bridge travelers, overhead travelling cranes or movable bridges. The writer shall submit his or her resume including complete samples of their work for approval to the Engineer as part of the manual outline.
   b. Maintenance Manuals - these shall contain descriptive material, catalog cuts with non-pertinent data blocked out, as-built drawings, spare parts list, troubleshooting techniques and any and all information necessary for successful operation and maintenance of the traveler functional systems and each piece of equipment furnished by the Contractor. Traveler functional systems shall include at a minimum all mechanical, electrical and control systems, and all other equipment for which periodic maintenance and operation is required.
   c. Operating Manuals - these shall contain written descriptions of the functional systems of the bridge travelers, with step-by-step operating instructions for each of these systems and any and all information and directions required for their successful operation.
   d. All revisions (errata or addenda) to the manuals shall be complete prior to the training sessions.
   e. All records (data, drawings, diagrams) shall be accurate, distinct, and easily legible and possess characters of clarity and legibility. Illustrations shall be clear and dimensions and lettering on drawings, shall be legible. If reduced drawings are incorporated to manuals, the original lines and letters shall be darkened as necessary to retain their legibility after reduction. Larger drawings may be folded and placed in pockets/sleeves in the manuals.

2. PRODUCT
   a. The general arrangement of each manual including the method of binding and the text shall all be submitted for approval by the Engineer.
   b. All printed matter, data, drawings, diagrams, etc., shall be produced by methods so as to result in permanence and durability, including paper that is water resistant. No materials shall be used which will adversely affect this permanence and durability.
c. The material for the final manuals shall be assembled in volumes with heavy plastic covers. Each manual shall be approximately 9in. x 12in. (229mm x 305mm), three-ring binder with 3in. "D" rings, and vinyl cover to allow insertable title sheets. 8 1/2in. x 11in. (216mm x 279mm), 20lb. hole-punched loose leaf paper shall be used. The paper shall have an acid free quality suitable for archival use. Holes for binding shall be 5/16in. minimum diameter, shall be reinforced with plastic or cloth, and shall be spaced at the standard three (3) hole spacing. Foldout drawings, diagrams and illustrations shall have 5/16in. minimum diameter punched holes reinforced with plastic or cloth and shall be spaced at the standard three (3) hole spacing. Foldout drawings, diagrams and illustrations shall be folded neatly to 8 1/2in. x 11in. (216mm x 279mm) dimensions. Each manual shall be neatly entitled with a descriptive title, the name of the bridge, the Authority, traveler location, the year of installation, the Contractor, and the Designer. Copies of drawings shall be in black on a white background and shall be easily legible. The technical drawings, catalog cuts, and manuals shall be complete and available at the traveler for use during the field testing.

d. All literature and descriptive materials for inclusion in any manual shall have all sheets numbered and listed by section in a table of contents.

e. Each section/subsection shall be separated with tabbed divider sheets. Each tab shall be color coded and suitably titled.

f. The Contractor shall assume responsibility for the systems provided by subcontractors and/or vendors. No disclaimer of any sub-Contractor or vendor shall apply to the overall traveler system as described in the operation and maintenance manuals.

g. Electronic submittals shall be in PDF format and shall include a complete table of contents including all chapters, sections and sub-sections which will display on the left side of the screen and which can be used to navigate to any section of the document by clicking on the appropriate chapter, section or sub-section line. The document shall be formatted to automatically re-size the screen to suit the size of the page being displayed.

3. OPERATIONS AND MAINTENANCE MANUAL DETAILS

a. For each submittal, the Contractor shall furnish to the Engineer a minimum of seven (7) bound copies of the Traveler Operations Manual, the Electrical Operating Manual, and the Mechanical Operating Manual, of which one each shall remain with the Design Consultant Engineer. The table of contents for each of the manuals is shown as follows:

b. Operations Manual – Table of Contents

(1) Introduction – a general description of the traveler and its facilities.
(2) Operating Procedure – a simplified step-by-step, operating procedure to normally operate the travelers. This description shall be augmented and cross-referenced with a layout of the control console, which shall be included in this section.
(3) Electric Power Sources – a description of the locations and precautions.
(4) Drives and Motors operation – including drive and motor bypassing.
(5) Miscellaneous Devices – a description of the methods and operation of all miscellaneous devices such as scissor lifts.
(6) Instrumentation and Controls – description of normal operating ranges.
(7) Sequence Interlocking – description of methods and precautions for use of the bypass switches including detailed operation.

(8) PLC Operation – a simplified description of how the traveler normally operates under normal and backup PLC control and how to recognize when there is a PLC malfunction.

(9) Abnormal PLC Indications – description of drive permissive fault, etc.

(10) Brakes – a detailed description of how to manually release and set the motor brakes and holding brakes.

c. Electrical Operating Manual – Table of Contents

(1) Introduction, including a general description of the traveler and its facilities.

(2) Description of all traveler functional systems and sub-systems, which shall include but not be limited to description of the traveler control system, which shall describe in full the functions of all protective devices, limit switches, PLC and associated equipment and all other electrical equipment used, both in the power service and in the control system, in connection with each step in the operating sequence. Wire and apparatus numbers appearing on the wiring diagrams shall be used in this description for identifying the various devices and circuits.

(3) A detailed and complete description of lockout steps for the electrical power during various maintenance procedures. These procedures shall include lockout of switchgear in NJ and NY tower, medium voltage switchgears on the lower roadway median, disconnect switches or circuit breakers of the corresponding devices being maintained. Furthermore, tag-out shall be installed on the control console to alert the operator not to operate a particular switch during maintenance of the respective electrical equipment. The lock-out and tag-out steps shall be in conformance with the latest Occupational Safety and Health Administration (OSHA) requirements.

(4) Operating Procedure and instructions, including a simplified step-by-step procedure to normally operate the traveler. This description shall be augmented and cross-referenced with a layout of the control console, which shall be included in this section.

(5) A description of the traveler electric power sources including methods and precautions for this equipment.

(6) A description of the conductor bar maintenance zone including methods and precautions for this equipment.

(7) Procedure for de-selecting drives and motors to operate the traveler.

(8) A description of miscellaneous devices on the control desk, such as navigation lights switch, lights switch, etc., including the methods and operation of these devices.

(9) A description of the traveler instrumentation and controls including normal operating ranges for this equipment

(10) A detailed and complete description of sequence interlocking including methods and precautions for use of the bypass switches.

(11) A simplified description of how the traveler normally operates under control of the PLC and how to recognize when there is a PLC malfunction. In addition, procedure for switch over to back-up PLC
(12) A description of abnormal indications such as, skew, traveler drive permissive fault, motor overload, etc.

(13) Reference drawings showing locations of equipment shall be included to further describe the control and operations.

(14) Detailed and complete description of all control equipment including instructions to achieve optimum settings of all limit switches, detectors, etc.

d. **Mechanical Operating Manual- Table of Contents**

(1) Introduction, including a general description of the traveler and its functions

(2) Description of traveler functional systems including but not limited to the following:

(a.) Support System

   i. Trolley and Equalizer Frames
   ii. Hanger Assemblies
   iii. Wire Rope Hangers
   iv. Swivel and Gimbal Assemblies

(b.) Drive Machinery

   i. Enclosed gear drives
   ii. Motor Brakes
   iii. Wheel assemblies

(c.) Miscellaneous

   i. Guide Assemblies
   ii. Damper assemblies
   iii. Bumper assemblies
   iv. Holding Brakes

e. For each submittal, the Contractor shall also furnish to the Engineer a minimum of seven (7) bound copies of the Electrical Maintenance Manual and of the Mechanical Maintenance Manual, of which one each remains with the Design Consulting Engineer. The table of contents for each of the manuals given as follows:

f. **Electrical Maintenance Manual-Table of Contents**

(1) Maintenance instructions for the electrical equipment, including warnings and precautions to be observed during maintenance actions. All preventive maintenance procedures are to be outlined and a chart listing all maintenance procedures in chronological order shall be provided.

(2) Listings of all parts suppliers’ local representatives, including suppliers’ and representatives’ names, addresses, telephone and fax numbers, and websites, if any. The names, addresses, telephone and fax numbers, and websites of the Contractor, all subcontractors installing any of the traveler functional systems or subsystems, and the Engineer shall also be provided.

(3) Listing of all spare parts and components provided by the Contractor.

(4) Preventative maintenance procedures, including the frequency at which the various procedures should be done. All safety precautions that are required to be observed in order for proper operation and maintenance shall be included in a separate section in addition to wherever noted in the manuals.

(5) Maintenance testing and procedure equipment lists.
Schematic indicating what items should be cleaned and painted on a regular basis.

Troubleshooting procedures and checklists, which shall include but not be limited to a troubleshooting flow chart for troubleshooting the traveler electrical system and instructions for diagnosing malfunctions of the programmable control system and for detecting failures in the external controls connected thereto.

Test data, equipment, criteria, and performance curves for all traveler drive motors.

Repair procedures and repair procedure equipment lists, including procedures for installation and removal of electrical and control items.

Description of the proper theoretical approach to installing and testing electrical and control systems.

Anticipation of possible breakdowns and development of trouble-shooting procedures and identification of corrective actions.

As-Built Shop Drawings which shall include but not be limited to schematic wiring diagrams, control console and control panel layouts, connection diagrams, PLC schematic wiring, PLC input/output hardware diagram, PLC logic, PLC ladder diagrams and PLC message display unit codes.

Conduit and electrical equipment layout and installation drawings, including mounting details and wire schedule.

Control console, cabinet and drive panel layouts and wiring diagrams.

Schematic-wiring diagrams.

Certified Drawings.

Steps for cursory inspection that should be carried out annually.

Steps for in-depth inspection that should be carried out every 2 years.

Manufacturer’s literature describing each piece of equipment and giving complete identification including manufacturer’s model number and drawing number. A set of descriptive leaflets, bulletins and Drawings covering all approved items of equipment furnished and installed, including any installation, alignment, maintenance, troubleshooting and repair procedures. The catalog number of each piece shall be given, to be used in case it becomes necessary to order replacement parts from the original manufacturer.

A hard copy of the PLC program software.

Any and all other material or information which in the opinion of the Engineer may be desirable to include in order to assist in maintaining the traveler functional systems and sub-systems.

Mechanical Maintenance Manual-Table of Contents

Index, in alphabetical order.

Provide complete instructions relative to assembly, installation, operation, adjustment, lubrication, maintenance, disassembly and carrying complete parts list shall be furnished by the Contractor for every item of equipment furnished by the Contractor.
(3) Manufacturer's literature describing each piece of equipment and giving complete identification including manufacturer's model number and drawing number. A set of descriptive leaflets, bulletins, and Drawings covering all items of equipment used in the traveler. The catalog number of each piece shall be given, to be used in case it becomes necessary to order replacement parts from the original manufacturer.

(4) Instructions, including step-by-step preparation for training of all the machinery components supplied by the Contractor. Instructions shall note all precautions required for correct and safe operation.

(5) Description of the holding brake system operation including interfaces with the control system, schematic and diagrammatic drawing.

(6) Holding brake manufacturer's hydraulic catalog cuts and maintenance instructions for all pumps, valves, filters, and cylinders.

(7) Holding brake hydraulic system and component troubleshooting guide, with a quick reference table showing any anticipated problem areas.

(8) Detailed and complete description of all hydraulic lines, ports and component labeling and code numbers.

(9) Hydraulic maintenance schedule and procedures.

(10) Maintenance and lubrication instructions for the machinery components.

(11) Lubrication schedule indicating method and frequency of lubrication.

(12) Schematic indicating what items should be cleaned and painted on a regular basis.

(13) Complete list of each bearing housing seal used on the traveler, including current part number and manufacturer of each seal furnished plus sufficient generic description and dimensions to order seals in the future when current models/manufacturers may no longer be available.

(14) Anticipation of possible breakdowns and development of trouble-shooting procedures and identification of corrective actions and all safety precautions that are to be observed for proper operation and maintenance.

(15) Manufacturer's parts list of functional components, control diagrams and wiring diagrams where required, giving manufacturer's model number and part number.

(16) Steps for cursory inspection that should be carried out annually.

(17) Steps for in-depth inspection that should be carried out every 2 years.

(18) List of nearest local suppliers of all component parts, including their addresses.

(19) Spare parts data as follows:

(a) Complete list of parts and supplies with sources of supply

(b) List of parts and supplies that are either normally furnished at no extra cost with purchase of equipment or specified herein to be furnished as part of this Contract.

(e) Name, address, and telephone number of the manufacturer's representative and service company, for each machinery component so that service or spare parts can be readily obtained.
C. TRAINING

1. GENERAL

   a. The training schedule, from review of course materials to field instruction, shall be submitted to the Engineer for approval.

   b. The Contractor shall submit to the Engineer the outline of topics to be covered and training material for review.

   c. The training shall start after final commissioning is completed and approved.

   d. Training of the designated traveler operational personnel shall commence prior to final acceptance of the travelers but after the final commissioning is completed and approved. The classroom training shall be scheduled for normal daytime working hours. The field testing shall be scheduled during normal daytime working hours. Instructions pertaining to hardware and maintenance shall be offered on two separate occasions so as to allow Authority operations personnel to coordinate the course with their normal activities. The classroom training will be held at PA facility and duration shall be minimum 4 hours per class per shift for 4 shifts (Total 16 Hours). Hands-on, field training for each maintenance traveler will be minimum 4 hours per shift for 4 shifts (16 hours per traveler and total 64 hours). Allocate extra 20 hours for additional training as requested by the Engineer. A total of 40 personnel shall be trained with a maximum of 10 personnel per shift.

   e. The Contractor shall furnish all necessary instruction sheets, student training aids, books, paper, and booklets to supplement training. The Contractor shall coordinate with Authority the location where training sessions will be held. Supplying of visual aid equipment and other miscellaneous items required for training shall be the responsibility of the Contractor.

2. TRAVELER OPERATORS AND ELECTRICIANS

   a. The Contractor shall provide persons to supervise the operation of the traveler and to train personnel for a period of 30 consecutive working days after the construction has been completed, fine-tuned, tested, and approved by the Engineer. Instructors shall include, but not be limited to, representatives from manufacturers of the major equipment and a Control Engineer.

   b. The Instructors shall be skilled persons competent to operate the traveler and be completely familiar with the operating equipment of the traveler and its auxiliaries. They shall be able to make any adjustments required to the electrical and mechanical equipment. The Instructor shall be in attendance at the bridge during all traveler testing.

   c. There shall be an on-site training of Authority electronic technicians, electricians, maintenance workers, and other personnel as indicated by the Authority on subjects such as how to troubleshoot, repair electronic motor controls, drive circuit logic, maintenance and adjustment of all electrical equipment, software, PLC hardware (including how to remove, replace and set I/O cards), and other items required for full traveler operation and maintenance. Sessions shall be devoted to hands-on training on all hardware, including PLC hardware. The training shall include a minimum of 3 days (classroom) and 4 days (field) focusing on the PLC and traveler control system.
3. OPERATING MACHINERY
   a. The Contractor shall provide instructions for at a minimum the following with respect to all traveler mechanical items:
   (1) Function, Purpose
   (2) Normal Operation
   (3) Inspection
   (4) Maintenance
   (5) Lubrication
   (6) Adjustment
   (7) Trouble shooting
   (8) Repair and Replacement

END OF SECTION
PAGES
539
THROUGH
556
NOT USED