Special Provisions

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SPECIAL PROVISIONS

1. Administrative.

1.1 General.

Perform the work under this construction contract for Project WK52362008, Milwaukee Streetcar, 4th Street to Ogden Ave, Milwaukee County, Wisconsin, as the plans show and execute the work as specified in the State of Wisconsin, Department of Transportation, Standard Specifications for Highway and Structure Construction, 2016 Edition, as published by the department, and these special provisions.

Perform the sanitary sewer and water main work in accordance to the Standard Specifications for Sewer and Water Construction in Wisconsin, latest Edition (SSSW) and addendums. If there is a discrepancy or conflict between the referenced specification and the standard specifications regarding contract administration, part 1 of the standard specifications governs.

Perform permanent and temporary signing work in accordance to the Manual on Uniform Traffic Control Devices (MUTCD), latest edition.

1.2 Scope of Work.

The work under this contract shall consist of removals, grading, dense graded base, concrete pavement, concrete curb and gutter, concrete sidewalk, asphaltic surface, HMA pavement, storm sewer, sanitary sewer, water main, erosion control, permanent signing, traffic signals, traffic control, pavement marking, street lighting, track work, communication installations, overhead electrical systems, concrete platforms, streetscaping, structures, restoration, and all incidental items necessary to complete the work as shown on the plans and included in the proposal and contract.

1.3 Other Contracts.

Coordinate your work in accordance to standard spec 105.5.

Modifications to the traffic control plan may be required by the engineer to be safe and consistent with adjacent work by others.

It is expected that routine maintenance by the City personnel may be required at certain times concurrently with the work being done under this contract.

The following contracts are anticipated to be under construction within the time period of this contract, unless otherwise indicated:

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I-794 Lakefront Gateway reconstruction. The contact is Brad Bacilek; bbacilek@benesch.com.

Milwaukee Water Works water main construction; various locations. The City of Milwaukee contact is Dave Goldapp at (414) 286-6301; dave.m.goldapp@milwaukee.gov.

City of Milwaukee combined sewer lining project; various locations. The City of Milwaukee contact is Josh Radomski (414-286-0557 office; joshua.radomski@milwaukee.gov.

1.4 Available Documents.

The City will make all its information available to bidding contractors. The list of documents that are available for contractors' information includes but is not limited to:

- Phase I Hazardous Material Assessment Report
- Phase II Hazardous Material Assessment Report
- Soils Management Plan
- WDNR Concurrence Letter
- Geotechnical Engineering Memorandum
- Environmental Assessment
- Finding of No Significant Impact
- Locally Preferred Alternative Document
- Design Criteria Report
- Traffic Operations Technical Memorandum
- Project Management Plan
- Safety and Security Management Plan
- Safety and Security Certification Plan
- Preliminary Hazard Analysis
- Plans for the 2013 Rehabilitation of the St. Paul Avenue Vertical Lift Bridge over the Milwaukee River.

These documents are available from Dave Windsor at 841 N. Broadway, Room 919 Milwaukee, WI, 53202, (414) 286-0459. PDFs will be made available upon request.

1.5 Pay Plan Quantity.

A Bid Items Designated as Pay Plan Quantity

Replace sub section 109.1.1.2 of the standard specifications with the following:

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If the schedule of items designates a bid item with a **P** in the title, the City will not measure that bid item. The City will use the plan quantity, the approximate quantity shown on the schedule of items, for payment unless a contract revision affects a designated bid item.

If the engineer revises the contract under standard spec 104.2, the City will adjust the quantity of designated items that are affected by the revised work. The engineer will adjust the affected quantity, with a contract modification as defined in standard spec 101.3, regardless of the magnitude of the revised work, which may result in either an increase or a decrease from the quantity shown on the schedule of items. The City will measure revised work as specified in standard spec 109.1.1.1. If the engineer revises the contract to eliminate a designated item, the engineer will not pay for the designated item, except as specified in standard spec 109.5.

The approximate quantity shown on the schedule of items for a designated item is for information only and only an estimate. The engineer makes no guarantee that the quantity, which can be determined by computations based on contract information, will equal the approximate quantity shown on the schedule of items. The engineer will not make a quantity adjustment for discrepancies.

1.6 Notice to Contractor - Milwaukee County Transit System.

The Milwaukee County Transit System (MCTS) maintains multiple bus routes throughout the project corridor along the project. Notify MCTS at least ten days prior to beginning work. The MCTS contact is Ms. Melanie MacArthur, (414) 343-1764.

Invite MCTS to all coordination meetings between the contractor, the City, local officials and business people to discuss the project schedule of operations including vehicular and pedestrian access during construction operations.

MCTS will remove their existing bus stop signs and shelters where needed. Notify MCTS at least ten days in advance. MCTS will install new bus stop signs and shelters prior to the opening of traffic on the new roadway pavement. Notify MCTS at least ten days prior to opening new pavement to vehicular traffic.

The contractor shall provide a safe boarding zone that is clear of debris and ADA compliant at each temporary bus stop. MCTS will install temporary bus stop signs if notified at least ten days in advance.

1.7 Notice to Contractor – Preserving Trees, Shrubs, and Planting Areas in the City of Milwaukee.

NOT FOR CONSTRUCTION

Replace standard spec 205.3.15 with the following:

A Description
This special provision applies to preserving trees, shrubs, and planting areas only located in the City of Milwaukee, which are NOT marked for removal.

B (Vacant)

C Construction
C.1 General
All cutting for the removal of sod and soil in order to establish a finished grade within 4 feet of existing trees must be done manually if necessary.

No construction equipment, cars, trucks, and/or materials shall be parked or stored on any median or tree border on this project or adjacent roadways.

Root foundations must remain adequate to withstand heavy windstorms.

Root systems of street trees may not be cut for the installation of any type of cable by the contractor or city department. Contact the forestry division at (414) 286-2428 for directional boring specifications.

The contractor will be responsible for excessive damage to the roots, trunks, and branches of all street trees. This responsibility may include the cost of any special treatment deemed necessary by the engineer to ensure survival of trees, or may include removal of trees at the contractor's cost.

Refrain from placing or storing any construction materials, sand, soil, or any other materials on the surface of the soil within the root zone of existing city street trees. Additionally, assure that no construction chemicals, tank rinsates, or petroleum products are deposited with the root zones of the trees. Root zone is defined as that area within the drip line of trees.

The contractor, prior to removal and/or replacement of sidewalk and/or curb and gutter, and driveways adjacent to all trees, shall review work operations with the engineer and/or Mr. Jim Kringer, forestry supervisor, at (414) 708-2428.

C.2 Sidewalk Construction
The root system on the walk side of the tree shall be cut not deeper than 9 inches below the finished grade of the new walks, and not more than 5 inches from the edge of the new walk. Roots in the walk area shall be removed only to a depth of 9 inches below finished grade of the new walk.

Sidewalks are to be removed, and roots cut, by use of hand implements only.

C.3 Carriage Walk Construction

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When constructing or replacing carriage walks, roots shall not be cut by means of using mechanical root cutting machines. If root removal is essential to carriage walk replacement, roots shall be manually cut with hand implements. Roots shall be removed not deeper than 9 inches below the finished grade of the new carriage walk.

C.4 Curb, Gutter, and Road Construction

When constructing or replacing driveways or driveway approaches; roots shall not be cut by means of mechanical root cutting machines. If root removal is essential to driveway replacement, roots shall be manually cut with hand implements.

Cover exposed tree roots with mulch and water from a period immediately following curb and gutter removal, until the area is backfilled following construction. The cost of this work is incidental to removal items.

C.5 Damage and Repair

Caution should be used during the construction process to avoid damage to the roots, trunks, and branches of all street trees. Damage caused to any street tree or irrigation system will be repaired by the City of Milwaukee's Forestry Division and the costs of repair, rejuvenation, and/or value lost will be billed to the contractor or credited against the contract at the option of the city. If any of the irrigation system is damaged immediately contact Mr. Andrew Witczak at (414) 708-3795 or (414) 803-7392, andywitczak@yahoo.com for repair. Any and all questions regarding the irrigation system can be directed to Mr. Witczak.

At locations where the contractor has not complied with the forestry special requirements stated in the special provisions above, and the maximum clearance was exceeded or a thin form was not used, a minimum credit to the city of $50.00 per location will be taken. The credit will increase in proportion to the excess distance beyond clearance allowed. The credit will be $50.00 for each 2-inch increment or part thereof in excess of the initial clearance allowed. Any damage to the tree's structure totaling 15 percent of the trees value will be billed on a prorata basis. If, in the opinion of the City of Milwaukee's Forestry Division, the tree has been damaged to the point that it warrants removal, the credit that will be taken will be equal to $100.00 per inch diameter of the tree. A field measurement will be taken to determine the tree size.

D (Vacant)

E Payment

The cost of this work shall be included under appropriate bid items for roadway and drainage excavation, sewer and water excavation, and removals. No separate payment will be made for preserving trees, shrubs, and planting areas located in the City of Milwaukee.

1.8 Contractor Notification.

Replace standard spec 104.2.2.2(2) with the following:

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If the contractor discovers the differing condition, provide a written notice, as specified in 104.3.3, of the specific differing condition before further disturbing the site and before further performing the affected work.

104.3.2 (Vacant)

104.3.3 Contractor Initial Written Notice
Replace standard specs 104.3.2 and 104.3.3 with the following:

If required by standard spec 104.2, or if the contractor believes that the City's action, the City's lack of action, or some other situation results in or necessitates a contract revision, promptly provide a written notice to the engineer. At a minimum, provide the following:

1. A written description of the nature of the issue.
2. The time and date of discovering the problem or issue.
3. If appropriate, the location of the issue.

Provide the additional information specified in standard spec 104.3.5 as early as possible to assist the engineer in the timely resolution of an identified issue. The engineer will not require, in subsequent submissions, duplication of information already provided.

1.9 Contractor Document Submittals.

This special provision describes minimum requirements for submitting project documents to the City. This special provision does not apply to shop drawing submittals.

Provide one electronic copy of all documents requiring City review, acceptance, or approval. Attach a completed engineer-provided transmittal sheet to each email submittal. The City will reject submittals with incomplete transmittal sheets and require re-submittal.

The City will return one reviewed, accepted, or approved original to the contractor. Additional return originals can be requested. Submit an additional original for each additional return original requested.

Submit electronic copies in Portable Document Format (PDF) to the engineer, and send alerts with a link to the document via email to (an) account(s) the engineer determines. If possible, translate original documents from their native format (e.g. Word, Excel, AutoCAD, etc.) using a Portable Document Format translation routine. Scan other documents to PDF format with a minimum resolution of 600 dpi.

All costs for contractor document submittals are incidental to the contract.

1.10 Material and Equipment Staging

Submit a map showing all proposed material stockpile or equipment storage locations to the engineer 14 days prior to either preconstruction or proposed use, whichever comes

NOT FOR CONSTRUCTION

first. Identify the specific purposes for the location. Obtain written permits from the property owner, and submit two copies to the engineer before use.

1.11 Pavement Breaking Equipment

Use only hydraulic pavement breaking equipment for breaking pavement within 300 feet of any structure. Do not use guillotine, drop hammer, falling weight, gravity impact breakers or equivalent equipment. A multi-head hydraulic drop hammer is allowed unless a structure is within 50 feet of the roadway.

1.12 Crack and Damage Survey, Item 999.1500.S.

A Description

This special provision describes conducting a crack and damage survey of the residences and business located in the project area. Locations of the specific residences and businesses to be included in the Crack and Damage survey will be as directed by the City of Milwaukee.

This Crack and Damage Survey shall consist of two parts. The first part, performed prior to construction activities, shall include a visual inspection, photographs, and a written report describing the existing defects in the building(s) being inspected. The second part, performed after the construction activities, shall also include a visual inspection, photographs, and written report describing any change in the building's condition.

B (Vacant)

C Construction

Prior to any construction activities, thoroughly inspect the building structures for existing defects, including interior and exterior walls. Submit a written report of the inspector's name, date of inspection, descriptions and locations of defects, and photographs. The intent of the written report and photographs is to procure a record of the general physical condition of the building's interior and exterior walls and foundation. The report shall be typed on bond paper and be in text form.

The photographs shall be taken by a professional photographer capable of producing sharp, grain free, high-contrast colored pictures with good shadow details. The photographs shall be 3½ inch by 5 inch color prints, glossy, and mounted in protective storage pages with clear slip-in pockets and clear background. Each sheet shall hold four prints. The back of each photograph shall contain the following information:

ID _____
Building Location _____
View looking _____
Date _____
Photographer _____

Prior to the start of any construction activities pertinent to this survey, submit a copy of the written report and photographs to the engineer.

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After the construction activities are complete, conduct another survey in the same manner, take photographs, and submit another written report to the engineer.

In lieu of photographs, a professional videographer may be hired to use a video camera capable of producing a video with the clarity required to perform this work.

D Measurement
The City will measure Crack and Damage Survey as single complete unit of work.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
999.1500.S	Crack and Damage Survey	LS

Payment is full compensation for providing the before and after written reports, and for photographs or video.
999-010 (20130615)

2. Prosecution and Progress.

2.1 Prosecution and Progress.

Begin work within ten calendar days after the engineer issues a written notice to do so.

Provide the start date to the engineer in writing within a month after executing the contract but at least 14 calendar days before the preconstruction conference. Upon approval, the engineer will issue the notice to proceed within ten calendar days before the approved start date.

To revise the start date, submit a written request to the engineer at least two weeks before the intended start date. The engineer will approve or deny that request based on the conditions cited in the request and its effect on the City's scheduled resources.

Indicate on the proposed schedule of operations that a large force and adequate equipment will be needed to assure that the work will be completed within the established contract time.

Be advised that there may be multiple mobilizations and/or remobilizations to complete construction operations, for example such items as: grading, concrete pavement repair/replacement, paving, traffic control, signing, temporary and permanent pavement marking, finishing items and other incidental items. No additional payment will be made, by the City, for additional mobilizations.

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There will be no adverse weather delay or additional compensation for cold weather construction, unless otherwise provided for in the contract.

After written notice to proceed, and prior to Final Acceptance of the work, assist with maintenance of existing roadways as specified in standard spec 104.6.1. This assistance may include performance of work covered under pay items or accommodating local repair forces within the work zones. Maintain all newly constructed work as specified in standard spec 104.6.1.

Place topsoil in all graded areas as designated by the engineer immediately after grading has been completed. Fertilize, and sod all areas within five calendar days after placement of topsoil.

Schedule of Operations
The Schedule of Operations will be developed in conjunction with the City of Milwaukee as part of the contractor's construction sequencing and maintenance of traffic plan to be submitted to the engineer for approval.

Contractor Coordination
Provide an individual to serve as the contractor's sole point of contact for field utility coordination and communication for the duration of the project.

Advance Notification
Notify the engineer if there are any changes in the schedule, early completions, or cancellations of scheduled work. Coordinate the locations of messages of portable changeable message sign with the engineer. Notify the engineer of proposed changes for alternate routes and detours and provide a revised signing plan for the review by and approval of the engineer.

Provide the engineer with a schedule of lane and ramp closures by 9:00 AM on Wednesday for the next ten calendar days. In addition, provide the following minimum advance notification to the engineer.

Service Ramp Closures	3 business days
Construction Stage Changes	14 calendar days
Detours	14 calendar days
Local Road Lane Closures	5 business days
Local Road/Intersection Full Closures	14 calendar days

Obtain prior acceptance from the engineer and the WisDOT STOC for Service Ramp Closures. Notify local emergency and police agencies seven calendar days prior to freeway ramp closure.

Notify the engineer, businesses and residents that live along the project limits three business days in advance of restricting access to their houses or business.

NOT FOR CONSTRUCTION

Ramp Closures
All entrance and exit ramps shall be posted three business days in advance of their closure with dates and time of closure.

Portable Changeable Message Signs
Obtain acceptance from the engineer regarding the wording of all messages on portable changeable message signs prior to placing the message.

Ramp Work Restrictions

Definitions
The following definitions apply to this contract for freeway work restrictions:

Service Ramps
- Freeway to/from local road ramps

Weekday Peak Hours
- 5:30 AM – 9:00 AM Monday, Tuesday, Wednesday, Thursday, and Friday
- 2:00 PM – 7:00 PM Monday, Tuesday, Wednesday, Thursday, and Friday

Weekday Midday
- 9:00 AM – 2:00 PM Monday, Tuesday, Wednesday, Thursday, and Friday

Weekend Peak Hours
- 10:00 AM – 7:00 PM Saturday, Sunday

Weekend Off-Peak Hours
- 8:00 AM – 10:00 AM Saturday, Sunday
- 7:00 PM – 11:00 PM Saturday
- 7:00 PM – 9:30 PM Sunday

Weekday Off-Peak Hours
- 7:00 PM – 9:30 PM Monday, Tuesday, Wednesday, Thursday
- 7:00 PM – 11:00 PM Friday

Night Time Hours
- 9:30 PM – 5:30 AM (Sunday PM to Monday AM, Monday PM to Tuesday AM, Tuesday PM to Wednesday AM, Wednesday PM to Thursday AM, Thursday PM to Friday AM)
- 11:00 PM – 8:00 AM (Friday PM to Saturday AM, Saturday PM to Sunday AM)

NOT FOR CONSTRUCTION

Close service ramps only during Night Time Hours, unless otherwise specified in the plan, or unless otherwise approved by the engineer for safety or operational reasons associated with other adjacent lane or freeway closures

Follow plan details for closures. If plan details are not provided in the traffic control plan, furnish plans for review by the engineer. Once approved, allow at least three business days prior to the closure of roadway, lane, and ramp as identified in Contractor Coordination.

Closure Restrictions

Service Ramp Closure Restrictions
Contractor shall coordinate any necessary service ramp closures with the Wisconsin Department of Transportation.

Work Zone Ingress/Egress.
All locations of work zone egress or ingress for construction vehicles are subject to approval from the engineer. Submit to the engineer locations for access into and out of the work zone for each stage.

Access for emergency responders shall be maintained at all times and not restricted by vehicles, equipment or the storage of equipment, vehicles or materials.

Exiting work zones are only allowed when operations do not obstruct or slow traffic. All construction vehicles shall yield to all through traffic at all locations.

Local Street Closure Restrictions

Definitions

The following definitions apply to this contract for local street closure restrictions:

Peak Hours
- 6:00 AM – 9:00 AM Monday, Tuesday, Wednesday, Thursday, Friday
- 3:00 PM – 7:00 PM Monday, Tuesday, Wednesday, Thursday
- 3:00 PM – 9:00 PM Friday
- 11:00 AM – 8:00 PM Saturday
- 1:00 PM – 5:00 PM Sunday

Off-Peak Hours
- 9:00 AM – 3:00 PM Monday, Tuesday, Wednesday, Thursday, Friday
- 7:00 PM – 6:00 AM Monday, Tuesday, Wednesday, Thursday
- 9:00 PM – 11:00 AM Friday PM to Saturday AM

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- 8:00 PM – 1:00 PM Saturday PM to Sunday PM
- 5:00 PM – 6:00 AM Sunday PM to Monday AM

Closure Restrictions

Closure restrictions will be developed in conjunction with the City of Milwaukee as part of the contractor's construction sequencing and maintenance of traffic plan to be submitted to the engineer for approval.

General
Provide Milwaukee County Transit System - Coordinator of Street Supervision, Melanie MacArthur, (414) 343-1764, with a schedule of any closures that affect any MCTS route and/or stop 14 calendar days prior to closure. Also coordinate the location of each Temporary Bus Stop Pad with Melanie MacArthur, 14 calendar days prior to installation.

Existing trees, street light poles, hydrants and other utility poles are to remain in place during construction unless otherwise noted in the plan.

All Work Restrictions
Excavation material and cleared and grubbed material should be stockpiled on upland areas an adequate distance away from storm sewer inlets, floodplains, and the waterways as determined by engineer.

Provide the City of Milwaukee Police Department with a 24-hour emergency contact number for when maintenance is required.
Interim and Final Completion of Work
Supplement standard spec 108.10 with the following:

The City will not grant time extensions for the following:
- Severe weather as specified in standard spec 108.10.2.2.
- Labor disputes that are not industry wide.
- Delays in material deliveries.

Each day is defined as a 24 hour period beginning at 12:01 AM.

Interim Completion of Work
Dates and locations for interim and final completion of work milestones will be developed in conjunction with the City of Milwaukee as part of the contractor's construction sequencing and maintenance of traffic plan to be submitted to the engineer for approval.

Winter Maintenance
The City of Milwaukee will perform snow removal operations for local streets that are open to traffic. Provide for snow removal in those areas closed to traffic as required to facilitate safe construction operations and stage changes and as required to eliminate snow

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melt run-off from crossing active roadways. Provide City of Milwaukee with a 24-hour emergency contact number for when maintenance is required.

3. Environmental.

3.1 Notice to Contractor – Environmental Mitigation Commitments.

The mitigation measures and other features of the project that reduce adverse impacts, to which Federal Transit Administration (FTA) and the City of Milwaukee committed in the Environmental Assessment (EA) and Finding of No Significant Impact (FONSI) are summarized below:

1. Historic and Archaeological Resources
If archaeological remains are discovered during construction, all work in the vicinity of the find will stop immediately and the area protected. The State Historic Preservation Office (SHPO), Burial Sites Preservation Office (BSPO), the Federal Transit Administration, and the City of Milwaukee will be notified immediately in accordance with Wisconsin Statute 157.70. This will entail evaluating the find to determine if it is significant and whether mitigation through avoidance or recovery is necessary. Work may proceed only after authorization from the BSPO. Although it is not anticipated that the construction activities for the project will have any adverse affects on any historic properties, all construction activities will be required to comply with the City of Milwaukee's Code of Ordinances, Chapter 80, Subchapter 2, Noise Control 80-73.2, Excessive Vibration Prohibited, Temporary and Mobile Services. The vibration limits established by this ordinance are equivalent to the Construction Vibration Criteria in the FTA Guidance Manual.

2. Noise and Vibration
Construction noise will be controlled as recommended in Section 5.2.5 of the Environmental Assessment. Construction activities will comply with the City of Milwaukee's Code of Ordinances, Chapter 80, Subchapter 2, Noise Control 80-60.

3. Construction Impacts
Construction and staging areas will be maintained as required by the City under Chapter 115 and any other applicable regulations of the City's ordinances. The contractor will be required to restore the staging area to its original condition once the project is completed. All standard City requirements regarding construction site control will be followed.

3.2 Dust Control Implementation Plan.

A Description
Develop, update, and implement a detailed Dust Control Implementation Plan (DCIP) for all land-disturbing construction activities and associated impacts both within the project site boundaries and outside the project site boundaries. Incorporate contract bid items that this article specifies into the DCIP.

B (Vacant)

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C Construction

C.1 General

Take responsibility for dust control on the project as specified in standard spec 107.18. Minimize dust emissions resulting from land disturbing activities. Do not generate excessive air borne particulate matter (PM) or nuisance dust conditions. Take direct responsibility for controlling dust at all times throughout the duration of the contract, 24 hours per day, 7 days per week, including non-working hours, weekends, and holidays.

Submit a DCIP to the engineer for review at least 14 calendar days before the preconstruction conference. Coordinate with the City, if requested, to resolve DCIP related issues before the preconstruction conference. The City will either approve the DCIP or request revisions. Do not initiate any land-disturbing activities without the City's approval of the DCIP.

C.2 Dust Control Implementation Plan Contents

Develop a DCIP tailored to the specific needs of the project. Consider potential impacts to businesses and residences adjacent to the job site. Describe in detail all land disturbing, dust generating activities. Identify strategies to prevent, mitigate, and collect excess dust. Establish clear lines of communication with the engineer to ensure that all dust control issues can be dealt with promptly.

The DCIP shall include, but not be limited to, all of the following:

1. A single contact person with overall responsibility for the DCIP development as well as surveillance and remediation of job related dust. Include the following:
    - Name, firm, address, and working-hours phone number.
    - Non-working-hours phone number.
    - Email address.
2. Individual contact persons and their respective areas of responsibility. Include the following:
    - Name, firm, address, and working-hours phone number.
    - Non-working-hours phone number.
    - Email address.
3. A site map locating project features, the job site boundaries, all ingress and egress points, air intakes and other dust-sensitive areas, and all public and private paved surfaces within and immediately adjacent to the job site. Show where specific land disturbing, dust generating activities will occur and, to the extent possible, where employing various dust control or prevention strategies.

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4. A matrix showing, for each anticipated land disturbing, dust generating activity, the following:
    - Preventive measures that shall be employed.
    - The applicable contact person.
    - The contractor's timetable and surveillance measures used to determine when remediation is required.
    - The specific dust control and remediation measures that shall be employed. List the specific contract bid items that shall be used for payment. Also indicate costs that are incidental to the contract.
    - Both maintenance and cleanup schedules and procedures.
    - How excess and waste materials shall be disposed of.
5. A description of how off-site impacts shall be monitored and dealt with.

C.3 Updating the Dust Control Implementation Plan

Update the DCIP throughout the term of the contract as the engineer directs. Obtain the engineer's approval for all DCIP alterations. Also obtain the engineer's approval for DCIP routine adjustments for weather, job conditions, or emergencies that will have an impact on payment under the bid items listed in the approved DCIP.

C.4 Dust Control Deficiencies

Correct engineer identified dust control deficiencies within the time the engineer specifies. The engineer will allow from 30 minutes to 24 hours from the time the engineer notifies the contractor in writing of the deficiency. Deficiencies include, but are not limited to, actions or lack of actions resulting in excessive dust, failing to comply with the contractor's dust control implementation plan or associated special provisions, and failing to properly maintain equipment.

D Measurement

The City will measure the various bid items associated with dust control as specified in the applicable measurement subsections of either the standard specifications or other contract special provisions. The City will not measure work performed under a DCIP alteration unless the engineer specifically approves that alteration.

Measurement under the DCIP shall include, but is not limited to, the contract bid items listed below:

624.0100	Water
SPV.0075.3505	Pavement Cleanup

The City will measure work completed under other existing contract bid items if approved as a part of the DCIP. The City will consider new bid items to the contract if proposed under the DCIP. The City will not measure work required under the DCIP that is not included in contract bid items.

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E Payment
All costs associated with the development and updating of the DCIP are incidental to the contract. The City will pay separately for the work required to implement the actions approved in the DCIP under the contract bid items approved as a part of the DCIP. All other costs associated with work approved under the DCIP are incidental to the contract.

3.3 Northern Long-eared Bat.

Northern Long-eared Bats (NLEB) have potential to inhabit the project limits.

There shall be no Clearing for this contract from April 1 to September 30 both dates inclusive, in order to avoid adverse impacts upon the NLEBs.

Notify Project Leader 14 days in advance of any work on box culverts or bridges to allow time for City to complete the Bats Presence Structure Inspection Form.

Submit a schedule and description of Clearing and Grubbing operations to the City 14 days prior to any Clearing and Grubbing operations. The City will determine, based on schedule and scope of work, what erosion control shall be implemented prior to the start of Clearing and Grubbing operations.

If the required clearing and removal is not completed by the end of the inactive period of the NLEB (March 31), the City will suspend all clearing and associated work directly impacted by clearing. The City will issue a notice to proceed with clearing and associated work directly impacted by clearing after consulting with the United States Fish and Wildlife Service (USFWS). The City will assess the contractor $5,000 in interim liquidated damages for each calendar day that clearing and removal remains incomplete beyond 12:01 AM, March 31. An entire calendar day will be charged for any period of time within a calendar day that the clearing and removal remains incomplete beyond 12:01 AM.

3.4 Management of Solid Waste, Item SPV.0195.9000.

A General
A.1 Description
This work will conform with the requirements of Section 205 of the Standard Specifications; to pertinent parts of the Wisconsin Administrative Code, Chapters NR 700-754 Environmental Investigation and Remediation of Environmental Contamination; Wisconsin Administration Code, Chapters NR 500-555, Solid Waste; and as shown on the plans and as supplemented herein.

Solid waste may be encountered within the construction limits. The potential solid waste may contain NR 500 non-exempt industrial wastes including soil mixed with foundry sand and slag. Potential impacted waste material excavated during construction which cannot in the opinion of the environmental consultant be managed as common excavation and will be managed as potential petroleum contaminated soil or solid waste (historic fill).

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This work consists of excavating, segregating, temporary stockpiling, testing, loading, hauling, and disposing of potential petroleum contaminated soil or solid waste material at a WDNR-approved disposal facility. The nearest WDNR-approved disposal facilities are:

Advanced Disposal Emerald Park Landfill, LLC
W124 S10629 S. 124th St.
Muskego, WI 53150
Phone # 414/529-1360

Waste Management Metro Landfill
10712 S. 124th St.
Franklin, WI 53132
Phone # 414/529-6180

Waste Management Orchard Ridge Landfill
N96W13503 County Line Road
Menomonee Falls, WI 53051
Phone # 262/253-8620

Provide information to the owner's environmental consultant and engineer at the preconstruction meeting that indicates the WDNR-approved disposal facility that the contractor will use.

A.2 Notice to the Contractor – Solid Waste Locations

The owner's environmental consultant completed hazardous materials assessment for locations within this project area where excavation is required. Investigation for soil contamination was conducted at elect locations. Results indicate that known petroleum contaminated soil and solid waste (historic fill) is present at the project corridor and material excavated (solid waste) at the 841 N. Broadway location (from the curb of N. Market St. to the traction power substation/retaining wall area) will be taken to the WDNR-approved disposal facility mentioned in A.1. The known petroleum contaminated soil and solid waste is impacted with polynuclear aromatic hydrocarbons (PAHs).

Directly load solid waste excavated by the project at the above locations into trucks that will transport the material to the WDNR-approved disposal facility mentioned in A.1.

A.3 Notice to the Contractor – Potentially Contaminated or Contaminated Locations Beyond the Construction Limits

Hazardous materials assessments revealed that there could potentially be 37 hazardous material sites beyond the construction limits along the route where various contaminants of concern may be encountered. A table of these sites and potential hazmat concerns are noted below:

Site No.	Site Name/Address/Direction	Potential Hazardous Material Concerns/Stationing

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Site No.	Site Name/Address/Direction	Potential Hazardous Material Concerns/Stationing
1	Former Gasoline Station 301 W. Clybourn Street	Historic Auto Station 100EBB+00 to 100EBB+25
2	Former Brass Foundry / Machine Shop (OMF Site) 433 W. Clybourn Street	Historic Brass Foundry / Machine Shop 100EBB+00 to 100EBB+25
3	Former Gasoline Station 404 W. St. Paul Avenue	Historic Auto Station 100EBB+25 to 102EBB+75
4	Former Soap Company 340, 350, 360 W. St. Paul Avenue	Historic Soap Company 100EBB+25 to 104EBB+50
5	Former Blacksmith 401 N. 3rd Street	Historic Blacksmith 104EBB+50 to 106EBB+50
6	US Post Office 341 - 345 W. St. Paul Avenue	LUST (closed), UST, SHWIMS 102EBB+75 to 110EBB+00
7	Pritzlaff Building 315 - 333 N. Plankinton Avenue	BRRTS, LUST (open), SHWIMS 110EBB+75 to 115EB+25
8	Minellis Brake Service Downtown 350 N. Plankinton Avenue	LUST (closed), UST, AST, SHWIMS, SPILLS (closed), Historic Auto Station 115EBB+75 to 117EBB+50
9	Former Machine Shop / Fur Processing / Gasoline Station 500 N. Broadway Street	Historic Machine Shop / Fur Processing / Auto Station / Auto Repair 230WBB+00 to 234WBB+25
10	Bank One Property 503 N. Broadway Street	ERP (closed) 230WBB+25 to 231WBB+00
11	Former Auto Repair 769 N. Broadway Street	Historic Auto Repair 245WBB+00 to 246WBB+25
12	City of Milwaukee Engine House #1 784 N. Broadway Street	LUST (closed), UST, SHWIMS 246WBB+00 to 246+75
13	City of Milwaukee 809 N. Broadway Street	BRRTS, SHWIMS, Historic Machine Shop 248WBB+00 to 249WBB+75
14	Former New Mikes Bar 500 N. Milwaukee Street	LUST (closed), UST, SHWIMS 133EBB+75 to 135EBB+25
15	Former South Milwaukee Automotive Service 322 E. Clybourn Street	Historic Auto Repair 133EBB+75 to 135EBB+00

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Site No.	Site Name/Address/Direction	Potential Hazardous Material Concerns/Stationing
16	Former Wadham's Oil Company 535 N. Milwaukee Street	Historic Auto Station 135EBB+25 to 137EBB+75
17	Marriot Hotel 625 - 633 N. Milwaukee Street 319 - 327 E. Wisconsin Avenue	ERP (closed) 138EBB+25 to 141EBB+00
18	Former Fur Company 329 - 331 E. Wisconsin Avenue	Historic Fur Company / Dry Cleaner 140EBB+50 to 141EBB+00
19	Wells Building 324 E. Wisconsin Avenue	UST, SPILLS (closed), SHWIMS 142EBB+75 to 144EBB+00
20	Former Alpine Dry Cleaners 717 N. Milwaukee Street	Historic Cleaners 144EBB+00 to 144EBB+50
21	Colby Abbot Building 767 N. Milwaukee Street	LUST (closed), UST, SHWIMS 148EBB+00 to 148EBB+50
22	London Cleaners 776 - 778 N. Milwaukee Street	SHWIMS, Historic Cleaners 148EBB+50 to 149EBB+50
23	Park Bank 330 E. Wells Street	AST, Historic Auto Station, Historic Cleaners 151EBB+7500 to 153EBB+50
24	Yankee Hill Apartments 626 E. Kilbourn Avenue	Historic Cleaners, Historic Auto Repair 162EBB+50 to 166EBB+00
25	Juneau Village Apts 1029 N. Jackson Street	ERP (closed), UST 262WBB+ 50 to 273WBB+00
26	Juneau Village Cleaners 1112 N. Jackson Street	Historic Cleaners 168EBB+50 to 171EBB+75
27	Former Auto Repair 1219 & 1229 N. Jackson Street	Historic Auto Repair 273WBB+50 to 277WBB+50
28	Former Gasoline Station 1319- 1339 N. Jackson Street	UST, Historic Auto Station, Historic Auto Repair 278WBB+00 to 282+00
29	Former Ice Cream Factory 601 E. Ogden Avenue	UST, Historic Ice Cream Factory 178EBB+00 to 183EBB+50
30	East Pointe Commons 716 E. Ogden Avenue	UST, SPILLS (closed), Historic Auto Station 185WBB+75 to 288WBB+75

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Site No.	Site Name/Address/Direction	Potential Hazardous Material Concerns/Stationing
31	St. Joan Antida High School 1329 N. Cass Street	LUST (closed), UST, SHWIMS, Historic Auto Repair 185EBB+50 to 188EBB+50
32	Thomas Cleaning & Shoe Repair 802 - 830 E. Ogden Avenue	Historic Cleaners 289WBB+00 to 292WBB+00
33	A Launderette Service 916 E. Ogden Avenue	Historic Cleaners 292WBB+25 to 295WBB+50
34	Paragon Health Network Property 1051 E. Ogden Avenue	LUST (closed) 299WBB+50 to 302WBB+75
35	Mandel Apartments 1122 E. Ogden Avenue	LUST (closed), UST, Historic Cleaners 199EBB+25 to 200EBB+75
36	Historic Auto Repair / Cleaners 1333 N. Franklin Place	Historic Cleaners, Historic Auto Repair 200EBB+75 to 201EBB+25
37	Amoco Oil Company 1425 N. Farwell Avenue	LUST (closed), UST, SHWIMS, Historic Auto Station 302WBB+75 to 303WBB+25

Notes:
AST = Aboveground Storage Tank; BRRTS = Bureau of Remediation and Redevelopment Tracking System; ERP = Environmental Repair Program; UST = Underground Storage Tank; LUST = Leaking UST; SHWIMS = Solid and Hazardous Waste Information Management System.

Contaminated soil at the above locations is expected to be beyond the excavation limits necessary to complete the work under this project. Control construction operations at these locations to ensure that they do not extend beyond the excavation limits indicated in the plans.

If obviously contaminated soils or other signs of NR 500 non-exempt solid waste and hazardous materials are unexpectedly encountered elsewhere on the project, terminate excavation activities in the area and notify the owner's environmental consultant and engineer. Examples of these unexpected conditions may include, but are not limited to, buried containers or tanks, noxious odors and fumes, stained soils, sheens on groundwater, other industrial wastes, significant volumes of municipal or domestic garbage, and materials that may contain asbestos containing materials.

No active groundwater monitoring wells were observed within the construction limits. If active groundwater monitoring wells are encountered during construction, notify engineer and protect them to maintain their integrity. The owner's environmental consultant will determine if monitoring wells need to be maintained. For monitoring wells that do need to be maintained, adjust the wells that do not conflict with structures or curb and gutter to

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be flush with the final grade. For monitoring wells that conflict with the previously mentioned items or if monitoring wells are not required to be maintained, they will be abandoned by the Contractor and are incidental to the cost.

If dewatering is required at the above locations, conduct the dewatering in accordance with Section C below.

A.4 Excavation Management Plan Approval

The soils management plan, including these special provisions, has been developed in cooperation with the Wisconsin Department of Natural Resources (WDNR). The WDNR concurrence letter is on file at the City of Milwaukee. For further information regarding previous environmental due diligence activities in the project corridor contact:

Engineer: HNTB Corporation
Name: Daniel K. Pelczar, CPG, P.G.
Address: 11414 W. Parke Place, Suite 300, Milwaukee, WI 53224
Phone: 414-359-2300
Fax: 414-359-2310
e-mail: dpelzcar@hntb.com

The contractor will provide an "Environmental Professional(s)" during earthwork activities to handout landfill disposal tickets for each truckload classified as solid waste. The environmental professional will meet the requirements of 40 CFR Part 312 and ASTM E 1527-13. The environmental professional will document site conditions and collect soil samples for field screening and/or laboratory analysis as needed for the solid waste landfill disposal facility. The contractor shall assist the environmental professional by using their excavation equipment to collect samples. Soil samples shall be collected by the contractors from the bucket of the excavation equipment. The soil sample frequency shall be determined by the contractor's environmental professional and the needs of the selected landfill facility. The contractor's environmental professional shall complete the waste profiling on behalf of the contractors selected solid waste landfill disposal facility and document all landfilling activities.

The contractor shall supply the schedule of operations in the contaminated areas to the Engineer at the preconstruction conference. The contractor shall provide the engineer and owner's environmental professional with a written notice at least 7 calendar days prior to the scheduled date of beginning work in the contaminated areas. The contractor shall inform the owner's environmental professional of the contractor selected landfill a minimum of 14 days prior to start of work in contaminated areas.

The potentially contaminated soils at the above sites (see table above) are expected to be beyond the excavation limits necessary to complete the work under this project. The contractor shall control construction operations at these locations to ensure that they do not extend beyond the excavation limits indicated in the plans. If suspect contaminated soils are encountered during excavation of the track areas within the City of Milwaukee

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rights of way (i.e., route), the contractor shall notify engineer and owner's environmental professional immediately of suspect contaminated soil areas.

The contractor shall provide an area acceptable by the owner and approved by engineer for the temporary stockpiling of up to 2,500 cubic yards of suspect contaminated soil that requires characterization (i.e., sites along the route) for waste disposal purposes. Temporary on-site storage of excavated solid wastes shall be conducted in accordance with Wis. Adm. Code ch. NR 718.05 requirements. The contractor shall place a cover under and over temporary stockpile to prevent water infiltration and leaching. Stockpiled material will be examined and sampled by the contractor's environmental professional. All further analytical and characterization cost to be paid for by the contractor is incidental to the work and shall be included in the unit rate. Any stockpiled material confirmed to be regulated solid waste will be managed and disposed of by the contractor. The contractors cost to provide temporary stockpiling and stockpiling management is incidental and shall be included in the unit rate. The contractors environmental professionals cost to provide environmental consulting services to contractor are incidental and shall be included in the unit rate. If the contractors environmental professional's examination should determine the stockpiled materials are exempt solid waste per Wis. Adm. Code NR 500.08(2)(a), then the materials will be managed as common excavation.

A.5 Coordination

Coordinate work under this contract with the owner's environment consultant (engineer):

Consultant: HNTB Corporation
Address: 11414 W. Parke Place, Suite 300, Milwaukee, WI 53224
Contact: Daniel K. Pelczar, CPG, P.G.
Phone: 414-359-2300
Fax: 414-359-2310
E-mail: dpelzcar@hntb.com

The role of the owner's environmental consultant will be limited to overviewing the contractor's environmental consultant.

The role of the contractor's environmental consultant will consist to advising the contractor and documenting that activities associated with management of solid waste are in conformance with the solid waste management plans for this project as specified herein. The contractor's environmental consultant will be on-call if obviously contaminated soils or other signs of NR 500 non-exempt solid waste and hazardous materials are unexpectedly encountered during the project.

Provide at least a 14-calendar day notice of the preconstruction conference date to the owner's environmental consultant. At the preconstruction conference, provide a schedule for all excavation activities in the area of potentially petroleum contaminated soil or solid waste (historic fill) described in A.2 to the owner's environmental consultant along with an example of the load ticket described in Section D.

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Coordinate with the owner's environmental consultant to ensure that the contractor's environmental consultant is on-call during excavation work. Notify the owner's environmental consultant at least three calendar days prior to commencement of excavation. Perform excavation work on a continuous basis until excavation work is completed. Do not transport soil containing petroleum contaminated soil and/or solid waste offsite without prior approval from the owner's environmental consultant.

A.6 Health and Safety Requirements

Supplement standard spec 107.1 with the following:

During excavation activities, expect to encounter petroleum contaminated soil and/or historic fill contaminated with industrial wastes (foundry sand and slag) and associated regulated metals and organic compounds. Site workers taking part in activities that will result in the reasonable probability of exposure to safety and health hazards associated with hazardous materials shall have completed health and safety training that meets the Occupational Safety and Health Administration (OSHA) requirements for Hazardous Waste Operations and Emergency Response (HAZWOPER), as provided in 29 CFR 1910.120.

Prepare a site-specific Health and Safety Plan, and develop, delineate and enforce the health and safety exclusion zones for the project site area as required by 29 CFR 1910.120. Submit the site-specific health and safety plan and written documentation of up-to-date OSHA training to the engineer prior to the start of work.

B Materials (Vacant)

C Construction

Subsection 205.3 of the Standard Specification is supplemented with the following:

The contractor's environmental consultant will periodically monitor soil excavated from the area identified in A.2 above. The contractor's environmental consultant will evaluate excavated soil based on field screening results, visual observations, and soil analytical results from previous environmental investigations. Assist the contractor's environmental consultant in collecting soil samples for evaluation using excavation equipment. The sampling frequency shall be of an on-call nature.

Directly load and haul petroleum contaminated soil and/or solid waste for offsite disposal to the contractor's selected WDNR disposal facility. Use loading and hauling practices that are appropriate to prevent any spills or releases of the material. Prior to transport, sufficiently dewater soils designated for off-site disposal so as not to contain free liquids. Verify that the vehicles used to transport material are licensed for such activity in accordance with applicable state and federal regulations. Do not transport regulated petroleum contaminated soil and/or solid waste off-site without obtaining the approval of the owner's environmental consultant and engineer.

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During excavations in the areas of potential petroleum contaminated soil and/or solid waste (historic fill), larger chunks of clean concrete (~2 cubic feet), asphalt and bricks will be segregated from the fill, to the extent practical and managed as common excavation. Under NR 500.08 this material is exempt from licensing and requirements of Wisconsin Administrative Code NR 500-555 of the solid waste regulations and it will be disposed of off-site at the contractor's common excavation disposal site(s).

If dewatering is required such water may, with approval of the Milwaukee Metropolitan Sewerage District (MMSD), be discharged to the sanitary sewer as follows:

1. Meet all applicable requirements of the MMSD including the control of suspended solids. Perform all necessary monitoring to document compliance with MMSD's requirements. Furnish, install, operate, maintain, disassemble, and remove treatment equipment necessary to comply with MMSD's requirements.

2. Ensure continuous dewatering and excavation safety at all times. Provide, operate, and maintain adequate pumping equipment and drainage and disposal facilities. Notify the owner's environmental consultant and engineer of any dewatering activities, and obtain any permits necessary to discharge water. Provide copies of such permits to the owner's environmental consultant and engineer. Meet any requirements and pay any costs for obtaining and complying with such permit use. Follow all applicable legislative statutes, judiciary decisions, and regulations of the State of Wisconsin.

Costs associated with excavation dewatering and disposal, if necessary, are considered incidental to this pay item. The owner will be the generator of regulated liquid waste from this construction project.

D Measurement
The landfill facility will measure known contaminated soil and/or solid waste by the ton of waste accepted by the WDNR-approved disposal facility and as documented by a weight tickets.

E Payment
The owner will pay for measured quantities at the contract unit price under the following item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0195.9000	Management of Solid Waste	Ton

Payment is full compensation for excavating, segregating, loading, and hauling; obtaining solid waste collection and transportation service operating licenses; assisting in the collection of soil samples for field evaluation; dewatering of soils prior to transport, if necessary; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

4. Traffic and Restrictions to Work.

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4.1 Traffic.

General
Keep all local streets open to through traffic at all times for the duration of this project except short term closures as shown in the plan.

No operation shall proceed until all traffic control devices for such work are in the proper location. Traffic Control is subject to change at the direction of the engineer in the event of an emergency.

Provide the Milwaukee County Sheriff's Department, City of Milwaukee Police Department, and the engineer a current telephone number with which the contractor or his representative can be contacted during non-working hours in the event a traffic control safety hazard develops.

Do not disturb, remove or obliterate any traffic control signs, advisory signs, shoulder delineators, sand barrel array or beam guard in place along the traveled roadways not shown on the plans without the approval of the engineer.

Complete pavement marking and signing work prior to switching to another phase.
Contractor shall coordinate and maintain access to fire station located at the southeast corner of N. Broadway and E. Wells St.

Contractor shall coordinate with local emergency personnel as to traffic control changes and short term roadway closures.

Residential and Business Property Access
Maintain access to properties along N. 4th St., W. St. Paul Ave., E. St. Paul Ave., N. Broadway, N. Milwaukee St., E. Kilbourn Ave., N. Jackson St., E. Ogden Ave., and any other local road affected by construction for local residents, businesses, and emergency vehicles.

Maintain and keep open the access to all driveways and parking lots where alternative access is not available at all times by closing one driveway at a time, building half the driveway at a time and/or plating concrete work. Plating of concrete work, as directed by the engineer, is included in the item that is being plated. In parking lots that are being reconstructed, stage operations so that parking and access is maintained on existing or proposed base aggregate or pavement.

Pedestrian Access
Maintain sidewalk at all times except as shown in the plan or as directed by the engineer. Provide a temporary surface for pedestrian access at all times in areas of sidewalk construction. Construct the temporary surface to meet Americans with Disabilities Act Accessibility Guidelines (ADAAG) requirements consisting of temporary asphaltic surface, any grade of concrete, skit resistant steel plating, or alternative material as

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approved by the engineer. Gravel or base course material is not acceptable. Maintain sidewalk access to all businesses and residences at all times.

Maintain existing pedestrian movements crossing the construction Zone at all intersections at all times, unless otherwise directed by the engineer. Construct pedestrian crossings of intersections to meet the requirements of the ADAAG consisting of temporary asphaltic surface, any grade of concrete, skid resistant steel plating, or alternative material as approved by the engineer. Gravel or base course material is not acceptable. At all times, ADAAG accessible pedestrian walkways shall be maintained free from mud, sand, and construction debris. Closures of sidewalk must be approved by the engineer. At locations where crosswalks crossing W. St. Paul Ave., E. St. Paul Ave., N. Broadway, N. Milwaukee St., E. Kilbourn Ave., N. Jackson St., and E. Ogden Ave., exist on both sides of the intersection, closure of one of the two crosswalks is permitted as long as all other crossings are completely open.

Sequence of Operations
Traffic shifts shown in a given phase of each zone may occur at different times during that phase depending on the controlling elements for a given traffic movement as approved by the engineer. The City anticipates that the sequencing of major traffic shifts and roadway openings and closings for each stage shall be as shown in the plan, unless approved by the engineer.

4.2 Holiday and Special Event Work Restrictions.

Holiday Restrictions
Do not perform work on, nor haul materials of any kind along or across any portion of the local streets, and entirely clear the traveled way of such portions of the local streets of equipment, barricades, signs, lights, and any other material that might impede the free flow of traffic during the following holiday periods:

- From noon Friday, May 27, 2016 to 6:00 AM Tuesday, May 31, 2016 for Memorial Day;
- From noon Friday, July 1, 2016 to 6:00 AM Tuesday, July 5, 2016 for Independence Day;
- From noon Friday, September 2, 2016 to 6:00 AM Tuesday, September 6, 2016 for Labor Day;
- From noon Wednesday, November 23, 2016 to 6:00 AM Monday, November 28, 2016 for Thanksgiving;
- From noon Friday, December 23, 2016 to 6:00 AM Tuesday, December 27, 2016 for Christmas;
- From noon Saturday, December 31, 2016 to 6:00 AM Monday, January 2, 2017 for New Years';
- From noon Friday, May 26, 2017 to 6:00 AM Tuesday, May 30, 2017 for Memorial Day;

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- From noon Monday, July 3, 2017 to 6:00 AM Wednesday, July 5, 2017 for Independence Day;
- From noon Friday, September 1, 2017 to 6:00 AM Tuesday, September 5, 2017 for Labor Day;
- From noon Wednesday, November 22, 2017 to 6:00 AM Monday, November 27, 2017 for Thanksgiving;
- From noon Friday, December 22, 2017 to 6:00 AM Tuesday, December 26, 2017 for Christmas.
- From noon Friday, December 29, 2017 to 6:00 AM Tuesday, January 2, 2018 for New Years;
- From noon Friday, May 25, 2018 to 6:00 AM Tuesday, May 29, 2018 for Memorial Day
- From noon Tuesday, July 3, 2018 to 6:00 AM Thursday, July 5, 2018 for Independence Day.

Provide any proposals to work within the work zone(s) carrying traffic during the established holiday periods to the engineer for approval. Proposals will include a plan that establishes work type, hours of operations, and will certify no ingress/egress to the site by construction or worker vehicles consistent with the above restrictions for equipment, barricades, signs, lights, and any other material that might impede the free flow of traffic as noted above.

Holiday work restrictions do not apply to roadways or ramps already closed long term during construction as shown on the plans. New long term closures of ramps and roadways must be coordinated with the holiday work restrictions.

Special event work restrictions do not apply to roadways or ramps already closed long term during construction as shown on the plans. New long term closures of ramps and roadways must be coordinated with the special event work restrictions.

Freeway Special Event Restrictions

During Summerfest, scheduled for June 29 through July 10, 2016, June 28-July 9, 2017 and June 27-July 8, 2018, keep open the following roadways until one hour after the event closes each night:

- Service ramps at the IH-794 service interchanges.

Local Road Special Event Restrictions

Local road special event restrictions will be developed in conjunction with the City of Milwaukee as part of the contractor's construction sequencing and maintenance of traffic

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plan to be submitted to the engineer for approval. These special events may include but are not restricted to:

- Summerfest, scheduled for June 29 through July 10, 2016, June 28-July 9, 2017 and June 27-July 8, 2018.
- Bastille Days
- Jazz-in-the-Park

4.3 MOT Project, Item SPV.0105.6500.

A Description

This special provision describes furnishing all labor, material, and tools required for the satisfactory completion of the MOT Project in accordance with the drawings and as set forth in these specifications.

Included are the following:

1. Cover Plates Temporary
2. Traffic Control Surveillance and Maintenance
3. Traffic Control Drums
4. Traffic Control Barricades Type II
5. Traffic Control Barricades Type III
6. Traffic Control Flexible Tubular Marker Posts
7. Traffic Control Flexible Tubular Marker Bases
8. Traffic Control Warning Lights Type A
9. Traffic Control Warning Lights Type C
10. Traffic Control Signs
11. Temporary Pedestrian Surface Asphalt
12. Temporary Pedestrian Safety Fence
13. Temporary Pavement Marking Reflective Paint 4-Inch
14. Temporary Pavement Marking Removable Tape 4-Inch

The work under this item shall be in accordance to the requirements of standard spec 643, and as shown on the plans, or as approved by the engineer, except as hereinafter set forth.

Supplement standard spec 643.3.1 with the following:

Have available at all times sufficient experienced personnel to promptly install, remove and reinstall the required traffic control devices to route traffic in order to perform the operations.

Do not permit equipment or vehicles to directly cross the live traffic lanes of the roadway.

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Yield to all through traffic at all locations. Equip all contractor's vehicles or equipment operating in the live traffic lanes with a hazard identification beam (flashing yellow signal light). Operate the flashing yellow beam only when merging or exiting live traffic lanes or when parked.

Obtain prior approval from the engineer for the locations of egress or ingress for construction vehicles to prosecute the work.

Replace standard spec 643.3.1(6) with the following:

Provide 24-hour a day availability of equipment, forces and materials to promptly restore barricades, lights, or other traffic control devices that are damaged or disturbed. Restore any barricade, light, or other traffic control so that the device is not out of service for more than two hours.

B Materials

Furnish materials that are in accordance with the plans and to the following sections of the standard specifications:

Traffic Control Surveillance and Maintenance……..643
Traffic Control Drums……..643
Traffic Control Barricades Type II……..643
Traffic Control Barricades Type III……643
Traffic Control Flexible Tubular Marker Posts……643
Traffic Control Flexible Tubular Marker Bases……...643
Traffic Control Warning Lights Type A……...643
Traffic Control Warning Lights Type C……...643
Traffic Control Signs……643
Temporary Pavement Marking Reflective Paint 4-Inch……...649
Temporary Pavement Marking Removable Tape 4-Inch ……649

Temporary Pavement Marking Reflective Paint 4-Inch may be used in place of Temporary Pavement Marking Removable Tape 4-Inch if conditions warrant the change and approval is obtained from the engineer.

Furnish materials that are in accordance with the plans and to the following sections of the standardized special provisions:

Cover Plates Temporary……...611
Temporary Pedestrian Surface Asphalt……644
Temporary Pedestrian Safety Fence……644

C Construction

Install and maintain traffic control materials that are in accordance with the plans and to the following sections of the standard specifications:

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Traffic Control Surveillance and Maintenance…….643
Traffic Control Drums……...……..643
Traffic Control Barricades Type II…….…...643
Traffic Control Barricades Type III…….……..643
Traffic Control Flexible Tubular Marker Posts……..……643
Traffic Control Flexible Tubular Marker Bases…….……643
Traffic Control Warning Lights Type A……..…...643
Traffic Control Warning Lights Type C……..…...643
Traffic Control Signs……...…643
Temporary Pavement Marking Reflective Paint 4-Inch……...649
Temporary Pavement Marking Removable Tape 4-Inch ……...649

Install and maintain traffic control materials that are in accordance with the plans and to the following sections of the standardized special provisions:

Cover Plates Temporary……....611
Temporary Pedestrian Surface Asphalt……644
Temporary Pedestrian Safety Fence…….644

D Measurement
The City will measure MOT Project, completed in accordance to the contract and accepted, as a single complete unit of work.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.6500	MOT Project	LS

Payment is full compensation for all materials, labor and incidentals for MOT Project, including Cover Plates Temporary, Traffic Control Surveillance and Maintenance, Traffic Control Drums, Traffic Control Barricades Type II, Traffic Control Barricades Type III, Traffic Control Flexible Tubular Marker Posts, Traffic Control Flexible Tubular Marker Bases, Traffic Control Warning Lights Type A, Traffic Control Warning Lights Type C, Traffic Control Signs, Temporary Pedestrian Surface Asphalt, Temporary Pedestrian Safety Fence, Temporary Pavement Marking Reflective Paint 4-Inch, and Temporary Pavement Marking Removable Tape 4-Inch, in accordance with the drawings and as set forth in these specifications.

Contractor to prepare and submit construction sequencing plan for approval by the engineer.

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5. Utilities.

5.1 Utilities.

This contract does not come under the provisions of Administrative Rule TRANS 220.

Additional information regarding recently relocated utility facilities may be available on permits issued to the utility companies. These permits can be viewed at the City of Milwaukee Zeidler Municipal Building, at 841 N. Broadway, Milwaukee, WI 53202. during normal working hours. Contact City of Milwaukee Utility Coordinator Tony Kotecki at (414) 286-2433 for further information.

Underground and overhead utility facilities are located within the project limits. Utility adjustments are required for this construction project as noted below and as shown in the Utility Plans. Coordinate construction activities with a call to Diggers Hotline or a direct call to the utilities that have facilities in the area as required per state statute. Use caution to ensure the integrity of underground facilities and maintain code clearances from overhead facilities at all times.

Some utility work, as described below, is dependent on prior work being performed by the contractor at a specific site. Provide the engineer and the affected utility a good faith notice of when the utility is to start work at the site. Notice shall be given 14 to 16 calendar days in advance of when the site will be available to the utility. Follow up with a confirmation notice to the engineer and the utility not less than 3 working days before the site will be ready for the utility to begin its work.

Contact utility companies listed in the plans prior to preparing bids to obtain current information on existing utility locations and the status of any new utility relocation work.

Utility companies will be performing utility work and adjustments within the limits and during the life of the project. The contractor shall cooperate and coordinate construction activities with these companies.

There may be abandoned utility facilities within the project limits. If a conflict with an abandoned utility facility is encountered, contact the appropriate utility owner/representative to coordinate construction activities and proper removal and disposal of said facility as necessary.

Utility working days shown herein are as defined in Wisconsin Administrative Code Chapter Trans 220.

Known utilities in the projects are as follows:

AT&T Corporation has existing underground communications facilities within the project limits in the following locations:

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- An underground communications line beginning west of 4th Street and running easterly along the north curb line of St Paul Avenue to the east side of 2nd Street where it turns southerly and crosses St. Paul Avenue. This line will remain in place without adjustment.

Contact Ken Nine (574-904-6336 cell) of JMC Engineers & Associates, Inc. 7 days in advance to coordinate locations and any excavation near their facilities.

AT&T Wisconsin has underground facilities located on every street throughout the project limits. These facilities will remain in place except as noted below.

AT&T Wisconsin will relocate, construct and reconstruct communication facilities in the project area at the following locations prior to construction:

- A new underground communications duct package in the vicinity of St. Paul Avenue running from 2nd Street to Plankington Avenue.
- A new underground communications duct package where it crosses perpendicular to the proposed track at various intersections and alleys throughout the project limits.
- Modifications to an existing manhole located in the intersection of Milwaukee Street and Kilbourn Avenue.

AT&T Wisconsin will also adjust manhole frames due to paving grade changes during construction. Contact Jay Bulanek (262-896-7669 office) of AT&T Wisconsin 3 days prior to any paving operations to coordinate manhole frame adjustments.

Contact Jay Bulanek (262-896-7669 office) of AT&T Wisconsin 7 days in advance to coordinate locations and any excavation near their facilities.

American Transmission Company (ATC) has underground electric transmission lines within the project limits in the following locations:

- A 138kV electric transmission line beginning north of I-794 and running southerly along the east sidewalk of 4th Street to St. Paul Avenue where it turns westerly and continues along the north sidewalk. This line will remain in place without adjustment. ATC will install a stray current monitoring station at this location.
- A 138kV electric transmission line beginning north of I-794 and running southerly along the east sidewalk of 2nd Street across St. Paul Avenue where it continues southerly along the east sidewalk. This line will remain in place without adjustment. ATC will install a stray current monitoring station at this location.

Contact Ivan Keller (262-422-0326) of American Transmission Company 7 days in advance to coordinate locations and any excavation near their facilities.

Level 3 Communications has existing communications facilities within the project limits in the following locations:

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- An underground communications line near the intersection of Milwaukee Street and Kilbourn Avenue and running half a block east. This line will remain in place without adjustment.

Contact Brahim Gaddour (414-704-1026 office/414-908-1027 cell) of Level 3 Communications 7 days in advance to coordinate locations and any excavation near their facilities.

Midwest Fiber Network has existing communications facilities within the project limits in the following locations:

- An underground communications line located in City of Milwaukee - Conduit running in Water Street crossing St. Paul Avenue. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line running in N. Broadway from Clybourn Street to north of Kilbourn Avenue. Midwest Fiber Network work plans for this area have not been finalized.
- An underground communications line running in Milwaukee Street from south of St. Paul Avenue Avenue to north of Kilbourn Avenue. Midwest Fiber Network work plans for this area have not been finalized.
- An underground communications line running in Michigan Street from west of N. Broadway to east of Milwaukee Street. Midwest Fiber Network work plans for this area have not been finalized.
- An underground communications line running in Wisconsin Avenue from west of N. Broadway to east of Milwaukee Street. Midwest Fiber Network work plans for this area have not been finalized.
- An underground communications line running in Mason Street from west of N. Broadway to east of Milwaukee Street. Midwest Fiber Network work plans for this area have not been finalized.
- An underground communications line running in Kilbourn Avenue from west of N. Broadway to east of Jackson Street. Midwest Fiber Network work plans for this area have not been finalized.

Contact Richard Trgovec (414-459-3554 office) of Midwest Fiber Network 7 days in advance to coordinate locations and any excavation near their facilities.

Milwaukee, City of - Cable has existing underground cable facilities in City of Milwaukee - Conduit throughout the project limits. Remove, adjust, reconstruct, abandon and leave in place the cable facilities as shown in the plans.

Contact Brian Pawlak (414-286-5970 office) of the City of Milwaukee - Cable 7 days in advance to coordinate locations and construction activities.

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Milwaukee, City of - Conduit has an existing underground conduit package throughout the project limits. Remove, adjust, reconstruct, abandon and leave in place the conduit facilities as shown in the plans.

Contact Karen Rogney (414-286-3243) of the City of Milwaukee – Conduit 7 days in advance to coordinate locations and any excavation near their facilities.

Milwaukee, City of - Forestry has existing facilities within the project limits within the following locations:

- Underground irrigation lines in the median of Kilbourn Avenue from N. Broadway to Jackson Street. Remove, adjust, reconstruct, abandon and leave in place the irrigation facilities as shown in the plans.

Contact the City of Milwaukee Forestry Division (414-286-2489) 7 days in advance to coordinate locations and any excavation near their facilities.

Milwaukee, City of - Lighting has existing overhead and underground street lighting facilities throughout the project limits. Remove, adjust, reconstruct, abandon and leave in place the lighting facilities as shown in the plans.

Contact Dennis Miller (414-286-5942 office/ 414-708-4251 cell), George Berdine (414-708-4245) or Thomas Hughs (414-286-3457 office/ 414-708-3175 cell) of the City of Milwaukee - Lighting 10 days in advance to coordinate removals, installation of temporary lighting and reinstallation of the street lighting system.

Milwaukee, City of – Sanitary has existing sanitary sewer facilities throughout the project limits. Remove, adjust, reconstruct, abandon and leave in place the sanitaryfacilities as shown in the plans.

Contact Josh Radomski (414-286-0557 office) of the City of Milwaukee - Sanitary 7 days in advance to coordinate locations and any excavation near their facilities.

Milwaukee, City of - Signals has existing signal facilities at various intersections throughout the project limits. Remove, adjust, reconstruct, abandon and leave in place the signal facilities as shown in the plans.

Contact Al Nichols, Traffic Operations Supervisor (414-286-3686 office/ 414-708-5148 cell) of the City of Milwaukee or Mr. Joseph Blakeman, Traffic Control Engineer (414-286-8070) of the City of Milwaukee 10 working days prior to requiring signal changes for staging at the intersections. Allow City of Milwaukee forces 5 working days to complete signal modifications.

Contact Al Nichols (414-286-5941 office/ 414-708-5148 cell) of the City of Milwaukee - Signals 7 days in advance to coordinate locations and any excavation near their facilities.

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Milwaukee, City of - Water has underground water facilities throughout the project limits. All of the underground water mains will remain in place. Water valves falling with in the paving limits will need to be adjusted as shown in the plans.

Contact Dave Goldapp (414-286-6301) of the City of Milwaukee 7 days in advance to coordinate locations and any excavation near their facilities.

MMSD has existing underground sewer facilities within the project limits in the following locations:

- An underground sewer line running in St. Paul Avenue from 3rd Street to east of Milwaukee Street. This line will remain in place without adjustment.
- An underground sewer line running in Water Street crossing St. Paul Avenue. This line will remain in place without adjustment.
- An underground sewer line running in N. Broadway from south of St. Paul Avenue to Kilbourn Avenue where it turns and goes westerly. This line will remain in place without adjustment.
- An underground sewer line running in Clyboun Street from west of N. Broadway tying into the sewer in N. Broadway. This line will remain in place without adjustment.
- An underground sewer line running in Michigan Avenue from west of N. Broadway tying into the sewer in N. Broadway. This line will remain in place without adjustment.
- An underground sewer line running in Wisconsin from west of N. Broadway tying into the sewer in N. Broadway. This line will remain in place without adjustment.
- An underground sewer line running in Mason Street from N. Broadway to Milwaukee Street. This line will remain in place without adjustment.
- An underground sewer line running in Milwaukee Street from Mason Street to north of Kilbourn Avenue. This line will remain in place without adjustment.
- An underground sewer line running in Knapp Street crossing N. Broadway. This line will remain in place without adjustment.
- An underground sewer line running in Van Buren Street from Knapp Street to north of Ogden Avenue. This line will remain in place without adjustment.

Certain MMSD structures will need to be reconstructed as part of this project at the following locations:

- Structure NS10F04 in St. Paul Avenue just east of Plankington Avenue. Reconstruct, the MMSD structure as shown in the plans.
- Structure 75032 in St. Paul Avenue just east of N. Broadway. Reconstruct, the MMSD structure as shown in the plans.

MMSD will adjust manholes in roadways throughout the project limits during construction. Contact Bob Rebitski (414-225-2214) of MMSD 5 days prior to any paving operations to coordinate manhole adjustments.

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Contact Debra Jensen (414-225-2143) of MMSD 7 days in advance to coordinate locations and any excavation near their facilities.

TCA has communication facilities within the project limits in the following location:

- An underground communications line located in We Energies - Electric conduit running in N. Broadway from south of St. Paul Avenue to Wisconsin Avenue. This We Energies - Electric line will be relocated out from under the track to a new location within N. Broadway.
- An underground communications line located in We Energies - Electric conduit running in Wisconsin Avenue running from west of N. Broadway to Milwaukee Street. This line will remain in place without adjustment.
- An underground communications line running in Mason Street crossing Milwaukee Street. TCA work plans for this area have not been finalized.
- An underground communications line running in Milwaukee Street from Wisconsin Avenue to Kilbourn Avenue. TCA work plans for this area have not been finalized.
- An underground communications line running in the alley between Milwaukee Street and Jefferson Street crossing Kilbourn Avenue. TCA work plans for this area have not been finalized.

Contact Debbie Sadler (414-459-3572 office/ 414-651-0036 cell) of Northwind Technical Services 7 days in advance to coordinate locations and any excavation near their facilities.

TDS Metrocom has existing underground communications facilities within the project limits in the following locations:

- An underground communications line located in City of Milwaukee - Conduit running in Water Street crossing St. Paul Avenue. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line located in Windstream conduit running in N. Broadway from Clybourn Street toWisconsin Avenue. Portions of this line fall within the utility review zone. TDS Metrocom work plans for this area have not been finalized.

Contact Michael Johnson (262-754-3052) of TDS Metrocom 7 days in advance to coordinate locations and any excavation near their facilities.

Time Warner Cable has existing underground communications facilities within the project limits in the following locations:

- An underground communications line located in City of Milwaukee - Conduit running in Water Street crossing St. Paul Avenue. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.

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- An underground communications line located in City of Milwaukee - Conduit running in N. Broadway from St. Paul Avenue to Kilbourn Avenue. This line will remain in place without adjustment.
- An underground communications line running in Milwaukee Street from Clybourn Street to Wisconsin Avenue and from half a block south of Mason Street to Mason Street. This line will remain in place without adjustment.
- An underground communications line located in City of Milwaukee - Conduit running in St. Paul Avenue from N. Broadway to Milwaukee Street. This line will remain in place without adjustment.
- An underground communications line located in City of Milwaukee - Conduit running in Clybourn Street from N. Broadway to Milwaukee Street. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line located in City of Milwaukee - Conduit running in Wisconsin Avenue from N. Broadway to Milwaukee Street. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line located in City of Milwaukee - Conduit running in Mason Street from N. Broadway to Milwaukee Street. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line located in City of Milwaukee - Conduit running in Wells Street from N. Broadway to Milwaukee Street. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line located in City of Milwaukee - Conduit running in Kilbourn Avenue from N. Broadway to Milwaukee Street. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line crossing Jackson Street just north of Kilbourn Avenue. Time Warner Cable work plans for this area have not been finalized.
- An underground communications line running in Juneau Avenue crossing Jackson Street. Time Warner Cable work plans for this area have not been finalized.
- An underground communications line crossing Jackson Street just north of Juneau Avenue. Time Warner Cable work plans for this area have not been finalized.
- An underground communications line running in Ogden Avenue from half a block west of Van Buren Avenue to Van Buren Avenue. This line will remain in place without adjustment.

Contact Steve Cramer (414-277-4045) of Time Warner Cable 7 days in advance to coordinate locations and any excavation near their facilities.

US Signal has existing underground communications facilities within the project limits in the following locations:

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- An underground communications line located in Winstream conduit within a We Energies – Electric ductbank running in N. Broadway from St. Paul Avenue to Wisconsin Avenue. This We Energies - Electric line will be relocated out from under the track to a new location within N. Broadway.
- An underground communications line running in N. Broadway from half a block south of Mason Street to Mason Street. This line will remain in place without adjustment.
- An underground communications line located in Winstream conduit within a We Energies – Electric ductbank running in Milwaukee Street from Mason Street to Kilbourn Avenue. This line will remain in place without adjustment.
- An underground communications line located in Winstream conduit running in Wisconsin Avenue from N. Broadway to Milwaukee Street. US Signal work plans for this area have not been finalized.
- An underground communications line located in Winstream conduit running in Kilbourn Avenue from N. Broadway to Jefferson Street. US Signal work plans for this area have not been finalized.
- An underground communications line located in Winstream conduit within a We Energies – Electric ductbank running in Jackson Street from State Street to Ogden Avenue. This line will remain in place without adjustment.

Contact Don Armstrong (262-784-0344) of US Signal 7 days in advance to coordinate locations and any excavation near their facilities.

Verizon has existing underground communications facilities within the project limits in the following locations:

- An underground communications line running in St. Paul Avenue from Water Street to Milwaukee Street. Verizon work plans for this area have not been finalized.
- An underground communications line running in the alley between Water Street and N. Broadway crossing St. Paul Avenue. Verizon work plans for this area have not been finalized.
- An underground communications line running in the alley between N. Broadway and Milwaukee Street crossing St. Paul Avenue. Verizon work plans for this area have not been finalized.
- An underground communications line running in N. Broadway from Wisconsin Avenue to north of Kilbourn Avenue. Portions of this line fall within the utility review zone. Verizon work plans for this area have not been finalized.
- An underground communications line running in Milwaukee Street from south of St. Paul Avenue Avenue to north of Kilbourn Avenue. Portions of this line fall within the utility review zone.. Verizon work plans for this area have not been finalized.
- An underground communications line running in Michigan Avenue from west of N. Broadway to east of Milwaukee Street. Verizon work plans for this area have not been finalized.
- An underground communications line running in Wisconsin Avenue from N. Broadway to half a block west of Milwaukee Street. Verizon work plans for this area have not been finalized.

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- An underground communications line running in Mason Street from west of N. Broadway to east of Milwaukee Street. Verizon work plans for this area have not been finalized.

Contact Grujo Milinkovic (424-238-8250) of Verizon 7 days in advance to coordinate locations and any excavation near their facilities.

We Energies – Electric has underground electric facilities located on every street throughout the project limits. These facilities will remain in place except as noted below.

We Energies - Electric will abandon, relocate, construct and reconstruct electric facilities in the project area at the following locations prior to construction:

- Construct a new underground electric line and manholes running in St. Paul Avenue from west of Water Street to N. Broadway.
- Construct a new underground electric line and manholes running in N. Broadway from St. Paul Avenue to Clybourn Street.
- Construct a new underground electric line and manholes running in N. Broadway from St. Paul Avenue to Kilbourn Avenue.
- Construct a new underground electric line and manholes running in Kilbourn Avenue from Milwaukee Street to Jackson Street.

Once their new facilities are operational, We Energies – Electric will abandon the old electric lines and manholes within the same limits mentioned above. In addition, they will also abandon existing facilities in the following locations:

- Abandon an existing underground electric manhole in the intersection of St. Paul Avenue and 4th Street. They will also abandon the underground electric line from this manhole to next manhole located westerly on St. Paul Avenue, northerly on 4th Street, and easterly on St. Paul Avenue.

Contact Matt Fehler (414-944-5646) of We Energies - Electric 7 days in advance to coordinate locations and any excavation near their facilities.

We Energies – Gas has underground gas facilities located on every street throughout the project limits. These facilities will remain in place except as noted below.

We Energies - Gas will abandon, relocate, construct and reconstruct gas facilities in the project area at the following locations prior to construction:

- Construct a new underground gas line running in St. Paul Avenue from 4th Street to the Milwaukee River.
- Construct a new underground gas line running in St. Paul Avenue from Water Street to half a block east of Water Street.
- Construct a new underground gas line running in St. Paul Avenue from half a block west of Milwaukee Street to Milwaukee Street.

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- Construct a new underground gas line running in Michigan Avenue. Construct a new Avenue crossing N. Broadway.
- Construct a new underground gas line running in Wisconsin Avenue crossing N. Broadway.
- Construct a new underground gas line running in N. Braodway from Wisconsin Avenue to Wells Street.
- Construct a new underground gas line running in N. Braodway from half a block south of Kilbourn Avenue to north of Kilbourn Avenue.
- Construct a new underground gas line running in Milwaukee Street from Clybourn Street to south of Wisconsin Avenue.
- Construct a new underground gas line running in Milwaukee Street from north of Wisconsin Avenue to north of Kilbourn Avenue.
- Construct a new underground gas line running in Kilbourn Avenue from Jefferson Street to Jackson Street.
- Construct a new underground gas line running in Jackson Street from Kilbourn Avenue to Ogden Avenue.
- Construct a new underground gas line running in Ogden Avenue from Jackson Street to Farwell Avenue.

Once their new facilities are operational, We Energies - Gas will abandon the old gas mains within the same limits mentioned above.

Contact Matt Fehler (414-944-5646)) of We Energies - Gas 7 days in advance to coordinate locations and any excavation near their facilities.

We Energies – Steam has underground steam facilities located on every street throughout the project limits. These facilities will remain in place except as noted below.

We Energies – Steam will abandon, relocate, construct and reconstruct steam facilities in the project area at the following locations prior to construction:

- Abate asbestos on an existing steam line east of the intersection of St. Paul Avenue and N. Broadway at Station 126EBB+48. Contractor will then remove the existing trench box and We Energies will cut and cap the existing pipe.
- Abate asbestos on an existing steam line north of the intersection of St. Paul Avenue and N. Broadway at Station 226WBB+39. Contractor will then remove the existing trench box and We Energies will cut and cap the existing pipe.
- Abate asbestos on an existing steam line north of the intersection of St. Paul Avenue and N. Broadway at Station 226WBB+89. Contractor will then remove the existing trench box and We Energies will cut and cap the existing pipe.
- Reconstruct a steam manhole at the intersection of Jackson Street and State Street.
- Abandon an existing steam manhole at the intersection of Ogden Avenue and Marshall Street.

At the time of this writing, We Energies – Steam has officially requested slurry backfill for excavation depths 14-inches or greater below pavement elevation at crossings of

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active and inactive steam lines. There are approximately 60 crossings on the mainline and Lakefront line routes. The City of Milwaukee is in the process of refining the number of locations where this will be required and will share with the contractor when available.

Contact Matt Fehler (414-944-5646)) of We Energies - Steam 7 days in advance to coordinate locations and any excavation near their facilities.

Windstream has existing underground communications facilities within the project limits in the following locations:

- An underground communications line located in City of Milwaukee - Conduit running in 4th Street from Clybourn Avenue to St. Paul Avenue where it turns westerly down St. Paul Avenue. Refer to Underground Conduit plans for potential relocations of the City of Milwaukee – Conduit in this area.
- An underground communications line located in We Energies - Electric conduit running in N. Broadway from St. Paul Avenue to Wisconsin Avenue. This We Energies - Electric line will be relocated out from under the track to a new location within N. Broadway.
- An underground communications line running in N. Broadway from Clybourn Street to half a block north of Wisconsin Avenue. Portions of this line fall within the utility review zone. Windstream work plans for this area have not been finalized.
- An underground communications line located in We Energies - Electric conduit running in Michigan Street from N. Broadway to Milwaukee Street. This line will remain in place without adjustment.
- An underground communications line running in Wisconsin Avenue from N. Broadway to Milwaukee Street. Windstream work plans for this area have not been finalized.
- An underground communications line located in We Energies - Electric conduit running in Milwaukee Street from Mason Street to Kilbourn Avenue. This line will remain in place without adjustment.
- An underground communications line running in Kilbourn Avenue from N. Broadway to Jefferson Street. Windstream work plans for this area have not been finalized.
- An underground communications line located in We Energies conduit running in Jackson Street from State Street to Ogden Avenue. This line will remain in place without adjustment.

Contact Jim Kostuch (262-792-7938 office) of Windstream 7 days in advance to coordinate locations and any excavation near their facilities.

WisDOT STOC has existing communication facilities within the project limits in the following locations:

- An underground communications line running under the centerline of I-794 from west of 5th Street to east of 4th Street. This line will be re-routed along the south

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end of the Operation Maintenance Facility. Remove, adjust, reconstruct, abandon and leave in place the conduit facilities as shown in the plans.

Contact Jeff Madson (414-225-3723) of WisDOT - STOC 7 days in advance to coordinate locations and any excavation near their facilities.

5.2 Exposing Existing Infrastructure, Item SPV.0060.2000.

A Description

This work includes locating and exposing existing infrastructure in paved or unpaved areas as directed by the engineer. The contractor shall be responsible for compliance with s.182.0175 (2), Stats., with respect to precautions to be taken to avoid and prevent damage to utility facilities. The location of existing utilities and infrastructure needed to complete the contract work shall be addressed independent of this provision. Conform to Wisconsin State Statute 182.0175 (2) and Wisconsin Administrative code Trans 220. The work includes exposing existing infrastructure, including utilities, under paved surfaces and providing both lateral and depth measurements for use in determining potential infrastructure conflict solutions, and backfilling.

B Materials

B.1 Backfill Slurry

Utilize backfill slurry as specified elsewhere in these special provisions.

C Construction

C.1 General

The location of existing utilities and infrastructure needed to complete the contract work shall be addressed independent of this provision. This item will only be used as determined by the City for unique locations as directed by the engineer. It does not remove the contractors obligation to locate utilities as specified by Wisconsin Administrative code Trans 220 and Wisconsin State Statute 182.0175. The engineer will direct all exposing existing infrastructure in writing. Coordinate infrastructure exposures with the engineer and notify the infrastructure owner or their agents of this work two working days in advance so that they may be present when the work commences.

C.2 Excavation

When required, remove all paved surfaces at locations where the existing infrastructure is being exposed. Saw or remove concrete and asphaltic pavements to the nearest joint. Remove all pavement surfaces in such a way that all existing edges consist of a true line having a perpendicular edge with no unraveling. Maintain drainage at all times in accordance to standard spec 205.3.3. Take precautions, including temporary shoring, in order to prevent any undermining of the existing roadway. Perform work in accordance to all applicable laws, ordinances, rules, regulations, and OSHA standards.

Expose all infrastructure locations within a given location to a minimum depth of 18-inches below the bottom of each infrastructure. Excavate in a manner that protects the integrity of the infrastructure and prevents any damage to wrappings or protective coatings such as by any mechanical method or hand digging. Notify the infrastructure

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owner promptly if damage or interruption of service occurs. Repair all damage caused to such infrastructure resulting from negligence or carelessness at own expense.

Take all lateral and depth measurements in US feet and tenths thereof. Identify horizontal locations of each exposed infrastructure with a coordinate northing and easting referenced to the Wisconsin County Coordinate System (WCCS), Milwaukee County, NAD 83 (97). Provide vertical elevations for each exposed infrastructure and reference to NAVD 88 (91).

The infrastructure location shall remain exposed and available for visual inspection until the completion of all work in a given location. If the infrastructure shall remain exposed overnight or for prolonged periods of time, protect the location with traffic-rated steel plating, safety barriers, and all necessary traffic control devices that may be required under applicable standards or as directed by the engineer.

C.3 Backfilling

Upon completion of the infrastructure exposure, restore the location in kind to its original condition. When exposed infrastructure locations fall within local streets or city right-of-way, use backfill slurry to fill the entire location to the subgrade elevation.

Restore concrete pavement and concrete base course to the depth found in the existing roadway. Replace all locations that fall within live lanes of any roadway or pedestrian traffic with a high early-strength concrete pavement mix design having a depth equivalent to the existing pavement structure unless directed otherwise by the engineer. Locations that are closed to through traffic may use an approved concrete pavement mix conforming to standard spec 501. If directed by the engineer, tie concrete pavement and/or dowel it to the existing pavement according to the standard detail drawing for concrete pavement. All locations requiring asphaltic pavement shall consist of HMA Pavement Type E-3 unless otherwise directed by the engineer. Place the HMA pavement in lifts to a depth as directed by the engineer. Apply tack coat to composite pavement structures and between lifts. Alternate restoration methods may be used upon written approval from the engineer.

Place base aggregate dense between the subgrade surface and the bottom of the pavement.

C.4 Documentation

Provide documentation to the engineer and include the coordinates, elevations, and sketches of the infrastructure locations tied to known features in the plans. Reference each infrastructure to a proposed alignment with a station and offset. Where near a ramp, reference the ramp alignment. Document the size and/or diameter, composition, and a description of each infrastructure and the location of the elevation with respect to each infrastructure noted. Supply digital photographs of the uncovered infrastructure to the engineer in .jpeg format for future reference.

D Measurement

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The City will measure Exposing Existing Infrastructure as a unit for each location. A location may have multiple infrastructures located within the same exposure area. An exposure area will include all infrastructures within 6 lateral feet of each other and payment will only be made for one unit regardless of the number of infrastructures exposed. If the distance from the existing ground elevation, located above the existing infrastructure, to a point 18 inches below the exposed infrastructure is between 0 and 6 feet, the City will measure each location as a single unit of work. If the distance from the existing ground elevation, located above the existing infrastructure, to a point 18 inches below the exposed infrastructure is greater than 6 feet and less than 12 feet, the City will pay for the item as two units of work.

E Payment

The City will pay for the measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2000	Exposing Existing Infrastructure	Each

Payment is full compensation for mobilization; for furnishing all excavation; for disposing of all materials; for locating all infrastructure within each respective location; for providing documentation and photographs of infrastructure locations to the engineer; for furnishing all surveying associated with exposing existing infrastructure; for furnishing all maintenance of the location during construction; for furnishing all traffic control, safety barriers, and steel plating required; for temporary shoring; and for furnishing all finishing items including, but not limited to, base aggregate dense, backfill slurry, concrete pavement, HMA pavement, curb and gutter, and sidewalk located above the subgrade elevation.

5.3 Adjusting TES Manhole Covers, Item SPV.0060.2005.

A Description

This special provision describes adjusting the existing chimney of the block, precast, or brick round manholes; furnishing, installing and removing protection of the cables in the manhole during adjustment operations. Perform work in accordance to the standard specifications, the provisions of the article Adjusting Manhole Covers, as shown on the plans, and as hereinafter specified.

B Materials

Furnish and install materials that conform to the requirements of standard spec 519. Salvage and reinstall existing covers on the manholes. The city will supply covers designated for replacement. Contractor shall contact Ricardo Lopez, Inventory Clerk at (414) 286-6123 prior to obtaining the frames and lids from the DPW Field Headquarters at 3850 N. 35th Street. Contractor must have the "Castings Requisitions Form" which shall be supplied by the city at the Preconstruction Meeting to obtain the covers.

C Construction

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Report any pre-existing problems to Ms. Karen Rogney of City Underground Conduits Section at (414) 286-3243 three working days in advance of any construction on manholes.

Before removing the pavement around the manhole, the contractor shall place a ¾-inch plywood cover or equal over existing active Street Lighting, Traffic Control, Communication or private vendor electrical cables. This cover shall be properly supported to/at the manhole floor.

Break out and remove pavement around manhole. Remove existing covers and store and secure them properly. Any damaged, lost, or stolen covers shall be the responsibility of the contractor and shall be replaced at contractor's expense.

Remove existing chimney to surface of concrete roof slab. If manhole does not have an existing concrete roof slab, remove sufficient chimney as to provide adequate corbel to fit new cast iron frame and cover.

Adjust manhole cover to proposed grade using bricks or concrete rings as necessary. Remove wedges/shims. Fill voids with grout. Do not back plaster inside walls.

After completion of paving, remove the temporary ¾-inch plywood cover or equal which is over the existing electrical cables in the manhole as mentioned above.

Notify Ms. Rogney three working days in advance of completion of each manhole adjustment, for inspection and acceptance of work performed. The contractor will receive no payment until the above work is approved by City Underground Conduits.

D Measurement

The City will measure Adjusting TES Manhole Covers as each individual unit, acceptably completed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2005	Adjusting TES Manhole Covers	Each

Payment is full compensation for furnishing all required materials, exclusive of frames, grates, or lids available and designated for adjusting; and for removing, reinstalling and adjusting the covers. Covers to be adjusted and which are rendered unfit for use by the contractor through the contractor's operations will be replaced by the contractor in kind at the contractor's own cost and expense.

5.4 Adjusting Water Boxes, Item SPV.0060.2010; Adjusting Water Manholes, Item SPV.0060.2011.

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A Description
This special provision describes adjusting, protecting, and maintaining accessibility, for the duration of the paving project, to all city water service boxes, water gate valve boxes and water manhole frames & lids located within the project limits.

B Materials
All material for the adjustment of these facilities must meet City of Milwaukee specifications and will be provided by the City of Milwaukee by contacting Jesse Hernandez, Milwaukee Water Works, at (414) 708-2670 (or Dave Goldapp, Milwaukee Water Works at (414)286-6301). If there is contractor damage, the materials must still be provided by the City of Milwaukee, however, in this case, the contractor will be charged for all materials. Materials furnished by the City of Milwaukee and not used on the project shall be delivered back to DPW Field Headquarters – Infrastructure, Operations, Water Works at 3850 N. 35th St.

C Construction
All water service boxes, water gate valve boxes and water manhole frames & lids within the project limits shall be adjusted to proposed elevations by the contractor using materials meeting city specifications.

The city will locate, mark, inspect and repair all water service boxes, water gate valve boxes and water manhole frames & lids within the limits of the project prior to commencement of work on the project.

Throughout the duration of the project, the contractor must ensure that all water service boxes, water gate valve boxes, and water manholes are adequately located and identified by blue paint, and that at all times, all water appurtenances remain accessible for operation by city forces. Exercise caution working adjacent to water facilities to avoid damage and ensure accessibility.

Upon completion of the contract, the city will inspect all water facilities to ensure the water boxes and manholes are clean, properly aligned, and accessible. The contractor shall be responsible to make identified repairs and adjustments, and if any repairs or adjustments are made by the city, the cost will be charged to the contractor.

D Measurement
The City will measure Adjusting Water Boxes and Adjusting Water Manholes as each individual unit acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2010	Adjusting Water Boxes	Each
SPV.0060.2011	Adjusting Water Manhole	Each

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Payment is full compensation for all excavation, backfilling, disposal of surplus materials, water box or manhole clean-out, and restoration of the work site; and for furnishing all labor, tools, equipment, and incidentals necessary to complete the work.

5.5 Remove and Cap Sewer Manhole; Item SPV.0060.2015.

A Description

This item describes removing and capping existing sewer manhole structures with concrete and necessary reinforcement, including required excavating and backfilling in accordance to construction details shown on plan, the standard specifications, and as hereinafter provided.

B Materials

Furnish materials conforming to section 501 for concrete, section 505 for reinforcement, and section 506 for structural steel and miscellaneous metals.

Furnish grade A concrete with Type II cement conforming to subsection 501.2. Furnish ASTM 617 Grade 60 reinforcing steel.

Furnish plastic waterstop conforming to subsection 502.3.6.4 or butyl rubber seal per sealant manufactuer's recommendations conforming to recommendation ASTM C 990.

Furnish support assemblies conforming to subsection 611.2.2.

C Construction

Excavate and backfill as specified for excavation for sewer structures in section 206, except do not backfill concrete brick until at least 3 days after completing the unit. Use granular backfill material for backfilling.

Construct concrete as specified in section 501, and as specified for culverts and retaining walls in section 504.

Construct concrete brick as specified in section 519.

Construct structural steel and miscellaneous metals as specified for steel bridges in section 506.

Cure the concrete by one of the methods specified in 502.3.8 for curing concrete in sub-sewer structure units.

Construct the masonry and install waterstop material to provide a watertight joint between new masonry cap and existing manhole.

Clean and remove all materials and debris deposited or lodged in the manhole due to the contractor's operations during construction.

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D Measurement
The City will measure Remove and Cap Sewer Manhole as each individual unit of work acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2015	Remove and Cap Sewer Manhole	Each

Payment for the Remove and Cap Sewer Manhole is full compensation for providing all materials, including all masonry; for all excavating; for sheeting and shoring; for backfilling; for providing granular backfill material; for control of water; for temporary support and protection of existing utilities to construction; for removing sheeting and shoring; disposing of surplus material, for providing waterstop or butyl rubber seal; and for cleaning out and restoring the work site. Granular backfill material required for backfilling is incidental to the work.

5.6 Abandoning Sewer Manhole; Item SPV.0060.2016.

A Description
This work includes abandoning existing sanitary manholes in place, in accordance to the plans, the Standard Specifications for Highway and Structure Construction, latest edition and amendments, Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition and amendments (SSSW), the "Special Provision Notes for Sanitary Sewer Work" as found in the plans, and as hereinafter provided and these special provisions.

B Materials
B.1 General
Furnish backfill blurry in accordance to the pertinent requirements of standard spec 209 except as hereinafter modified. Use aggregates that conform to section 501 of the standard specifications for Grade A Concrete. Weigh aggregates at a batch plant suitable for batching concrete masonry. Mix and deliver to the project site using a truck mixer. Add enough water to enable the mixture to flow readily.

C Construction
C.1 General
Clean manhole thoroughly. Plug the existing pipe with an 8-inch brick or concrete wall. Remove the walls of the structure to a depth of 3 feet below grade or to the base if directed by the engineer. Fill the excavation with backfill blurry, to existing surface or to appropriate depth for pavement restoration. Maintain satisfactory bypass service during these operations.

Salvaged castings become the property of the contractor.

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Provide by-pass pumping of wastewater round construction zone during working hours. During non-work hours, provide temporary connection of replacement sanitary sewer to existing sanitary sewer to provide uninterrupted sanitary sewer service.

D Measurement
The City will measure Abandoning Sewer Manhole as a unit for each individual manhole, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2016	Abandoning Sewer Manhole	Each

Payment is full compensation for furnishing and installing all materials; for providing positive drainage of the area to be backfilled; for furnishing and placing backfill blurry; for salvaging frames and covers and for disposing of materials.

5.7 Reconstructing Offset Manhole 4-FT Diameter, Item SPV.0060.2022; Reconstructing Offset Manhole 5-FT Diameter, Item SPV.0060.2023.

A Description
This work includes reconstructing sanitary or combined sewer manholes to the locations and the elevations shown in the plans or as as determined by the Engineer, in accordance with the Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition and amendments (SSSW), and as hereinafter provided.

This item applies to structures where the frame/lid, chimney and cone portion of the manhole will be removed and reconstructed offset from the current position as necessary to move the frame/lid away from the proposed streetcar rail.

B Materials
B.1 Manhole
Manhole barrel and cone sections shall be constructed of precast reinforced concrete sections.
Precast manholes and tops shall conform to ASTM Specifications, C478, latest revision.

B.1 Adjusting Rings
Adjustment rings shall be concrete with steel reinforcement in conformance with ASTM C-478. Precast concrete rings shall have an inside diameter to match the manhole opening, be not less than 2 inches nor more than 6 inches high, and have a wall thickness of 6 inches unless otherwise specified. The rings shall contain a minimum of one No. 2 reinforcing rod centered within the ring. Do not use any cracked or broken rings. The minimum number of adjusting rings shall be one 2-inch ring. The maximum height of

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adjusting rings shall be 8 inches in paved areas. All joints between the adjusting rings shall be filled with grout or mortar, including between the cone and the adjusting ring and the adjusting ring and the frame. Rings shall be grooved to receive a step.

B.2 Manhole Frame and Cover
Manufacturers: Neenah Foundry Company, Neenah, WI.

Manhole Frame and Covers: Gray iron castings; ASTM A-48, Class 35B, machined horizontal bearing surface, with concealed pickhole, solid gasketed self-seal cover, R-1661-B, or an approved equal; with word "SEWER" cast in cover.

B.3 Manhole Seal
For sanitary sewer manholes, furnish new Cretex, NPC Flexrib, or approved equal internal frame/chimney Seal, as shown in the plans. The seal shall meet the material requirements of section 8.42.3 and the performance requirements of section 8.42.4 of the SSSW. Seals are not required for combined sewer manholes.

B.4 Joints
Joints for precast manholes shall meet the requirements of ASTM C-443, latest revision, except that sealant shall be butyl rubber gasket or butyl rubber rope. Flexible butyl rubber gaskets or rope shall comply with the physical requirements for Type “B” gaskets in AASHTO Designation M-198, or Federal Specification SSS-00210-A, sealing compound, preformed plastic for expansion joints and pipe joints.

B.5 Steps
All manholes shall be provided with steps equally spaced vertically on center installed by the manufacturer as shown on the standard detail sheet. Steps shall be embedded into the riser or conical top section of the wall a minimum of 3 inches. Manhole steps shall be Type PS-2-BG as manufactured by M.A. Industries, Peachtree City, GA 30269; or equal. Provide certified test data that the steps are capable of withstanding an 800- pound vertical load without sustaining more than a 3/8-inch permanent set when tested in accordance to Section 10 of ASTM C 497.

B.6 Elastomeric Waterproofing Sealer
Elastomeric waterproofing membrane shall be a single component, bitumen-modified, moisture-curing polyurethane similar to TREMproof 60 as manufactured by Tremco, 10701 Shaker Blvd., Cleveland, Ohio 44104; Duramem V500 as manufactured by Pecora Corporation, 2601 Oakland Avenue, Garland, Texas 75040; Thiodeck C.F. as manufactured by Toch/Carboline Company, 350 Hanley Industrial Court, St. Louis, Missouri 63144; or equal.

B.7 Plastic Sheet
Plastic sheet shall be clear plastic, minimum 4 mils. thick, of length and width to cover elastomeric waterproofing sealer.

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B.8 Backfill
Slurry backfill shall meet the material requirements of Section 8.43.8 of the SSSW.

C Construction
C.1 General

The locations of existing sanitary or combined sewer manholes to be reconstructed are indicated on the plans. Reconstruct these items as shown in the plans.

Locate the proposed streetcar rail adjacent to the manhole, and verify that the proposed frame/lid will be installed in the correct position.

Reconstruct manholes as necessary so that the frames and cover when placed will be at the established required grade; remove the existing frame and cover. For sanitary sewer manholes, install seals in accordance with the manufacturer's recommended installation procedures. Furnish and use Slurry Backfill in the manhole excavation area to existing surface or to appropriate depth for pavement restoration. Salvage the existing frame and cover. Coordinate with the City regarding delivery of the salvaged frame and cover.

C.2 Surface Preparation
For sanitary sewer manholes to receive seals, remove all loose and protruding mortar and brick from the chimney and clean surface by power wire brushing. Provide a 4-Inch wide sealing surface starting 2 inches down from the bottom of the frame.

All sealing surfaces must be circular, reasonably smooth, clean and free of any loose material or excessive voids. If such a surface does not exist for the bottom of the sleeve to seal against, use one-component, quick-set, high strength, non-shrink, polymer modified patching mortar which has been formulated for vertical or overhead use. If the bottom of the sleeve is to seal against the top of an eccentric (straight side) cone and an inadequately high vertical surface does not exist, contact the manufacturer to obtain details to build the required vertical surface.

Use caulk to fill minor irregularities in the bottom sealing surface. The caulk shall be a butyl rubber caulk conforming to AASHTO M-198, Type B. Apply a single bead of the caulk to the center portion of the lower sealing surface of the sleeve.

C.3 Manhole Seal
Field-measure the inside diameter of the manhole frame and the manhole chimney, and determine as to whether the inside face of the frame is vertical or tapered in order to obtain the proper size and shape rubber seal.

Install internal rubber chimney seals no sooner than 24 hours following chimney back plastering.

The surfaces against which the sleeve is to be compressed shall be circular, clean, reasonably smooth and free of any loose materials and excessive voids. Repair all

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flaws in these surfaces with the approved low-shrink mortar or grind the surfaces smooth. Apply a bead of butyl rubber caulk conforming to ASSHTO M-198 Type B to the lower sealing surface of sleeve.

Install the seal according to the manufacturer's instructions. (Refer to the plan data for configuration of chimney seal.)

C.4 Backfill
Furnish and use slurry backfill in the manhole excavation area to existing surface or to appropriate depth for pavement restoration or reconstruction. Place backfill in accordance with Section 8.43.8 of the SSSW.

C.5 Elastomeric Waterproofing Sealer
Elastomeric waterproofing sealer shall be applied to all gravity sewer manholes. Thoroughly sandblast the section of the manhole frame over which the sealer is to be applied, the manhole header, extension and cone and the top 12 inches of the manhole riser. All surfaces shall be free of dust, oil, rust, loose materials and other contaminants. Take necessary precautions to prevent rebound from the sandblasting operation to enter the sewer system. If the mortar between grade rings or brick courses is removed to a depth greater than 1/4 inch by the sandblasting, the joints shall be refilled with mortar as specified herein. All new masonry work shall be cured a minimum of 24 hours prior to applying the waterproofing sealer.

Apply the 4-inch wide bond breaker tape completely around the manhole circumference and centered over the mortar joint between the manhole frame and the manhole extension. Immediately before applying the sealer, wipe all surfaces with a cleaner and immediately prime. The cleaner and primer shall be furnished by the sealer manufacturer. Apply the sealer with a trowel, roller or by spraying to achieve a thickness of not less than 100 wet mils. Do not apply the sealer when the ambient temperature is below 40 degrees F. The sealer shall extend from 9 inches below the bottom of the manhole cone and be carried over the top and onto the flange of the frame a minimum of 5 inches.

Allow the sealer to cure a minimum of 24 hours before backfilling when the ambient temperature is above 70 degrees F, and 48 hours when the ambient temperature is below 70 degrees F. Immediately before backfilling, loosely wrap two layers of 4 mil plastic sheet over the sealed area to prevent direct contact between the sealer and the backfill material.

D Measurement
The City will measure Reconstructing Offset Manhole 4-FT Diameter and Reconstructing Offset Manhole 5-FT Diameter as a unit for each individual manhole, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

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ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2022	Reconstructing Offset Manhole 4-FT Diameter	Each
SPV.0060.2023	Reconstructing Offset Manhole 5-FT Diameter	Each

Payment is full compensation for furnishing and installing all materials including frame and cover, adjusting rings, masonry, pre-cast concrete eccentric cones, and internal frame/chimney seals; for excavating, backfilling, and compacting; for disposing of surplus materials; and for cleaning out and restoring the structure.

5.8 Sewer Manhole 4-FT Diameter, Item SPV.0060.2024; Sewer Manhole 5-FT Diameter, Item SPV.0060.2025; Sewer Manhole 6-FT Diameter, Item SPV.0060.2026; Sewer Manhole 7-FT Diameter, Item SPV.0060.2027;

A Description

Construct sanitary manholes consisting of pre-cast reinforced concrete, pre-cast concrete adjustment rings, watertight joints, pre-cast concrete base, pre-cast concrete eccentric cone tops, frames and covers, internal frame/chimney seals, steps, connections with all incoming and outgoing sewer, all excavation and granular backfill, and all necessary bypass pumping.

Perform the work in accordance to the plans, the Standard Specifications for Highway and Structure Construction, latest edition and amendments, the Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition and amendments (SSSW), the "Special Provision Notes for Sanitary Sewer Work" as found in the plans, and as hereinafter provided and these special provisions.

B Materials

B.1 General

All materials and work required to install the manhole will conform to the SSSW. Any material tests required as part of the sewer work shall be performed at a testing laboratory designated by the "facility owner". The test results shall be provided to the construction engineer for approval at the time of delivery.

B.2 Bedding

Bedding shall conform Class "C" bedding of section 3.2.6(a) and File No. 3 of the SSSW. Bedding material shall conform to Table 32 of Section 8.43.2 of the SSSW except the gradation requirements shall be modified as follows;

Gradation requirements for 3/8-Inch Crushed Stone Chips

Sieve sizes	Percent passing by weight
1/2-inch	100%

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3/8-inch	90-100
No. 8	0-50
No. 30	0-5

B.3 Backfill
Granular backfill as required in Chapter 2.6.2 of the SSSW, shall conform to the requirements for Base Aggregate Dense 3/4-Inch, of Section 305.1 of the standard specifications.

B.4 Manhole
Provide sanitary manholes with a minimum 48-inch inside diameter pre-cast concrete barrel sections, with eccentric type cone top section with 24-inch minimum opening, and with an 8-inch thick integral pre-cast concrete base. Provide concrete with a compressive strength of 4000 psi and conforming to ASTM C478. Minimum manhole wall thickness shall be 5 inches. Manholes shall conform to Chapter 8.39.0 of the SSSW and construction details in the plans.

B.5 Frame and Cover-City of Milwaukee
Solid gasket lids meeting the requirements of MS 58-A shall be installed on all new sanitary manholes and shall conform to Chapter 8.48.0 of the SSSW. The new lid shall fit the new frame without rocking or protruding above the surrounding surface. Castings will be furnished and installed by the contractor. Salvaged castings become the property of the contractor.

B.6 Frame and Cover-City of Wauwatosa
New frames and covers are required on all new sanitary manholes and shall be supplied by the contractor. Sanitary or combined sewer manhole covers shall be self-sealing with an O-ring gasket. Castings shall be non-rocking, Type-B self-sealing lid with concealed pick holes. Neenah R-1661-B or approved equal. They shall have one 1-Inch vent hole which is sealed with a removable flexible plug and two concealed pick holes. Frames for sanitary or combined sewer manholes shall be compatible with the covers.

B.7 Manhole Adjusting Rings
Provide concrete adjustment rings with steel reinforcement in conformance with ASTM C-478 and a minimum of 4-inch in thickness. A maximum of 10-inch for adjustment will be allowed. Multiple grade rings will not be allowed where one will suffice.

B.8 Manhole Seal
Provide internal chimney seal made of a rubber-type product, with a minimum thickness of 3/16 inches, a minimum unstretched width of 8 inches and extruded or molded from a high grade rubber compound conforming to the applicable requirements of ASTM C923. Fabricate the bands used for compressing the sleeve against the manhole from stainless steel conforming to ASTM A240, Type 304, for sheet and ASTM A479, Type 304, for rods. Any screws, bolts, or nuts used on these bands are to be stainless steel conforming to ASTM F593 and F594, Type 304. The internal seal or its appurtenances are not to extend far enough into the manhole opening to restrict entry into or exit from the manhole.

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B.9 Manhole Boots
Provide sanitary sewer pipe to pre-cast manhole wall connection with flexible, watertight boot or cast-in seal. Manhole boots for connecting pipes to the sanitary manholes shall be a watertight flexible connection meeting the requirements of ASTM C923. The rubber boots shall be supplied with two stainless steel clamps for attaching the boot to the pipe. A stainless steel "power sleeve" shall be supplied for connecting the boot to the manhole.

B.10 Joints
Provide manhole barrel joints with rubber ring gasket material or butyl plastic gasket material. Rubber gaskets shall conform to requirements of ASTM C443. Butyl plastic gasket material shall conform to requirements of ASTM C990 and AASHTO M-198.

All exterior joints shall be wrapped with Mac-Wrap or approved equal. This shall be considered incidental to the installation of the sanitary or combined sewer manhole.

B.11 Steps
Furnish and install ½ inch diameter manhole steps of grade 60 steel reinforcing rods with molded plastic covering conforming to Detail File No. 15 of the SSSW. Each section of the manhole shall be aligned so the steps create a continuous ladder.

C Construction
C.1 General
Excavate to provide a smooth, compacted flat bottom. Place a minimum 6-inch depth of bedding material conforming to the requirements of the SSSW and compact prior to setting manhole base and riser section.

Construct concrete bench in the interior bottom of the sanitary manhole which are precast or poured-in-place. The bench shall extend to the top of the pipe. Construct the bench invert to provide a smooth flow line and conform to the curvature of the pipe.

Install external manhole joint seal on all manhole barrel section joints in addition to joint gasket seal.

Reconnect existing sewer main and laterals which are to enter new manholes in accordance to chapter 3.4.0 of the SSSW.

Provide granular backfill as required in Chapter 2.6.2 of the SSSW, meeting the requirements for Base Aggregate Dense 3/4-Inch, of Section 305.1 of the standard specifications.

Consolidate all backfill by mechanical compaction per specification 2.6.14(B) of the SSSW, except the initial compacted lift shall be two (2) feet, and shall be modified to read, "Each subsequent compacted lift of material shall be one (1) foot". Special compaction equipment and measures are required where standard compaction equipment

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cannot be utilized. Flooding of backfill will not be allowed. Compaction shall achieve uniform consolidation in conformance with section 2.6.14(b) of the SSSW.

Final rim elevations shall be ¼" to ½" below final grade in asphalt pavement and at final grade in concrete pavement and in grass. Adjustment rings shall not exceed 7.5 inches.

Perform a vacuum test on each new sanitary manhole in accordance with section 3.7.3 of the SSSW, work to be completed and paid as a separate pay item.

Provide by-pass pumping of wastewater round construction zone during working hours. During non-work hours, provide temporary connection of replacement sanitary or combined sewer to existing sanitary or combined sewer to provide uninterrupted Sanitary or combined sewer service.

D Measurement

The City will measure Sewer Manhole 4-FT Diameter, Sewer Manhole 5-FT Diameter, Sewer Manhole 6-FT Diameter, and Sewer Manhole 7-FT Diameter as each individual manhole, acceptably completed.

E Payment

The City will pay for measured quantities at the contract price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2024	Sewer Manhole 4-FT Diameter	Each
SPV.0060.2025	Sewer Manhole 5-FT Diameter	Each
SPV.0060.2026	Sewer Manhole 6-FT Diameter	Each
SPV.0060.2027	Sewer Manhole 7-FT Diameter	Each

Payment is full compensation for furnishing and installing all materials including pre-cast manhole base, riser, bench, cone section, chimney adjustment rings, frames, grates or lids, gaskets, manhole boots, manholes seals, joint seals, steps, bedding material, granular backfill material; and fasteners; for furnishing all excavation, dewatering, sheathing and shoring, forming foundation, and masonry work; for making sanitary or combined sewer connections; for making lateral connections: for backfilling including mechanical compaction and compaction testing; for removing sheeting and shoring; for disposal of all surplus or waste material; and for clean-up. Vacuum Testing will be paid at a separate unit price. The removal of existing sanitary or combined sewer pipe and manholes from within the trench of replacement of sanitary or combined sewer manholes will not be paid for separately, but shall be considered incidental to the item.

5.9 Internal Sanitary Manhole Seal, Item SPV.0060.2028.

A Description

This special provision describes furnishing and installing internal manhole chimney seals.

B Materials

NOT FOR CONSTRUCTION

Use a Cretex or equal internal manhole seal.

C Construction
Field-measure the inside diameter of the manhole frame and the manhole chimney, and determine as to whether the inside face of the frame is vertical or tapered in order to obtain the proper size and shape rubber seal.

Install internal rubber chimney seals no sooner than 24 hours following chimney back plastering.

The surfaces against which the sleeve is to be compressed shall be circular, clean, reasonably smooth and free of any loose materials and excessive voids. Repair all flaws in these surfaces with the approved low-shrink mortar or grind the surfaces smooth. Apply a bead of butyl rubber caulk conforming to ASSHTO M-198 Type B to the lower sealing surface of sleeve.

Install the seal according to the manufacturer's instructions. (Refer to the plan data for configuration of chimney seal.)

D Measurement
The City will measure Internal Sanitary Manhole Seal by each individual unit, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2028	Internal Sanitary Manhole Seal	Each

Payment is full compensation for furnishing and installing internal rubber chimney seals.

5.10 Abandoning MMSD Manhole 00318, Item SPV. 0060.2035.

A Description
This special provision describes installing corrugated HDPE half pipe, concrete, and steel reinforcement over the bench of the manhole and abandon existing MMSD manhole 00318 in place as shown in the plans.

B Materials
B.1 Corrugated HDPE Half Pipe
Corrugated HDPE half pipe shall conform to ASTM F-714 requirements of Chapter 8.51.3 of the SSSW.

B.2 Concrete
Concrete shall be high early strength Class A Concrete conforming to the requirements of Chapter 8.35.0 and Table 29 of Chapter 8 of the SSSW.

NOT FOR CONSTRUCTION

B.3 Steel Reinforcement
Steel reinforcement shall conform to C-478 requirements of ASTM specifications.

B.4 Bentonite Waterstops
Bentonite waterstops shall be 1-inch by 3/4 inch size flexible strip of bentonite waterproofing compound with an adhesive surface on one side of the strip, waterstop Type RX.

B.5 Bonding Agent
Bonding agent for use on existing concrete surfaces shall be Sikastix 370, Sikadur Hi-Mod; Horn Co. Epoxtite Binder 2385; or equal.

B.6 Backfill
Utilize granular backfill as specified in chapter 8.43.4 and table 37 of chapter 8 of the SSSW.

C Construction
C.1 General
Notify Larry Anderson (MMSD), (414) 225-2241, at least 3 days in advance of the commencement of construction.

The pipe segments between the manhole upstream and manhole downstream of the manhole to be abandoned shall be televised prior to and after construction. A copy of the televised inspection shall be submitted to MMSD.

Excavate the existing manhole to access the structure, salvage existing MMSD frame and lid for reinstallation on manhole NS10F04. Clean manhole thoroughly and install the corrugated HDPE half pipe, high early strength concrete and steel reinforcement as detailed in the plans.

After the concrete attains a 4000 psi compressive strength, abandon the existing manhole by filling the existing manhole with granular backfill, as detailed in the plans, compact granular backfill to ensure adequate consolidation.

The sewer line shall be kept free of debris at all times. Take care to prevent any loose material from entering outlet sewer lines.

D Measurement
The City will measure Abandoning MMSD Manhole 00318 as a unit for each individual manhole, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2035	Abandoning MMSD Manhole 00318	Each

NOT FOR CONSTRUCTION

Payment is full compensation for furnishing and installing all materials including corrugated HDPE half pipe, concrete, steel reinforcement, waterstops, bonding agent; for salvaging existing MMSD frame and lid, for excavation; for furnishing and placing backfill; for abandonment and removals; for disposing of materials; and for televised inspection.

5.11 Structure Modification MMSD NS10F04, Item SPV.0105.2036; Structure Modification MMSD 75032, Item SPV.0105.2037.

A Description

This special provision describes modifying Milwaukee Metropolitan Sewerage District structures made of concrete, with necessary reinforcement, metal frames, grates and lids, including excavating, partial structure removal, and backfilling as shown on the plans and in accordance to the pertinent requirements of the standard specifications and as hereinafter provided.

B Materials

Furnish materials that are in accordance to the following sections of the standard specifications as modified in this special provision:

Excavation..... 206
Backfill..... 210
Concrete 501
Non-Bituminous Joint Sealer 502
Reinforcement..... 505
Miscellaneous Metals..... 506
Mortar 519

Furnish grade A, A-FA, A-S, A-T, A-IS, A-IP, or A-IT concrete conforming to 501 as modified in 716. Provide QMP for class III ancillary concrete as specified in 716. The concrete for shall have a 28-day compressive strength of at least 4,000 psi.

Furnish reinforcement conforming to AASHTO M31, grade 60.

Furnish rolled shapes, plates, and bars conforming to ASTM A36/A36M. Zinc coat the according to ASTM A123.

Furnish ductile iron castings of the size and shape shown on the plans conforming to AASHTO M105, class 30. Plane or grind bearing surfaces to insure flat, true surfaces. Covers shall be true and seat within the frame. Salvage the manhole and frame from MMSD Manhole 00318 and install it in structure NS10F04.

Furnish cylindrical sealant backing rod conforming to ASTM C1330 Type O.

NOT FOR CONSTRUCTION

Furnish 60 durometer neoprene bearing pads conforming to ASTM D-1056 Classification SCE-41. Size and cut the bearing pads to suit the dimensions shown on the plans. Bond the pads to the bearing angle with an epoxy adhesive in accordance with the bearing manufacturer's recommendations.

Use epoxy bonding agent conforming to ASTM C881 Type V to bond old concrete to new concrete.

Use precast reinforced concrete grade rings conforming to ASTM C478 for final adjustment of manholes to grade. Grade rings shall contain a minimum of one No. 2 reinforcing rod centered within each ring.

C Construction

Excavate all material required for modification of the structures below the bottom of the existing concrete pavement base.

Secure grade riser with mortar, engineer-approved mastic, or using the manufacturer's recommended method.

Backfill all spaces excavated and not occupied by the new structures to the bottom of the new concrete base pavement.

D Measurement

The City will measure Structure Modification MMSD as a single lump sum for each for each structure acceptably completed.

Removing and replacing the existing pavement and concrete base are measured and paid for separately.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.2036	Structure Modification MMSD NS10F04	LS
SPV.0105.2037	Structure Modification MMSD 75032	LS

Payment is full compensation for excavation, partial structure removal, concrete with necessary reinforcement, metal frames, grates and lids, and backfilling.

6. Clearing / Removals / Demolition.

6.1 Clearing and Grubbing, Emerald Ash Borer.

This applies to projects in the emerald ash borer (EAB) quarantined zones to include Fond du Lac, Kenosha, Milwaukee, Ozaukee, Racine, Sheboygan, Washington and Waukesha counties.

NOT FOR CONSTRUCTION

Supplement standard spec 201.3 with the following:

The emerald ash borer (EAB) has resulted in a quarantine of ash trees (*Fraxinus sp.*) by the Wisconsin Department of Agriculture, Trade, and Consumer Protection (DATCP) and the Wisconsin Department of Natural Resources (DNR).

Ash trees species attacked by emerald ash borer include the following:

(a) Green ash (F. pennsylvanica) is found throughout the state, but is most common in southern Wisconsin. It may form pure stands or grow in association with black ash, red maple, swamp white oak, and elm. It grows as an associate in upland hardwood stands, but is most common in and around stream banks, floodplains, and swamps.
(b) Black ash (F. nigra) is distributed over the entire state but is most frequently found in northern Wisconsin. It is most common in swamps, but is also found in other wet forest types.
(c) Blue ash (F. quadrangulata) is a threatened species that is currently found only at a few sites in Waukesha County. The species is at the edge of its range in Wisconsin, but is common in states farther south. The species is not of commercial importance. Blue ash twigs are 4-sided.
(d) White ash (F. americana) tends to occur primarily in upland forests, often with Acer saccharum.

The quarantine of ash trees includes all horticultural cultivars of the species listed above.

Note that blue ash twigs are 4-sided. All other Wisconsin ash trees have round stems. Also, Mountain ash (Sorbus americana and S. decora) is not a true ash and is not susceptible to EAB infestation.

The contractor shall be responsible for hiring a certified arborist to identify all ash trees that will be cleared and grubbed for the project. In addition, prior to scheduled clearing and grubbing activities, the arborist shall mark all ash trees with florescent lime flagging tied around the trunk perimeter.

Follow and obey the following Wisconsin Department of Agriculture, Trade, and Consumer Protection order:

ATCP 21.17 Emerald ash borer; import controls and quarantine.

Importing or Moving Regulated Items from Infested Areas; Prohibition.
Except as provided in subparagraph (3), no person may do any of the following:

(a) Import a regulated item under sub. (2) into this state if that item originates from an emerald ash borer regulated area identified in 7CFR 301.53-3.

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(b) Move any regulated item under sub. (2) out of an emerald ash borer regulated area that is identified in 7CFR 301.53-3 and located in this state.

Note: the United States Department of Agriculture-Animal and Plant Health Inspection Service (USDA-APHIS) periodically updates the list of regulated areas in 7CFR 301.53-3. Subsection (1) applies to new regulated areas as those areas are identified in the CFR.

Regulated Items
The following are regulated items for purposes of subparagraph (1):

The emerald ash borer, Agrilus planipennis Fairmaire in any living stage.

Ash trees.

Ash limbs, branches, and roots.

Ash logs, slabs or untreated lumber with bark attached.

Cut firewood of all non-coniferous species.

Ash chips and ash bark fragments (both composted and uncomposted) larger than one inch in diameter.

Any other item or substance that may be designated as a regulated item if a DATCP pest control official determines that it presents a risk of spreading emerald ash borer and notifies the person in possession of the item or substance that it is subject to the restrictions of the regulations.

Regulatory Considerations
The quarantine means that ash wood products may not be transported out of the quarantined area.

Clearing and grubbing includes all ash trees that are to be removed from within the project footprint. If ash trees are identified within clearing and grubbing limits of the project, the following measures are required for the disposal:

Chipped Ash Trees
May be left on site if used as landscape mulch within the project limits. If used as mulch on site, chips may not be applied at a depth greater than standard mulch applications as this will impede germination of seeded areas.

May be buried on site within the right-of-way in accordance to standard spec 201.3 (14).

May be buried on adjacent properties to projects within the quarantined zone with prior approval of the engineer in accordance to standard spec 201.3 (15).

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May be trucked to a licensed landfill within the quarantined zone with the engineer's approval in accordance to standard spec 201.3 (15).

Burning chips is optional if in compliance with standard spec 201.3.

Chips must be disposed of immediately if not used for project mulching and may not be stockpiled and left on site for potential transport by others. Chips may be stockpiled temporarily if they will be used for project mulching and are not readily accessible to the public.

Chipper equipment must be cleaned following post-chipping activities to ensure no spread of wood chip debris into non-quarantined counties.

Ash logs, Branches, and Roots
May be buried without chipping within the existing right-of-way or on adjacent properties in accordance to standard spec 201.3 (14)(15).

May be trucked to a licensed landfill within the quarantined zone with the engineer's approval in accordance to standard spec 201.3 (15).

Burning is optional if in compliance with standard spec 201.3.

Ash logs, branches, and roots must be disposed of immediately and may not be stockpiled.

All additional costs will be incidental to clearing and grubbing items.

Do not bury or use mulch in an area that will be disturbed again during later phases of the project.

Anyone moving firewood or ash products from the state or these counties is subject to state and federal fines up to $1,000.00. All fines are the responsibility of the contractor. Obtain updated quarantine information at the DNR Firewood Information Line at (800) 303-WOOD.

Furnishing and Planting Plant Materials
Supplement standard spec 632.2.2 with the following:

Ash trees may be obtained from inside or outside the quarantine area and planted within the quarantined area. Ash trees from within the quarantine area may not be transported and planted into the non-quarantined area.

Updates for Compliance
Each year, as a service, the Wisconsin Department of Agriculture, Trade and Consumer Protection distributes an updated federal CFR listing to nursery license holders and other

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affected persons in this state. More frequent updates, if any, are available on the Department of Agriculture, Trade, and Consumer Protection (DATCP) website at **www.datcp.state.wi.us** . Subsection (1) applies to new regulated areas as those areas are identified in the CFR, regardless of whether affected persons receive update notices from the DATCP. Persons may request update notices by calling (608) 224−4573, by visiting the DATCP website, or by writing to the following address:

Wisconsin Department of Agriculture, Trade and Consumer Protection
Division of Agricultural Resource Management
P.O. Box 8911
Madison WI 53708−8911

Regulated Items
More frequent updates, if any, are available on the DATCP website at **www.datcp.state.wi.us** . Subsection (1) applies to new regulated areas as those areas are identified in the CFR, regardless of whether affected persons receive update notices from DATCP. Persons may request update notices by calling (608) 224−4573, by visiting the DATCP website, or by writing to the above address.
201-SER1 (20100401)

6.2 Removing Railroad Track.

Supplement standard spec 204.5.1 with the following:

Refer to Article 3.4 for proper disposal of railroad track.

6.3 Removing or Abandoning Miscellaneous Structures

Replace standard spec 204.5.1(3) with the following:

When backfilling with Backfill Granular as specified in this special provision article or as directed by the engineer, the item Backfill Granular is considered incidental to the appropriate bid item.

At locations where Backfill Granular is not specified, contractor may choose to use either Backfill or Backfill Granular, and no separate payments will be made for using Backfill Granular.

Supplement standard spec 204.3.2.2 with the following:

Backfill existing storm sewer or existing storm sewer structure locations shown for removal or abandonment outside the new traveled way with native backfill immediately after completing the sewer work. Backfill according to standard spec 209 within the traveled way.

NOT FOR CONSTRUCTION

All backfill, including native material, provided for removal or abandonment of existing storm sewer structures and pipes is considered incidental to the appropriate bid item.

6.4 Removing Utility Vault, Item SPV.0060.2040.

A Description

This special provision describes completely or partially removing utility vaults, including manholes, and disposing of all resulting materials in accordance to the plans, standard specifications, Standard Specifications for Sewer and Water Construction in Wisconsin, latest edition and amendments (SSSW), and as hereinafter provided.

The utility vaults generally vary in size from 4 feet by 6 feet to 8 feet by 12 feet and the utility manholes generally vary in diameter from 4 feet to 8 feet. The utility vault walls vary in thickness between 8 inches and 18 inches and vary in depth between 4 feet and 10 feet.

Removing and abandoning storm sewer manholes and sanitary sewer manholes will be paid for under separate items.

B Materials

Furnish Backfill Granular in accordance to the pertinent requirements of standard spec 209 for use as backfill material as directed by the engineer.

C Construction

Obtain approval from the engineer before removing utility vault. Perform work in accordance to standard spec 204 and as hereinafter provided. The contractor is responsible for the safe methods and sequence of controlled removal operations.

As directed by the engineer, completely remove the utility vault or break down and remove walls and foundations, including all attached parts and connections, to the extent required to avoid interfering with new construction work.

Thoroughly clean the ends of the existing pipes or ducts and bulkhead the existing utility connections to remain with brick or concrete block masonry, or with any grade of concrete specified under standard spec 501.3.1.3, or any engineer-approved commercial grade of concrete, or plug by other engineer-approved method.

Backfill all excavations or voids not occupied by other work under this contract in accordance to standard spec 204.3.1.2.

All materials generated during removal activities are the property of the contractor. Dispose of removed material as specified for disposing of materials in standard spec 203.3.4. This includes, but is not limited to; frames, grates, adjusting rings, bricks, mortar, concrete foundation, conduit, hangers, racks, wiring, pipe, and fittings.

D Measurement

NOT FOR CONSTRUCTION

The City will measure Removing Utility Vault by each individual unit, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2040	Removing Utility Vault	Each

Payment is full compensation for furnishing all excavating; for breaking down the utility vault; for cutting and removing the utility vault; for furnishing any required brick, concrete block, or concrete; for furnishing all plugging and bulkheading; for furnishing all backfilling; for furnishing, placing, and compacting Backfill Granular; and for hauling and disposing of all materials.

6.5 Removing We Energies Steam Trench Box, Item SPV.0090.2050.

A Description
This section describes excavating, removing the concrete trench box, steam pipe, and backfilling of an existing We Energies steam trench box. The insulating materials may contain asbestos and special precautions need to be taken.

B Materials
Furnish granular backfill for backfill conforming to section 209.2.

C Construction
We Energies is to be notified a minimum of one week in advance of potential abatement work for coordination of the abatement contractor.

Excavate and expose the top of the existing trench box, taking care not to expose the inside of the trench box, within the limits of the construction area. Ensure that the trench walls are sloped or shored as necessary so that the We Energies abatement contractor can access the trench box to perform abatement activities. Excavation to the top of the box and sawcutting may be completed for the entire length of the abatement. Once the trench box has been exposed and sawed, and only in the presence of the We Energies abatement contractor, remove the top of the trench box in longitudinal increments not to exceed260 feet or as directed by the We Energies abatement contractor.

The We Energies abatement contractor will then properly abate, remove and dispose of the asbestos in the trench box. The contractor shall provide traffic control permits and signage for the We Energies abatement contractor to use during abatement work. If debris from the top of the trench box fall into the trench box during removal, the We Energies abatement contractor will be responsible for removal and disposal of that debris.

Upon completion of the abatement work, We Energies will install pipe caps on the remaining pipe on each side of the excavation. Then remove the trench box and steam line in the abated area. Bulkhead the ends of the remaining trench box as shown in the plans.

NOT FOR CONSTRUCTION

Backfill all trenches, holes, and pits resulting from the trench box excavation and removal in accordance with subsection 203.3.5 of the standard specifications

D Measurement
The City will measure Removing We Energies Steam Trench Box by the linear foot of steam trench box acceptably completed.

E Payment
The City will pay for the measured quantity at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.2050	Removing We Energies Steam Trench Box	LF

Payment is full compensation for Removing We Energies Steam Trench Box including excavation, sawing and removal of the top of the trench box, removal and proper disposal of the existing steam pipe and trench box, backfill, and for furnishing all labor, equipment, tools and incidentals necessary to complete the work in accordance with the contract.

7. Earthwork.

7.1 Common Excavation

Supplement standard spec 205.3.1 with the following:

Excavate using remote equipment and a smooth-edge bucket.

7.2 EBS Excavation, Item SPV.0035.0001.

A Description
This special provision describes excavating and disposing of material taken below the subgrade of future pavement structures at locations determined by the engineer.

B Materials
Excavate all materials below subgrade as determined by the engineer.. Perform work in accordance to standard spec 205.2.2 and as hereinafter provided.

C Construction
Perform work in accordance to the pertinent provisions of standard spec 205.3 and as hereinafter provided.

C.1 Yielding Subgrade
After rough grading on all or a portion of the subgrade in cut areas and in areas requiring 2 feet or less embankment is complete and the grade is ready for blue tops, point out areas of yielding subgrade to the engineer. The engineer will evaluate the subgrade to determine if EBS Excavation is required.

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If the engineer requests, provide loaded trucks or smaller equipment if needed to prevent disturbance of the subgrade as the engineer directs to evaluate suitability of the subgrade. Perform EBS Excavation in yielding or otherwise unsuitable areas as directed by the engineer.

C.2 Excavation Below Subgrade

Excavate materials as directed by the engineer. Remove unsuitable soil to the depth below finished grade as the engineer directs. Suitable soil includes deposits of frost-heave material; soft, loose, or unstable soil; material salvaged from prior excavation or construction;topsoil or other material containing considerable amounts of humus or vegetable matter;, and other undesirable foundation material as determined by the engineer..

Excavate using remote equipment and a smooth-edge bucket. Except for a smooth drum roller in static mode, tracks or tires may not be allowed on the overexcavated subgrade until geotextile and at least one foot of backfill has been placed on an approved subgrade.

Compact, or prepare otherwise as required, the existing ground within the roadway foundation as necessary to support the roadway and attain the specified density.

Dispose of all excavated materials offsite at no expense to the City. Locate disposal sites outside the right-of-way and comply with all regulations relating to disposal of solid waste. Ensure that disposal sites are neatly constructed. In performing these operations, do not create a nuisance or cause pollution or siltation of natural watercourses, streams, lakes, wetlands, or reservoirs. Obtain written permits for disposal from the owner of the property where placing the material, unless disposing of the material at a licensed waste disposal operation. Furnish permits, or copies of permits, to the engineer before disposal. Do not deposit waste in wetlands.

C.3 Temporary Drainage

During construction, slope and drain the excavation bottoms to prevent water accumulation and deterioration of approved subgrades. If it is necessary in the prosecution of the work to interrupt existing surface drainage, sewers, or under drainage, provide temporary drainage until completing permanent drainage work.

D Measurement

The City will measure EBS Excavation by the cubic yard, acceptably completed as computed using the method of average end areas, with no correction for curvature.

The City will not measure for payment materials excavated in forming benches or steps in preparing the foundation for embankments placed on slopes.

The City will not measure for payment materials excavated to remove frost from newly constructed embankments or cut subgrades unless directed by the engineer.

NOT FOR CONSTRUCTION

If undercutting designated slopes to provide for placing topsoil or salvaged topsoil, the undercut is incidental to the Topsoil or Salvaged Topsoil bid items.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0035.0001	EBS Excavation	CY

Payment for EBS Excavation is full compensation for performing excavation below subgrade after receiving engineer approval; for the satisfactory disposal of all resulting material offsite; for obtaining and furnishing copies of permits; for furnishing, placing, and removing all temporary drainage installations; and for providing loaded trucks and running them on the subgrade to confirm yielding areas.

The City will only pay for engineer-approved EBS Excavation to correct problems beyond the contractor's control. Work performed under standard spec 105.3 to correct unacceptable work is the contractor's responsibility.

7.3 EBS Backfill, Item SPV.0035.0002.

A Description

This special provision describes backfilling EBS Excavation with select crushed material.

B Materials

Furnish all materials in accordance to standard spec 312.2 and as hereinafter provided.

C Construction

Place WisDOT Type SR Geotextile directly on approved overexcavated subgrade prior to backfilling. The geotextile shall be installed across the entire width of the pavement cut, along sides, and wrap at least 1 foot on top of as shown on the plans. Backfill placed upon the geotextile shall consist of crushed limestone conforming to WisDOT Open Graded Base, standard specification 310. After placing at least 12 inches but no more than 15 inches of Open Graded Base, compact Open Graded Base using a smooth drum roller in static mode or other suitable compaction equipment, Compaction effort shall consist of making two passes in the longitudinal direction of the track alignment. Place and compact any subsequent lifts in loose lifts not exceeding 6 inches in thickness.

Except for a smooth drum roller in static mode, tracks or tires may not be allowed on the backfill until geotextile and at least one foot of backfill has been placed on an approved subgrade. Vibratory equipment shall not be used for rolling or compaction.

D Measurement

The City will determine weight or volume, adjust for moisture, and convert between weight and volume as specified in standard spec 301.4.

The City will measure EBS Backfill by the cubic yard, acceptably completed.

NOT FOR CONSTRUCTION

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0035.0002	EBS Backfill	CY

Payment for EBS Backfill is full compensation for providing and compacting select crushed material in areas of EBS Excavation.

The City will only pay for EBS Backfill at engineer-approved EBS Excavation locations. Work performed under standard spec 105.3 to correct unacceptable work is the contractor's responsibility.

The City will not pay for EBS Backfill to replace materials excavated to remove frost from newly constructed embankments or cut subgrades.

8. Roadway and Miscellaneous Civil.

8.1 Open Graded Base

Supplement standard spec 310.3 with the following:

Place WisDOT Type SR Geotextile directly on approved excavated subgrade prior to backfilling. The geotextile shall be installed across the entire width of the pavement cut, along sides, and wrap at least 1 foot on top of as shown on the plans. Backfill placed upon the geotextile shall consist of crushed limestone conforming to WisDOT Open Graded Base, standard specification 310. After placing at least 12 inches but no more than 15 inches of Open Graded Base, compact Open Graded Base using a smooth drum roller in static mode or other suitable compaction equipment, Compaction effort shall consist of making two passes in the longitudinal direction of the track alignment.

Except for a smooth drum roller in static mode, tracks or tires may not be allowed on the backfill until geotextile fabric and at least one foot of backfill has been placed on an approved subgrade. Vibratory equipment shall not be used for rolling or compaction.

8.2 Geotextile Fabric Type SR.

Supplement standard spec 645.2.5 with the following:

Use geotextile fabric conforming to the following physical properties or better:

Mechanical Properties	**Test Method**	**Unit**	**Minimum Average Roll Value**	
			MD	**CD**
Tensile Strength (at	ASTM	lbs/ft	3600	3240

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ultimate)	D4595			
Tensile Strength (at 5% strain)	ASTM D4595	lbs/ft	1500	1560
			Minimum Roll Value	
Flow Rate	ASTM D4491	gal/min/ft^2	40	
Permittivity	ASTM D4491	sec^{-1}	0.9	
			Minimum Opening Size	
Apparent Opening Size (AOS)	ASTM D4751	U.S. Sieve	40	
			Typical Test Value	
Pore Size 0_{95}[1]	ASTM D6767	microns	292	
Pore Size 0_{50}[1]	ASTM D6767	microns	158	
			Minimum Test Value	
Factory Sewn Seam	ASTM D4884	lbs/ft	2400	
UV Resistance (at 500 hours)	ASTM D4355	% strength retained	80	

[1] Based on Third Party Testing

Replace standard spec 645.3.5(1) with the following:

Before placing the geotextile smooth and shape the roadway to the required grade and section, and overexcavate unsuitable material or scarify and compact to the specified density. After placing the geotextile on the earth grade as shown on the plans, the contractor shall not allow traffic or construction equipment to travel on the geotextile until at least 12 inches of material has been placed.

Replace standard spec 645.3.5(5) with the following:

Place the backfill material in an initial minimum lift of 12 inches. Maximum loose lift thickness of subsequent lifts shall be 6 inches. Spread each lift with a crawler type tractor and compact with a smooth drum roller in static mode or other suitable compaction equipment. The contractor shall not use construction equipment that causes ruts and tracks or tires may not be allowed on the backfill until geotextile and at least one foot of backfill has been placed on an approved subgrade and geotextile.

Compaction effort shall consist of making two passes in the longitudinal direction of the track alignment. Vibratory equipment shall not be used for rolling or compaction.

NOT FOR CONSTRUCTION

The engineer will not allow turning movements for any hauling or spreading equipment on the geotextile until at least 2 feet of backfill is placed and compacted. Do not begin subsequent lifts until spreading and compacting a distance of at least 200 feet of the previous lift. Maintain a minimum 200-foot interval between subsequent lifts until completing each lift. If ruts develop during construction operations, the engineer shall require the contractor to use lighter equipment, equipment with lower contact pressure, or smaller loads on existing equipment.

Delete standard spec 645.3.5(6)

8.3 Removing Concrete Surface Partial Depth, Item 204.0109.S.

A Description
This special provision describes removing a portion of the concrete surfaces as shown on the plans according to standard spec 204, and as hereinafter provided.

B (Vacant)

C Construction

C.1 Equipment
Use a machine that provides a surface finish acceptable to the engineer. Shroud the machine to prevent discharge of any loosened material into adjacent work areas or live traffic lanes.

Use a machine that is equipped with electronic devices that provide accurate depth, grade and slope control, and acceptable dust control system.

C.2 Methods
Remove existing concrete to the depths as shown on the plan by grinding, planing, chipping, sawing, milling, or by using other methods approved by the engineer.

Perform the removal operation in such a manner as to preclude damage to the remaining pavement and results in a reasonable uniform plane surface free of excessive large scarification marks and having a uniform transverse slope.

The sequence of removal operations shall be such that no exposed longitudinal joints 2 inches or more in depth remain during non-working hours. Windrowing or storing of the removed material on the roadway will only be permitted in conjunction with a continuous removal and pick-up operation. During non-working hours, clear the roadway of all materials and equipment.

The removed pavement shall become the property of the contractor. Properly dispose of it according to standard spec 204.3.1.3.

D Measurement

NOT FOR CONSTRUCTION

The City will measure Removing Concrete Surface Partial Depth in area by the square foot of surface area removed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
204.0109.S	Removing Concrete Surface Partial Depth	SF

Payment is in full compensation for removing the concrete; and for disposing of materials.

204-041 (20080902)

8.4 Trenching & Trench Restoration, Item SPV.0090.0005.

A Description

This special provision describes trenching for conduit placement and restoration of disturbed areas as shown on the plans and in accordance to the pertinent requirements of the Standard Specifications and as hereinafter provided.

B Materials

Furnish materials that are in accordance with the plans and to the following sections of the Standard Specifications and as modified in the special provisions:

Removing and Abandoning Miscellaneous Structures 204
Roadway and Drainage Excavation 205
Borrow 208
Granular Backfill 209
Dense Graded Base 305
Concrete Pavement 415
Concrete Pavement – Appurtenant Construction 416
Asphaltic Materials 455
Hot Mix Asphalt Pavement 460
Concrete Curb and Gutter 601
Concrete Sidewalks, Loading Zones, Safety Islands, and Steps 602
Topsoil and Salvaged Topsoil 625
Sodding 631
Sawing 690

For backfill slurry use fine aggregate in accordance to standard spec 501.2.5.3 and number 1 coarse aggregate conforming to standard spec 501.2.5.4, and water conforming to standard spec 501.2.4 in the backfill slurry mix. Weigh aggregates at a batch plant suitable for batching concrete masonry. Mix and deliver to the project site using a truck mixer. Add enough water to enable the mixture to flow readily. Submit a mix design for the engineers review prior to placement. Backfill Slurry is considered a class III concrete mix and the City will accept the mix by certification and will follow the QMP process per section 716. Mix acceptance and testing in the field is not required.

NOT FOR CONSTRUCTION

C Construction

Construct trenching & trench restoration in accordance with the plans and to the following sections of the standards specifications and as modified in the special provisions:

Removing and Abandoning Miscellaneous Structures 204
Roadway and Drainage Excavation 205
Borrow 208
Granular Backfill 209
Dense Graded Base 305
Concrete Pavement 415
Concrete Pavement – Appurtenant Construction 416
Asphaltic Materials 455
Hot Mix Asphalt Pavement 460
Concrete Curb and Gutter 601
Concrete Sidewalks, Loading Zones, Safety Islands, and Steps 602
Topsoil and Salvaged Topsoil 625
Sodding 631
Sawing 690

Prior to placement of backfill slurry provide for positive drainage of the area to be backfilled. Discharge from the truck in a manner to prevent segregation. Consolidation or compaction effort will not be required. Twelve hours shall elapse before paving over the backfill.

Material placed within trenches is subject to the quality control for the zone that the material is located in and conforms to Standard Specifications Part 7 – Quailty Management Program and Chapter 8 of the Wisconsin Department of Transporation's construction and materials manual (CMM). Non-conforming slurry will be replaced at no additional cost to the City.

The contractor may obtain the CMM from the department's web site at:
http://roadwaystandards.dot.wi.gov/standards/cmm/index.htm

D Measurement

The City will measure Trenching & Trench Restoration as a linear foot of work acceptably completed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.0005	Trenching & Trench Restoration	LF

NOT FOR CONSTRUCTION

Payment is full compensation for:

E.1 Removing or Abandoning Miscellaneous Structures

(1) Breaking down, removing, closing, plugging, or sealing
(2) Obtaining any required work permits
(3) Hauling and disposing of materials
(4) Providing any required bentonite, soil, brick, concrete block, or concrete
(5) Restoring the roadway cross-section
(6) Backfilling using the Backfill Granular or Slurry
(7) Other work involved in removing or abandoning miscellaneous structures within the roadway is incidental to the work.
(8) Removing existing railroad tracks in accordance to Standard Specifications section 204.

E.2 Roadway and Drainage Excavation

(1) Providing common excavation
(2) Engineer-approved EBS to correct problems beyond the contractor's control. Work performed under 105.3 to correct unacceptable work is the contractor's responsibility.
(3) Removing walls, foundations, etc., the satisfactory disposal of resulting material, and the backfilling of basements or openings resulting from removing walls, foundations, etc.
(4) Constructing and removing all temporary drainage installations as specified under 205.3.3 is incidental to the work under this section.
(5) Refilling and compacting washouts caused by erosion under the contract bid item for the additional volume of material used, or as extra work according to 107.14, except that if the erosion is caused by the contractor’s negligence then the contractor performs refilling and compaction at no expense to the City.

E.3 Borrow

(1) Providing all borrow material.
(2) Clearing, grubbing, excavating, sloping, shaping, trimming, loading, hauling, and placing.
(3) Compacting.
(4) Disposing of surplus and unsuitable material.
(5) Salvaging, stockpiling, rehandling, and spreading salvaged material for covering the surfaces of excavated areas within borrow sites.
(6) Water for compaction and dust control.
(7) Erosion control, fertilizing, and seeding of borrow sites and associated areas separately as specified for borrow sites and material disposal sites in 628.5.1.

E.4 Granular Backfill

(1) Providing all granular backfill material.
(2) Excavating, loading, hauling, placing, compacting, and finishing the material.
(3) Stripping, clearing, grubbing, shaping, trimming and cleaning up the pits.

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(4) Salvaging, stockpiling, rehandling, and spreading salvaged material over excavated pit areas
(5) Disposing of surplus materials.
(6) Erosion control, fertilizing, and seeding of borrow sites and associated areas separately as specified for borrow sites and material disposal sites in 628.5.1.
(7) The City will not pay separately for granular backfill material specifically designated as incidental to other contract bid items.

E.5 Backfill Slurry
(1) Providing mix design
(2) Furnishing, mixing, transporting and placing backfill slurry
(3) QMP certification.
(4) No separate payment will be made for providing positive drainage of the area to be backfilled.

E.6 Dense Graded Base
(1) Preparing the foundation.
(2) Stockpiling, placing, shaping, compacting, and maintaining the base.
(3) Water for compaction and dust control.

E.7 Concrete Pavement
(1) Providing pavement.
(2) Preparing the foundation.
(3) Placing thickness plates.
(4) Sawing joints.
(5) Thickness coring and filling core holes as required under 415.3.16.4.
(6) Providing tie bars and dowel bars within concrete placed under the contract.
(7) Providing Drilled Tie Bars and Drilled Dowel Bars to connect work to concrete not placed under the contract.
(8) The City will not pay for removal and replacement of pavement not meeting the surface smoothness tolerances specified in 415.3.11
(9) The City will adjustment for materials in accordance with sections 415.5.2 and 415.5.3 of the Standard Specifications.

E.8 Concrete Pavement – Appurtenant Construction
(1) Providing tie bars, including coating.
(2) Providing dowel bars
(3) Drilling holes in concrete not placed under the contract.
(4) Epoxying or driving.
(5) The City will adjustment for materials in accordance with section 416.5.2 of the Standard Specifications.

E.9 Asphaltic Materials
(1) Providing the asphaltic material, including recovered asphaltic material as calculated under 455.4.2; and for
(2) Transporting, heating, and placing in the mixer.

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(3) Providing tack coat.
(4) Preparing the surface.
(5) Transporting and heating.
(6) Diluting with water.
(7) Maintaining the completed work.
(8) The City will adjustment for materials in accordance with sections 455.5.2 and 455.5.3 of the Standard Specifications.

E.10 Hot Mix Asphalt Pavement

(1) providing HMA mixture designs.
(2) preparing foundation.
(3) furnishing, preparing, hauling, mixing, placing, and compacting mixture.
(4) QMP testing and aggregate source testing; for warm mix asphalt additives or processes.
(5) All materials including asphaltic materials
(6) Warm mix asphalt additives and processes
(7) Leveling layer, placed to correct irregularities in an existing paved surface before overlaying
(8) If the City waives density testing under 460.3.3.3, the City will not adjust pay under either 460.5.2.2 or 460.5.2.3.
(9) Restore the surface after cutting density samples as specified in 460.3.3.2(1) at no additional cost to the City.
(10) Additional materials and equipment specified for cold weather paving under 460.3.4 including costs for preparing, administering, and following the contractor's cold weather paving plan.

E.11 Concrete Curb and Gutter

(1) All foundation excavation and preparation.
(2) All special construction required at driveway and alley entrances, or curb ramps.
(3) Providing all materials, including concrete, expansion joints.
(4) Placing, finishing, protecting, and curing.
(5) Sawing joints.
(6) Disposing of surplus excavation material, and restoring the work site.
(7) Providing tie bars in accordance with section 416 of the Standard Specifications.
(8) Drilling holes in concrete not placed under the contract.

E.12 Concrete Sidewalks, Loading Zones, Safety Islands, and Steps

(1) Providing all materials, including concrete, reinforcement, and expansion joints.
(2) Excavating and preparing the foundation.
(3) Backfilling and disposing of surplus material.
(4) Placing, finishing, protecting, and curing; and restoring the work site.
(5) Sawing joints.
(6) Providing tie bars and dowel bars in unhardened concrete.
(7) Drilling holes in concrete not placed under the contract

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(8) When preparing the foundation the contractor may use granular subbase, or aggregate base, in this case, the City will not make additional compensation for this item.

E.13 Topsoil and Salvaged Topsoil

(1) Providing, excavating, loading, hauling, and placing this material.
(2) Undercutting excavations, or underfilling embankments necessary to receive this material.
(3) The City will make no allowance, adjustment, or measurement for payment under the Excavation bid items for undercutting cut sections, or underfilling embankments.

E.14 Sodding

(1) Preparing the earth bed.
(2) Furnishing, placing, staking, and rolling the sod.
(3) Providing, hauling, and applying the water.

E.15 Sawing

(1) All sawing and sludge removal.

8.5 Concrete Curb 18-Inch, Item SPV.0090.0010; Rolled Curb & Gutter 24-Inch, Item SPV.0090.0011; Concrete Curb & Gutter 25-Inch, Item SPV.0090.0012; Concrete Curb & Gutter 43-Inch, Item SPV.0090.0013.

A Description

This work consists of furnishing all materials and constructing a cast-in-place concrete curb and concrete curb & gutter section as shown on the plans, in accordance with section 601 of the standard specifications, and as hereinafter provided.

B (Vacant)

C (Vacant)

D Measurement

The City will measure Concrete Curb 18-Inch, Rolled Curb & Gutter 24-Inch, Concrete Curb & Gutter 25-Inch, and Concrete Curb & Gutter 43-Inch by the linear foot acceptably completed, measured along the gutter flow line.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.0010	Concrete Curb 18-Inch	LF
SPV.0090.0011	Rolled Curb & Gutter 24-Inch	LF
SPV.0090.0012	Concrete Curb & Gutter 25-Inch	LF

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SPV.0090.0013	Concrete Curb & Gutter 43-Inch	LF

Payment is full compensation for excavating and preparing the foundation; for providing all materials, including concrete, and expansion joints; placing, finishing, protecting and curing concrete; and for furnishing all labor, equipment, tools and incidentals necessary to complete the work.

8.6 Concrete Base Variable Depth, Item SPV.0180.0015.

A Description
This work consists of furnishing all materials and constructing a concrete base as shown on the plans, in accordance with section 320 of the standard specifications, and as hereinafter provided.

B (Vacant)

C (Vacant)

D Measurement
The City will measure Concrete Base Variable Depth by the square yard acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0180.0015	Concrete Base Variable Depth	SY

Payment is full compensation for providing curing, and protecting concrete; for providing tie bars and dowel bars in unhardened concrete; and for furnishing all labor, equipment, tools and incidentals necessary to complete the work.

8.7 Joint Sealing, Item SPV.0180.0020.

A Description
This special provision describes preparing the pavement joint or crack, and furnishing and installing sealant. Seal all expansion, hand-formed, and sawed joints in the pavement. Also seal bond or construction joints.

B Materials
B.1 Joint Sealer
Use joint sealer that complies with the requirements of ASTM Designation D3405. Joint sealer shall be composed of a mixture of materials that will form a resilient and adhesive compound capable of effectively sealing joints in concrete against the infiltration of moisture and foreign material throughout repeated cycles of expansion and contraction with temperature changes, and that will not flow from joints or be picked up by vehicle tires at summer temperatures. The material shall be capable of being brought to a uniform

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pouring consistency suitable for completely filling the joints without inclusion of large air holes or discontinuities.

The joint sealer shall be elastic-type, but poured, and it shall be melted by indirect heat in suitable equipment provided with positive temperature control and mechanical agitation. The material shall not be damaged when heated to the temperature required for satisfactory pouring.

Only apply joint sealer when the atmospheric and concrete temperatures are above 40° F.

C Construction

C.1 Preparation of Pavement Joint or Crack

Clean the pavement joint or crack of all foreign material prior to the installation of the. joint sealer. Completely remove the slurry resulting from the sawing operations from the joint by blowing it clean with compressed air using a minimum air pressure of 80 psi.

D Measurement

The City will measure Joint Sealing by the area of pavement acceptably sealed in square yards.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0180.0020	Joint Sealing	SY

Payment is full compensation for furnishing and placing the sealant; properly cleaning the cracks and joints; and for furnishing all labor, tools, equipment and incidentals necessary to complete the work.

8.8 Stop Platform 1C, Item SPV.0105.0030; Stop Platform 2E, Item SPV.0105.0031; Stop Platform 2W, Item SPV.0105.0032; Stop Platform 3E, Item SPV.0105.0033; Stop Platform 3W, Item SPV.0105.0034; Stop Platform 4E, Item SPV.0105.0035; Stop Platform 4W, Item SPV.0105.0036; Stop Platform 5E, Item SPV.0105.0037; Stop Platform 5W, Item SPV.0105.0038; Stop Platform 6C, Item SPV.0105.0039; Stop Platform 7E, Item SPV.0105.0040; Stop Platform 7W, Item SPV.0105.0041; Stop Platform 8E, Item SPV.0105.0042; Stop Platform 8W, Item SPV.0105.0043; Stop Platform 9E, Item SPV.0105.0044; Stop Platform 9W, Item SPV.0105.0045; Stop Platform 10C Item SPV.0105.0046.

A Description

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This special provision describes construction of the Stop Platforms as shown on the plans and in accordance to the pertinent requirements of the standard specifications and as hereinafter provided.

B Materials

Furnish materials that are in accordance with the plans and to the following sections of the standard specifications and as modified in the special provisions:

Excavation..... 205
Open Graded Base 310
Reinforcement..... 505
Concrete 602
Geotextile Fabric Type SR..... 645

Furnish Detectable Warning Fields in accordance with section 602 of the standard specifications and of the color yellow.

C Construction

Construct stop platforms in accordance with the plans and to the following sections of the standards specifications and as modified in the special provisions:

Excavation..... 205
Open Graded Base 310
Reinforcement..... 505
Concrete 602
Geotextile Fabric Type SR..... 645

D Measurement

The City will measure Stop Platforms as a lump sum unit for each stop platform placed and accepted.

Architectural amenities affixed to Stop Platforms are measured and paid for separately.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.0030	Stop Platform 1C	LS
SPV.0105.0031	Stop Platform 2E	LS
SPV.0105.0032	Stop Platform 2W	LS
SPV.0105.0033	Stop Platform 3E	LS
SPV.0105.0034	Stop Platform 3W	LS
SPV.0105.0035	Stop Platform 4E	LS
SPV.0105.0036	Stop Platform 4W	LS
SPV.0105.0037	Stop Platform 5E	LS

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SPV.0105.0038	Stop Platform 5W	LS
SPV.0105.0039	Stop Platform 6C	LS
SPV.0105.0040	Stop Platform 7E	LS
SPV.0105.0041	Stop Platform 7W	LS
SPV.0105.0042	Stop Platform 8E	LS
SPV.0105.0043	Stop Platform 8W	LS
SPV.0105.0044	Stop Platform 9E	LS
SPV.0105.0045	Stop Platform 9W	LS
SPV.0105.0046	Stop Platform 10C	LS

Payment is full compensation for excavating and preparing the foundation; for furnishing and installing all materials, including Open Graded Base, Geotextile Fabric, Concrete, Reinforcement, and Detectable Warning Fields; and for furnishing all equipment, labor, tools, and incidentals necessary to complete the contract work.

9. Structures.

9.1 Construction on the St. Paul Avenue Lift Bridge.

The City of Milwaukee will be responsible for raising, lowering, and opening the existing bridge to river traffic until the contractor is permitted to begin rehabilitating the bridge.

Work restrictions and permitting requirements for work on the St. Paul Avenue lift bridge over the Milwaukee River are in the process of being developed by the City of Milwaukee. Information will be shared with the contractor once available.

9.2 Debris Containment St. Paul Avenue Bridge, Item 203.0225.S.

A Description

This special provision describes providing a containment system to prevent debris from structure removal, reconstruction, or other construction operations from falling onto facilities located under the structure. Using this containment system does not relieve the contractor of requirements under standard spec 107.17 and standard spec 107.19 or requirements under a US Army Corps of Engineers Section 404 Permit.

B (Vacant)

C Construction

Prior to starting work, submit a debris containment plan to the engineer for review. Incorporate engineer-requested modifications.

Maintain adequate protection throughout construction for people and property within the potential fall zone. Ensure that a containment system capable of protecting underlying facilities from falling construction debris is in place before beginning deck repair, parapet removal, or other operations that may generate debris.

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D Measurement
The City will measure Debris Containment St. Paul Avenue Bridge as a single lump sum unit of work for each structure, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
203.0225.S.	Debris Containment St. Paul Avenue Bridge	LS

Payment is full compensation for furnishing, installing, maintaining, and removing a debris containment system.
203-010 (20080902)

10. Drainage and Erosion Control.

10.1 Erosion Control.

Supplement standard spec 107.20 with the following:

Erosion control best management practices (BMP's) shown on the plans are at suggested locations. The actual locations will be determined by the contractor's ECIP and by the engineer. Include each dewatering (mechanical pumping) operation in the ECIP submittal. The ECIP will supplement information shown on the plans and not reproduce it. The ECIP will identify how to implement the project's erosion control plan. ECIP will demonstrate timely and diligently staged operations, continuing all construction operations methodically from the initial removals and topsoil stripping operations through the subsequent grading, paving, and re-application of top soil to minimize the period of exposure to possible erosion.

Do not allow any excavation for; structures, utilities, grading, maintaining drainage that requires dewatering(mechanical pumping) of water containing sediments (sand, silt, and clay particles) to leave the work site or discharge to a storm water conveyance system without sediment removal treatment. Prior to each dewatering operation, submit to the City a separate ECIP amendment describing in words and pictorial format an appropriate BMP for sediment removal, in accordance to WisDNR Storm Water Construction Technical Standard, Code 1061, Dewatering. Include reasoning, location, and schedule duration proposed for each operation. Per Code 1061, include all selection criteria: site assessment, dewatering practice selection, calculations, plans, specifications, operations, maintenance, and location of proposed treated water discharge. Provide a stabilized discharge area. If directing discharge towards or into an inlet structure, provide additional inlet protection for back-up protection. Dewatering will be paid for under other bid items in this contract.

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10.2 Maintaining Drainage.

Maintain drainage at and through worksite during construction in accordance to standard specs 107.22, 204, 205 and 520.

Use existing storm sewers, existing culvert pipes, existing drainage channels, temporary culvert pipes, or temporary drainage channels to maintain existing surface and pipe drainage. Pumps may be required to drain the surface, pipe, and structure discharges during construction. Costs for furnishing, operating, and maintaining the pumps is considered incidental to the project.

Dewatering (Mechanical Pumping) for Bypass Water (sediment-free) Operations
If dewatering bypass operations are required from one pipe structure to another downstream pipe structure or from the upstream to downstream end of a culvert and the bypass flow is not transporting sediments (sand, silt, and clay particles) from a tributary work site area, bypass pumping operations will be allowed provided that the City has been made aware of and approves operation. When pumping bypass flows, the discharge location will need to be stable and not produce any erosion from the discharge velocity that would cause release of sediment downstream.

Dewatering (Mechanical Pumping) for treatment Water (sediment-laden) Operations
If dewatering operations require pumping of water containing sediments (sand, silt, and clay particles), the discharge will not be allowed to leave the work site or discharge to a storm water conveyance system without sediment removal treatment. Refer to article Erosion Control in these special provisions for additional requirements.

10.3 Inlet Screen Type M, Item SPV.0060.3500; Inlet Screen Type R, Item SPV.0060.3501.

A Description
This special provision describes furnishing, installing, and maintaining proper inlet screens as directed by the engineer, as shown on the drawings, and as hereinafter provided.

B Materials
Use woven filtration geotextile fabric with the following physical properties:

Test	Method	Value
Grab Tensile Strength (lbs)	ASTM D-4632	180 min.
Mullen Burst (lbs/in^2)	ASTM D-3786	200 min.
Equivalent Sieve Size	ASTM D-4751	US No. 30 max.
Water Flow Rate (gpm/ft^2)	ASTM D-4491	140 min.
Permitivity (sec^{-1})	ASTM D-4491	1.9 min.
Permeability (cm/sec)	ASTM D-4491	0.14 min.

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C Construction

C.1 Installation

The control of soil erosion requires flexibility to accommodate changing conditions as the construction project progresses. In general, install the erosion control device at locations as described on the plan.

At the inlet locations where curb and gutter and the inlet frame are removed, install a Type R screen. Following curb and gutter replacement, install a Type M screen.

Install Type M screens at all locations designated as overflow inlets and also at inlets where curb will not be removed. If the inlet being protected has a side inlet box, seal the inlet box until inlet protection is no longer needed. These screens must be in place prior to the start of any work, including sawing.

Install Type R screens at all inlets and storm or combined sewer manholes, should the frame on the structure be removed. Install these screens, for preventing infiltration of solids into the sewer system, on the day that the removal takes place. When it becomes necessary to remove a brick from a drainage structure in order to drain the subgrade, use 6 filter screen approximately the size and shape of one-half of the Type R. Cost of providing this protection, as well as that required for storage piles of earth, gravel, stone, or other debris shall be the responsibility of the contractor.

C.2 Maintenance

Continue cleaning and repair of all types of control devices until the engineer accepts the work. All such cleaning and repair, as well as the eventual removal of the devices, is the responsibility of the contractor.

Completely clean out manholes into which dirt or other debris has fallen before the end of each work day. Should the contractor not perform the cleaning as required, his operation may be shut down until the situation is corrected.

Protect all control measures protruding above the normal paved and/or ground surface where vehicular and/or pedestrian traffic is being maintained by barricades with flashing lights.

Inspect the inlet basket within 24 hours after each rainfall or daily during extended periods of precipitation. Make repairs immediately, as necessary, to prevent particles from reaching the sewage system and/or causing surface flooding.

Remove sediment deposits after each storm event, or as often as the fabric becomes clogged. Failure to maintain clean debris-free inlet baskets may result in the contractor's operations being shut down.

D Measurement

The City will measure Inlet Screens (Type) as each individual unit, acceptably completed.

NOT FOR CONSTRUCTION

E Payment

The City will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.3500	Inlet Screen Type M	Each
SPV.0060.3501	Inlet Screen Type R	Each

Payment is full compensation for the number of actual devices supplied, installed and properly maintained.

10.4 Pavement Cleanup, Item SPV.0075.3505.

A Description

This special provision describes cleanup of dust and debris from pavements within and adjacent to the job site. Pavement Cleanup includes surveillance and reporting of all active haul routes.

B Materials

B.1 Pavement Cleanup

Furnish a vacuum-type street sweeper equipped with a power broom, water spray system, and a vacuum collection system.

Utilize vacuum equipment with a self-contained particulate collector capable of preventing discharge from the collection bin into the atmosphere.

Use a vacuum-type sweeper as the primary sweeper, except as specified herein or approved by the engineer.

C Construction

C.1 Surveillance

Provide daily surveillance of active haul routes to identify if material is being tracked from the jobsite. Document the condition of the roads and if they needed to be swept in a daily report. Submit reports to the engineer daily, including hourly metered tickets for that day's sweeping activities. Clean up spillage and material tracked to/from the project within an hour of occurrence or as directed by the engineer. Perform cleanup operations in a safe manner.

C.2 Pavement Cleanup

Keep all pavements, curb lanes and gutters both closed and open to public traffic within the job-site boundaries free of dust and debris generated from any activity under the contract. Keep all pavements, curb lanes and gutters adjacent to the project free of dust and debris that are affected by land disturbing, dust generating activities, as defined in the contractor's dust control implementation plan.

NOT FOR CONSTRUCTION

Provide routine sweeping of all pavements, curb lanes and gutters on local street active haul routes a minimum of once a day as defined in the Dust Control Implementation Plan (DCIP) or as directed by the engineer.

In addition to routine sweeping, conduct sweepings as the engineer directs or approves, to deal with dust problems that might arise during off-work hours or emergencies. Provide the engineer with a contact person available at all times to respond to requests for emergency sweeping. Respond to emergency sweeping requests within 4 hours of notice.

D Measurement
The City will measure Pavement Cleanup (Project) by the hour acceptably completed.

Tickets shall include date, company, operator name, equipment make/model, routes swept, and total hours. Total hours shall be to the nearest 0.25 hour that work under this item was performed.

Compensation for mobilizing equipment shall be included in the contract price for Pavement Cleanup and no additional compensation therefore will be allowed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0075.3505	Pavement Cleanup	HR

Payment is full compensation for daily surveillance; preparing and submitting the daily surveillance report with hourly metered tickets; mobilization; sweeping; and disposing of materials.

10.5 Manhole Cover Type 58A, Item SPV.0060.3510.

A Description
This special provision describes furnishing and installing Manhole Cover Type 58A.

Perform work under these items in accordance to the requirements of standard spec 611 and the details as shown on the plans.

B (Vacant)

C (Vacant)

D Measurement
The City will measure Manhole Cover Type 58A as each individual unit, acceptably completed.

E Payment

NOT FOR CONSTRUCTION

The City will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.3510	Manhole Cover Type 58A	Each

Payment is full compensation for removing and salvaging the existing covers where they exist; and for providing new covers, including frames, grates or lids, and all other required materials and for installing and adjusting each cover. Old covers removed remain the property of the City.

10.6 Catch Basin Type 44A, Item SPV.0060.3511.

A Description
This special provision describes furnishing and installing Inlet Type 44A.

Perform work under these items in accordance to the requirements of standard spec 611 and the details as shown on the plans.

B (Vacant)

C (Vacant)

D Measurement
The City will measure Inlet Type 44A as each individual unit, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.3511	Catch Basin Type 44A	Each

Payment is full compensation for providing all materials, including masonry, conduit and sewer connections, and other fittings; for furnishing all excavating, backfilling, disposing of surplus material, and for cleaning out and restoring the work site; for furnishing all labor, equipment tools, and incidentals necessary to complete the work in accordance to the contract; except that the City will pay for covers, including frames, grates, and lids under separate bid items.

10.7 Bowl Curb Inlet, Item SPV.0060.3512.

A Description
Furnish and Install the Bowl Curb Inlet at the locations indicated on the plans and specified herein.

B Materials

NOT FOR CONSTRUCTION

Furnish Bowl Curb Inlet that is in accordance to the pertinent requirements of section 611 of the standard specifications and the details as shown on the plans.

C Construction
Take adequate measures to install and maintain necessary support under the Bowl Curb Inlet, during the paving operations.

Perform work under this item in accordance to the requirements of Section 611 of the standard specifications, and the details as shown on the plans and described in this special provision.

D Measurement
The City will measure Bowl Curb Inlet by each individual unit acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.3512	Bowl Curb Inlet	Each

The cost of concrete base and modifications to the subgrade supporting the Bowl Curb Inlet, and rebar in the concrete curb head shall be included in the unit price for the item Bowl Curb Inlet.

Payment is full compensation for installing and furnishing all required materials, including cast iron sub-basin bowl, catch basin elbow, and flexible clamped coupling.. This includes all labor, tools, equipment and incidentals necessary to complete the work.

10.8 Inlet Cover Type 57, Item SPV.0060.3513.

A Description
This special provision describes furnishing and installing Inlet Covers Type 57.

Perform work under these items in accordance to the requirements of standard spec 611 and the details as shown on the plans.

B (Vacant)

C (Vacant)

D Measurement
The City will measure Inlet Cover Type 57 as each individual unit, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT

NOT FOR CONSTRUCTION

SPV.0060.3513	Inlet Cover Type 57	Each

Payment is full compensation for removing and salvaging the existing covers where they exist; and for providing new covers, including frames, grates or lids, and all other required materials and for installing and adjusting each cover. Old covers removed remain the property of the City.

10.9 Low-Flow Check Valve, Item SPV.0060.3520.

A Description

This special provision describes furnishing and installing a low-flow check valve at track drain connections to combined sewer manholes.

B Materials

Low-flow check valves shall be slip-in or flanged Tideflex Technologies CheckMate or approved equal.

Supplier shall have at least twelve (12) years experience in the design and manufacture of low-flow check valves.

Manufacturer shall have conducted independent hydraulic testing to determine headloss, jet velocity and vertical opening height characteristics on multiple sizes of low-flow check valves ranging from 4" through 72". The testing must have been conducted for free discharge (discharge to atmosphere) and submerged conditions.

Low-flow check valves are to be all rubber and the flow operated check type with slip-in cuff or flange connection. The entire valve assembly shall be ply reinforced throughout the body, disc and bill, which is cured and vulcanized into a one-piece unibody construction. A separate valve body or pipe used as the housing shall not be accepted. The valve shall be manufactured with no metal, mechanical hinges or fasteners, which would be used to secure the disc or bill to the valve housing. The port area of the disc shall contour down, which shall allow passage of flow in one direction while preventing reverse flow. The entire valve shall fit within the pipe I.D. Once installed, the valve assembly shall not protrude beyond the face of the structure or end of the pipe.

The downstream end of the valve must be circumferentially in contact with the pipe while in the closed positions.

Slip-in style low-flow check valves will be furnished with a set of stainless steel expansion clamps. The clamps, which will secure the valve in place, shall be installed inside the cuff portion of the valve, based on installation orientation, and shall expand outwards by means of a turnbuckle. Each clamp shall be predrilled allowing for the valve to be pinned and secured into position in accordance with the manufacturer's installation instructions. Flange style low-flow check valves will be furnished with a stainless steel, ANSI 125/150 drilled, retaining ring unless specified otherwise.

NOT FOR CONSTRUCTION

Manufacturer must have flow test data from an accredited hydraulics laboratory to confirm pressure drop and hydraulic data. Company name, plant location, valve size patent number, and serial number shall be bonded to the check valve.

When line pressure exceeds the backpressure, the line pressure forces the bill and disc of the valve open, allowing flow to pass. When the backpressure exceeds the line pressure, the bill and disc of the valve is forced closed, preventing backflow.
Manufacturer's authorized representative shall be available for customer service during installation and start-up, and to train personnel in the operation, maintenance and troubleshooting of the valve.

C Construction
C.1 Submittals
Submit product literature that includes information on the performance and operation of the valve, materials of construction, dimensions and weights, elastomer characteristics, headloss, flow data and pressure ratings.

Upon request, provide shop drawings that clearly identify the valve materials of construction and dimensions.

C.2 Installation
Valve shall be installed in accordance with manufacturer's written Installation and Operation Manual and approved submittals.

D Measurement
The City will measure Low-Flow Check Valve by each individual unit, acceptably installed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.3520	Low-Flow Check Valve	Each

Payment is full compensation for providing all materials; for furnishing all labor, equipment tools, and incidentals necessary to complete the work in accordance to the contract.

10.10 Reconnect Storm Sewer Lateral, Item SPV.0090.3525.

A Description
This special provision describes reconnecting existing storm sewer lateral to new structures or new pipe.

B Materials

NOT FOR CONSTRUCTION

Provide culvert pipe concrete collars in accordance to standard spec 520.2.4. Provide storm sewer pipe-to-pipe couplings and joint mastic sealant in accordance to standard spec 608.2.

C Construction

Identify all connecting storm sewer laterals in to existing storm sewer structures prior to structure modification or removal. Remove existing storm sewer lateral pipes to the nearest structurally whole intact joint. Brush and clean the pipe joint at the connection. Replace lateral pipes in-kind having equivalent diameters, materials, and lateral pipe classing. Ensure positive drainage is achieved when connecting the storm sewer lateral to the new inlet or curb outlet structure. The contractor may salvage surplus pipe with prior approval by the engineer. Connect the existing pipes to the new pipes with the appropriate mission pipe–to-pipe couplings, mastic joint sealant, concrete collars, or by other means approved by the engineer.

D Measurement

The City will measure Reconnect Storm Sewer Lateral as a linear foot of work acceptably completed

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.3525	Reconnect Storm Sewer Lateral	LF

Payment is full compensation for removing existing connections, furnishing and installing all materials, brushing and cleaning existing pipe, coring structures, couplings, joint mastic sealant, concrete collars, and pipe.

10.11 Variable Height Slotted Drain With ADA Cover, Item SPV.0090.3540.

A Description

This special provision describes furnishing and installing Variable Height Slotted Drain With ADA Cover.

B Materials

Provide slotted drain fabricated from galvanized corrugated steel pipe. The materials must meet the applicable requirements specified in the following subsection and section of the Standard Specifications:

Concrete 602
Underdrains 612
(8 inch dia., 16 gauge, galvanized, per AASHTO M 36)

NOT FOR CONSTRUCTION

Provide all associated items, such as steel grates, spacer plates, bolts, nuts, and washers as recommended by the manufacturer of the slotted drain and as approved by the Engineer and galvanized in accordance with AASHTO M 232.

The slotted opening must be 1¾ inches wide and a minimum 6 inches deep with a trapezoidal grate. The trapezoidal grate must have reinforcing spacer plates a minimum of 3/16 inch thick spaced 6 inches on center. The spacer plates must be slanted to direct flow toward the drainage structure.

Provide manufacturer's certification that the drain grating is ADA compliant. Refer to ADA Accessibility Guidelines for Buildings and Facilities which states, in part: trench drain grates located in walking surfaces must have spaces no greater than 1/2-inch wide in one direction. If gratings have elongated openings, then they must be placed so that the long dimension is perpendicular to the dominant direction of pedestrian travel.
All slotted drain is subject to visual inspection prior to acceptance and must conform to the requirements in the proposal.

Use concrete, Grade P1 in accordance with section 601 of the Standard Specifications for Construction for backfill.

C Construction
Install the slotted drain to the line and grade shown on the plans or as directed by the Engineer. The slotted drain must be completely encased in concrete and poured monolithically as shown in the construction details. The slots (grate assembly) must be covered during encasement operations to prevent infiltration of concrete and other foreign material into the pipe. Prior to placing the concrete, the slotted drain pipe must be secured in the proposed line and grade to prevent shifting or floating during the encasement stage of construction.

If positive flow or the final grade of the slotted drain is not maintained during the encasement stage of construction, the drain must be removed and replaced at the Contractor's expense.

D Measurement
The City will measure Variable Height Slotted Drain With ADA Cover by the linear foot, acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid items:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.3540	Variable Height Slotted Drain With ADA Cover	LF

Payment is full compensation for providing all materials, including drainage structure taps, and all necessary hardware including clean-out structures, metal caps, elbows, wye

NOT FOR CONSTRUCTION

and tee fittings and the length of galvanized pipe required for the connection to drainage structure; for furnishing all excavating, backfilling, disposing of surplus material, and for cleaning out and restoring the work site; for furnishing all labor, equipment tools, and incidentals necessary to complete the work in accordance to the contract. Payment for concrete used for encasement of slotted drain and for connection to the proposed adjacent sewer will be incidental to this pay item.

10.12 Corrugated PVC Pipe Storm Sewer 8-Inch, Item SPV.0090.3545.

A. Description
This special provision describes furnishing and installing storm sewer in accordance with section 608 of the standard specifications, as shown on the plans, and as follows.

B. Materials
Subsection 608.2 of the standard specifications is supplemented as follows:

Furnish corrugated polyvinyl chloride (PVC) pipe. Storm sewer will be accepted on the basis of a manufacturer's Certificate of Compliance and the City's field inspection upon delivery to a project.

Manufacturer of corrugated PVC must request evaluation and approval of their products by filing with the City's research supervisor, Bureau of Highway Construction, a certificate setting forth the name and brand of pipe to be furnished, the specified type, category, grade and PVC plastic cell classifications. Attach to this a certified test report from an approved independent testing laboratory showing specific results of tests performed on each diameter pipe to be furnished conforming to all requirements of these specifications. The independent testing laboratory will randomly select the pipes tested and will be considered representative of that manufacturer's pipe. The manufacturer of the pipe must also submit with the certification, a guarantee that all pipe furnished is of the same quality and composition and conforms to the specification requirements as tested by the independent laboratory, as long as the manufacturer continues to furnish materials for WisDOT projects.

Corrugated PVC pipe and fittings must conform to the requirements of Standard Specification for Poly (Vinyl Chloride) (PVC) Corrugated Sewer Pipe with a Smooth Interior and Fittings, ASTM Designation: F949. Include gaskets for joints as recommended by the manufacturer.

C. Construction
Subsection 608.3 is supplemented for corrugated PVC pipe as follows:

Trench width must be in accordance with Standard Practice for Underground Installation of Flexible Thermoplastic Sewer Pipe, ASTM Designation D 2321. Minimum trench width must not be less than the greater of either the pipe outside diameter plus 16 inches or the pipe outside diameter times 1.25 plus 12 inches.
Seal joints for sewer pipe so they are soil tight in accordance with AASHTO Standard Specifications for Highway Bridges, Section 26.4.2.4(e).

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Protect all storm sewer pipes until final acceptance of the work. Replace, at contractor's own expense, all pipe that is damaged either through the contractor's operations or due to the contractor's failure to properly protect the same.
Backfill all trenches and excavations immediately after the sewers have been constructed therein. Use backfill material that conforms to Granular Backfill, Section 209, except that all such material placed around the pipe and to 6 inches, above the pipe shall pass a 25 mm sieve.

D. Measurement
The City will measure Corrugated PVC Pipe Storm Sewer 8-Inch by the linear foot in accordance with subsection 608.4.1 of the standard specifications.

E. Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.3545	Corrugated PVC Pipe Storm Sewer 8-Inch	LF

Payment will be in accordance with subsection 608.5.1 of the standard specifications.

Supplement standard spec 608.5.1.1 with the following:

Payment includes coring holes into existing structure to connect new pipe

11. Track Work.

11.1 General Track Construction (112 TRAM Rail), Item SPV.0090.4500; General Track Construction with Pre-Curved Rail (112 TRAM Rail), Item SPV.0090.4501; General Track Construction (115 RE Rail), Item SPV.0090.4502; General Track Construction with Pre-Curved Rail (115 RE Rail), Item SPV.0090.4503; General Track Construction with Recycled Pavers, Item SPV.0090.4504; General Track Construction with Bridge Track, Item SPV.0060.4505; General Track Construction 115 RE Rail Only, Item SPV.0090.4506; General Track Construction with 115 RE Rail in Pre-Constructed Trough, Item SPV.0090.4507; Furnish and Install Track Drain, Item SPV.0060.4508

A Description
This section specifies general track construction which consists of the mainline and yard trackwork indicated on the plans including installing embedded track, special trackwork, and track appurtenances.

NOT FOR CONSTRUCTION

A.1 References

A.1.1 American Railway Engineering and Maintenance-of-Way-Association (AREMA):

- AREMA - "Manual for Railway Engineering" (AREMA Manual)
- AREMA - "Portfolio of Trackwork Plans"

A.1.2 ASTM International (Formerly known as American Society for Testing and Materials) (ASTM):

- ASTM A 123-Standard Specification for Zinc (Hot dip Galvanized) Coatings on Iron and Steel Products.
- ASTM 0570-98 (2010) e1 – Standard Test Method for Water Absorption of Plastics
- ASTM D638-10 – Standard Test Method for Tensile Properties of Plastics
- ASTM D3786 - Standard Test Method for Hydraulic Bursting Strength of Textile Fabrics-Diaphragm Bursting Strength Tester Method
- ASTM D4318-10 - Standard Test Methods for Liquid Limit, Plastic Limit, and Plasticity Index of Soils
- ASTM D4491-99a (2009) - Standard Test Methods for Water Permeability of Geotextiles by Permittivity
- ASTM D4533-11 - Standard Test Method for Trapezoid Tearing Strength of Geotextiles
- ASTM D4632 - Standard Test Method for Grab Breaking Load and Elongation of Geotextiles
- ASTM D4833 - Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products
- ASTM D5199-12 - Standard Test Method for Measuring Nominal Thickness of Geosynthetics
- ASTM E10-12 - Standard Test Method for Brinell Hardness of Metallic Materials
- ASTM G165-99 – Standard Practice for Determining Rail-to-Earth Resistance

A.1.3 American Public Transportation Association (APTA):

- APTA - "Guidelines For Design of Rapid Transit Facilities" (APTA Guidelines)

A.1.4 The Society for Protective Coatings (Formerly known as Steel Structures Painting Council (SSPC)):

- SPCC-SP 1 – Solvent Cleaning

A.1.5 American Association of State and Highway Transportation Officials (AASHTO)

A.1.6 Wisconsin Department of Transportation Standard Specifications – 2016 Standard Specifications

A.2 Definitions

NOT FOR CONSTRUCTION

A.2.1 Bumping Post: A device placed at the end of stub-end tracks to prevent a moving rail vehicle from inadvertently rolling off the end of the track.

A.2.2 Closure Rails: The rails between the parts of any special trackwork layout, such as the rails between the switch and the frog in a turnout; also the rails connecting the frogs of a crossing or of adjacent crossings, but not forming parts thereof.

A.2.3 Continuous Welded Rail (CWR): A number of rails welded together into a single length.

A.2.4 Crossing, Road: The intersection of one or more tracks and a street, road, or highway, at grade.

A.2.5 Crossing, Railroad: The intersection of two tracks, at grade, consisting of four frogs, also known as a ‘‘diamond’’.

A.2.6 Crosslevel: The difference in elevation of the tops of heads of opposite rails measured at right angles to the track alignment.

A.2.7 Frog: A device used at the intersection of two running rails to provide support for wheel treads and passageways for their flanges, thus permitting wheels traversing either rail to cross the other left hand, joining two nearby parallel tracks. The two single crossovers are located in close proximity to one another and typically are operated by the same signal interlocking.

A.2.8 Frog Number: The number used to designate the size of a frog, and being equal to one-half the cotangent of one-half the frog angle.

A.2.9 Guard Rail: A rail or other device laid parallel with the running rails of a track to prevent wheels from being derailed; or to hold wheels in correct alignment to prevent their flanges from striking the points of frogs. A rail or other device laid parallel with the running rails of a track to keep derailed wheels adjacent to running rails.

A.2.10 Inside Rail: On curved track, the rail closest to the curve center, the rail with the shorter radius. Sometimes referred to as the "low rail".

A.2.11 Joint Bar: A steel member, embodying beam-strength and stiffness in its structural shape and material; commonly used in pairs for the purpose of joining rail ends together, and holding them accurately, evenly, and firmly in position with reference to surface and gauge-side alignment.

A.2.12 Outside Rail: On curved track, the rail farthest from the curve center; the rail with the longer radius. Sometimes referred to as the "high rail".

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A.2.13 Profile Grade Line (PGL): The datum line which defines the vertical alignment of the track, applied at the top of the low rail.

A.2.14 Rail Joints: A fastening designed to unite the abutting ends of contiguous rails.

A.2.15 Rail Joint, Insulated: A rail joint designed to arrest the flow of electric current from rail to rail by means of insulation so placed as to separate the rail ends and other metal parts connecting them. Commonly called insulated joints or ‘‘IJ’s’’.

A.2.16 Restraining Rail: A guard rail installed parallel to, concentric with, and on the gauge side of the inside running rail of curved track with a flangeway of approximately 2-1/8 inches. It extends into the tangent track on each end of the curve, bears against the back side of the wheels, and steers the inside wheels of each truck around the curve, thereby reducing the degree of contact of the leading outside wheel flange with the outside rail. It also reduces gauge wear on the outside running rail.

A.2.17 Roadbed: The foundation (prepared subgrade) on which the track structure is placed.

A.2.18 Special Trackwork: A generic term referring to turnouts, single and double crossovers, track crossings, and other such items.

A.2.19 Standard Rail: A synonymous term to 115 RE rail.

A.2.20 Stock Rail: A running rail against which a switch rail bears in a turnout.

A.2.21 Stub-up: A conduit temporarily terminated in the roadbed for later use by signal, communication, or traction power installers.

A.2.22 Subgrade: The finished surface of the roadbed below the level of track slab.

A.2.23 Superelevation: The vertical distance of the outer rail of a curve above the inner rail. It is provided to overcome or partially overcome the effects of curvature and speed.

A.2.24 Switch, Point of: The tip of the tapered end of a switch rail; the end of a switch rail farthest from the frog or heel block.

A.2.25 Switch Point, Undercut: A switch point planed to mate with a stock rail having a planed undercut, in order to provide an effective point width of zero.

A.2.26 Switch Rail (Switch Point): A planed, tapered, movable rail which mates with a stock rail to enable movement of a train from one track to another.

NOT FOR CONSTRUCTION

A.2.27 Switch, Split: The common type of track switch consisting essentially of two planed, movable switch rails.

A.2.28 Top of Rail (T/R): The top surface of the head of the running rail.

A.2.29 Track, Embedded (Paved): Track constructed on a track slab and, except for the flangeways, embedded in asphalt, concrete, paving blocks, rubber epoxy, or other such material to the elevation of the top of rail.

A.2.30 Track, Gauge: The distance between the inside faces of running rails at right angles measured at a point 5/8 inch below the top of rail. Standard gauge: 4 feet 8-1/2 inches.

A.2.31 Track, Mainline: A track designated by route name and direction, and which is for the purpose of carrying revenue passengers.

A.2.32 Track, Secondary and Yard: Track constructed for the purpose of switching, storing, or maintaining rail vehicles or connecting such tracks to mainline tracks.

A.2.33 Trackway: The foundation on which the track is constructed. It usually consists of an earthen roadbed, but it may also be one of the following: a concrete roadbed for support of direct fixation track or paved track; a ballasted bridge deck (designed to receive ballast); or an aerial structure.

A.2.34 Turnout: An arrangement of a switch and a frog with stock rails and closure rails, enabling rail vehicles to be diverted from one track to another.

A.2.35 Turnout Number: The number corresponding to the number of the frog used in the turnout

A.2.36 Zero Thermal Stress: The state of uniform stress in CWR, while the rail is unrestrained and free to move longitudinally.

A.2.37 For additional definitions, refer to AREMA Manual and Portfolio of Trackwork Plans.

B Materials

B.1 City Furnished Materials

B.1.1 None.

B.2 Contractor Furnished Materials

B.2.1 Concrete Materials:

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- Provide concrete reinforcement as specified in Wisconsin Department of Transportation Specification Section 415.2.2, ‘‘Reinforcement”.

- Track slab concrete shall be as specified in Wisconsin Department of Transportation Specification Section 415, ‘‘Concrete Pavement” or approved equal.

B.2.2 Embedded Support Ties:

- Embedded support ties with nylon fasteners shall be furnished complete for assembly of rail and rail boot.

- Steel C-Channels shall be used as support ties for segments of the alignment where 115RE rail is used. Steel Angles welded 4” apart shall be used as support ties for segments of the alignment where 112TRAM rail is used. Low-profile flat bar steel ties may be used in areas where a lower clearance is required. Submit shop drawings for approval by the Engineer for all support ties proposed for use.

A.

- Support ties shall be spaced as follows:

B.

  - For 115RE rail support ties shall be spaced at 10 feet or less (3.0 meters) on tangent and curves with a radius larger than 400 feet (122 meters).
  - For 112TRAM rail support ties shall be spaced at 7.5 feet or less (2.3 meters) on tangent and curves with a radius larger than 400 feet (122 meters).
  - For curves 400 feet (122 meters) or less (115RE or 112TRAM rail), support ties shall be spaced at 5 foot or less (1.5 meter) intervals.

C.

- Nylon reinforced plastic clips shall be IHECO (Iron Horse Engineering Co.) Part Number 22.242 or approved equivalent. Clips shall be one-piece clips bolted to the steel support ties that securely hold rails and boot in place. Clips must allow for minor adjustments of rail gauge during installation.

- Where necessary, provide 4" x 4" x 3/16" bearing plates fabricated of ASTM A36 steel or equivalent.

B.2.3 Rail Boot

- Provide extruded rubber rail boot as recommended by manufacturer. The rail boot shall be fabricated to fit 115RE or 112 TRAM rail.

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- Provide splices for the rail boot as required, fabricated to be compatible with the rail boot. Include all required splice materials as recommended by the boot manufacturer to fully isolate the rails electrically.

B.2.4 Track Drains

- Provide track drains fabricated of materials approved by the City. Include appropriate end panels, outlets, and grates. Furnish devices as necessary to secure the grates to the troughs.

- Where embedded track is in shared right-of-way, track drain grate and frames must be traffic rated (HS20-44 loading). Steel angle support and bolting of grating to angles shall be strong enough and designed to transfer HS20-44 loading into the concrete slab.

- Rail must be isolated from track grate, frame, and any other metal items.

D.

- The track drain shall be as shown in the Drawings.

B.3 Rail

B.3.1 Tee-rail: 115 RE section either standard or premium rail in accordance with the requirements of AREMA "Specifications for Steel Rails" and as specified.

B.3.2 Block Rail (112 TRAM) Manufacture:

- The steel shall be melted using electric-furnace process

- The steel in liquid form shall be vacuum degassed.

E.

- The steel shall be produced using a continuous casting process. The minimum reduction ratio from cast bloom to final product will be 8:1.

F.

- The Product shall be hot rolled.

G.

- All aspects of the Manufacturer’s quality system shall be in effect.

H.

B.3.3 Block Rail Chemical Composition

B.3.3.1 Standard Strength

NOT FOR CONSTRUCTION

Element	Chemical Analysis (wt %)	Product Analysis Tolerance (wt %)	
		Under Min.	Over Max.
Carbon	0.50 - 0.65	0.02	0.02
Manganese	1.00 - 1.25	0.05	0.05
Phosphorus Max.	0.025		0.008
Sulfur Max.	0.025		0.008
Silicon	0.15 – 0.58	0.02	0.02
Chromium Max.	0.15		0.03
Molybdenum Max.	0.050		
Aluminum Max.	0.010		
Copper Max.	0.40		
Hydrogen Max.	3.0 ppm		

B.3.3.2 Premium Strength

Element	Chemical Analysis (wt %)	Product Analysis Tolerance (wt %)	
		Under Min.	Over Max.
Carbon	0.62 - 0.80	0.02	0.02
Manganese	0.70 - 1.20	0.05	0.05
Phosphorus Max.	0.025		0.008
Sulfur Max.	0.025		0.008
Silicon	0.15 – 0.58	0.02	0.02
Chromium Max.	0.15		0.03
Molybdenum Max.	0.050		
Aluminum Max.	0.010		
Copper Max.	0.40		
Hydrogen Max.	2.5 ppm		

B.3.3.3 Hydrogen

- Hydrogen shall be subject to the limits listed above. If the hydrogen exceeds those limits, the blooms from the heat shall be slow cooled and the rails will be tested.

B.4 Pre-curved Rail

B.4.1 Pre-curved rail shall be fabricated in accordance with the approved final shop drawings.

B.4.2 Lengths of pre-curved rails shall be shown on shop drawings and approved by the owner's representative prior to fabrication.

B.4.3 Pre-curved rails shall be uniformly curved to match the required geometry. Tolerances for rail bending must ensure that bent rails can be laid out on a flat concrete surface at the required geometry without requiring bracing or other measures to hold the required geometry. Any rail twisting that results in more than a 1/16" gap under any portion of the rail base will be cause for rejecting the curved rail.

NOT FOR CONSTRUCTION

B.4.4 The Contractor must ensure the facility uses rollers to bend the rails (not a three-point press) unless otherwise approved by the owner's representative. Any rails damaged during the pre-bending process shall be replaced by the Contractor and the Contractor shall bear all the costs of replacing the damaged rails.

B.4.5 Rail ends shall be cut square to the vertical axis of the rail. A tolerance of 1mm out of square from the base to the head will be permitted.

B.5 Recycled Granite Pavers

B.5.1 Recycle all granite pavers in areas indicated for removal in the Contract Documents. Granite pavers shall be used for construction of General Track Construction with Recycled Pavers portions of the track alignment as indicated in the Contract Documents.

C Construction

C.1 Submittals

C.1.1 Shop Drawings, include the following:

C.1.1.1 General plan for distributing CWR, including:

- Storage location upon delivery and prior to installation.
- General layout of CWR site.

C.1.1.2 Complete details of the proposed methods, including equipment, of laying and fastening CWR. Include method and equipment proposed for achieving zero thermal stress.

C.1.1.3 Description of temperature adjustment and final anchoring procedures for CWR, including charts, tables, and field instructions on heating, cooling and stretching.

C.1.1.4 Charts shall be provided that indicate gaps for varying lengths of rail and varying rail temperatures.

C.1.2 Procedures: Provide complete details of the end-hardening procedures, including identification of personnel to perform the procedure, the equipment, and the test results required no less than 30 days prior to initiating any end-hardening.

C.1.3 Installation Procedures: Prepare and submit a description of the procedures and methods to be employed in the construction of embedded track. At a minimum, include the following:

NOT FOR CONSTRUCTION

C.1.3.1 The methods of placing rail, supporting structures, and concrete to produce finished track meeting the alignment requirements within the specified tolerances.

C.1.3.2 The procedure for handling, installing, and field welding continuous welded rail.

C.1.3.3 In accordance with the requirements of APWA 2703, "Special Aggregate Concrete – Bridge Deck, Sidewalk, Barriers and Curbs, Diaphragms, and Approach Slab", including:

- Procedures for forming, mixing, placing, and curing of concrete.
- Proposed concrete and joint materials; include packing, storing, handling, proportioning, additives, mixing, and placing details.

C.1.3.4 The method of ensuring that the rail and supporting structure are not dislocated during placement of concrete.

C.1.3.5 The procedures for erecting the support beams and securing the rail.

C.1.3.6 Procedures for installation of track drain components.

C.1.3.7 Procedures for installing the rail boot, including splices, and boot clips.

C.1.3.8 Quality control procedures to ensure proper installation.

C.1.4 Track equipment to be used on Roadbed: Submit weights and dimensions of track equipment proposed for use on roadbed prior to employ it on roadbed.

C.1.5 Rail Mounted or Hi-Rail Construction Equipment: Submit a complete list of track equipment for use during trackwork construction, within 30 days after receipt of the Notice to Proceed. Include rail-mounted geometry inspection vehicle.

- Equipment to be utilized shall not exceed design clearance envelope and loading criteria for the Streetcar System.
- Submit a complete description of all proposed modified equipment, including calculations verifying that loading criteria for the streetcar system will not be exceeded.
- Certify that the equipment modifications will clear all structures and other facilities at the areas where the equipment will be used.

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- Certify rail wheels are in good condition, without excessive wear. Damage to frogs, crossing panels, etc. shall be repaired or replaced as determined by the City.

C.1.6 Product Data: Submit manufacturer's data for Contractor-furnished material including non-woven filter fabric and adhesive for bonding tags to concrete. Submit installation information and sufficient description to verify that materials comply with the specifications. Include specification data and manufacturer's installation instructions for non-woven filter fabric. Submit product data for support beams and associated hardware, rail boot, and slab joint materials.

C.1.7 Mix Design: Submit concrete mix design as specified in APWA 2703, "Special Aggregate Concrete – Bridge Deck, Sidewalk, Barriers and Curbs, Diaphragms, and Approach Slab"

C.1.8. Certification: Certification of concrete mix design, reinforcement, and bonding agents.

C.1.9 Samples: Submit sample for non-woven filter fabric.

C.1.10 Test Reports: Submit summaries of test results each week for field weld tests, Brinnell Hardness Tests, insulated joint continuity tests, track geometry vehicle measurements, and any other periodic testing required by Contract. If there was no activity during the week, submit each summary noting no activity.

C.1.11 Rail Laying Record: Submit records in accordance with Section C.17.4 herein.

C.1.12 Submit manufacturers' rail specifications to the City for approval.

C.1.13 The contractor shall submit shop drawings for rails that will be pre-bent with roller bending equipment. These drawings shall include the following information:

- Curve designation
- Start and end stationing of curve
- Location of any joints in the curve (by stationing or length along curve)
- Width of gaps between rails through curves.
- Length of rails within the curve.
- Points of curvature (PC, PT, TS or ST).

Rails shall not be pre-bent until shop drawings have been reviewed and approved by the owner's representative. Existing contract drawings may be submitted as shop drawings as long as the information required above has been included on the drawings.

C.2 Quality Assurance

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C.2.1 Comply with:

- Codes and regulations of the jurisdictional authority.
- APTA Guidelines.
- AREMA Manual.

C.3 Product Delivery, Storage and Handling

C.3.1 City-Furnished Material:

- None.

C.3.2 Contractor-Furnished Material:

- Supply track construction material indicated in the Contract Drawings.

C.4 Monumentation and Surveying

C.4.1 Monuments will be provided by the City to establish the centerlines of tracks as specified in Wisconsin Department of Transportation Specification Section 621, ‘‘Landmark Reference Monuments”.

C.4.2 The Contractor shall set monuments at all points as shown on the Contract Drawings.

C.4.3 The Contractor shall be responsible for the preservation of all Geographic Reference Stations, State of Wisconsin and City of Milwaukee, Wisconsin maintained benchmarks, section corners, property monuments of any kind and other reference marks set by the City or any other governmental authority as shown on the plans or informed of in writing in accordance with Wisconsin Department of Transportation Specification Section 107.11, ‘‘Protecting and Restoring Property”.

C.4.4 Do not use controls for surveys other than the monumentation described above unless otherwise approved by the Contracting Officer.

C.4.5 Perform surveying required herein in accordance with Wisconsin Department of Transportation Specification Section 105.6, ‘‘Construction Staking”. Assume full responsibility for all dimensions and elevations taken and the setting of lines and grades relating thereto.

C.4.6 Verify layout information shown in relation to the existing City-provided monuments and existing structures before proceeding with layout of the actual

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work. As the work proceeds, check every major element of work for line. Bring discrepancies in location of structures to the attention of the City before starting trackwork. Maintain an accurate surveyor's field book of such checks; make available for the City's reference. Record deviations which are accepted by the City on the Record Drawings.

C.4.7 Verify the actual grade line and the profile of the top of the sub-ballast. Variations from the design grade line and profile shall meet tolerances specified in Wisconsin Department of Transportation Specification Section 105.6, ‘‘Construction Staking”.

C.4.8 Furnish and place markers for the control points and reference points of the track centerlines, as indicated. Stake centerlines at station platforms, grade crossings, and bridge structures for inspection by the City.

C.4.9 Upon completion of the project, the Contractor shall provide the City with all original surveying field notes, layouts, and computations in standard bound survey books. The Contractor shall also provide the City all electronic files, code libraries, CAD drawings and any other files or documents, whether electronic or paper, that are part of the survey work. Point code files shall be submitted in raw data file format and plain text ASCII, comma or space delimited format having one record of point number, northing, easting, elevation and point code (in that order per line). All electronic files must be submitted in an uncompressed file format on a USB flash drive or CD-ROM disk. Individual electronic files shall not span multiple disks. All disks shall be labeled with the City project number, project location, date (month and year) of the survey and disk number if more than one as required under Wisconsin Department of Transportation Specification Section 104, ‘‘Scope of Work”.

C.4.10 Maintain control points and reference points for the duration of the project.

C.5 Gauge

C.5.1 Measure the track gauge between points 5/8 inch below the top. For tee rail, measure perpendicular to and from inside face to inside face of the running rails. For 112 TRAM rail, measure from outside face of groove to and from outside face of groove.

C.5.2 Tangent and curved track gauge:

- 4 feet 8-1/2 inches for tee rail.
- 4 feet 8-1/2 inches for 112 TRAM rail

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C.5.2 Special trackwork track gauge (tee rail and/or 112 TRAM rail): 4 feet 8-1/2 inches. Special trackwork manufacturer shall conduct a wheel/rail study to verify gauge and include with trackwork submittal for engineer's review.

C.5.3 Allowable gauge variation:

- Ballasted mainline track: plus or minus 1/8 inch.
- Direct fixation mainline track: plus or minus 1/8 inch.
- Paved mainline track: plus or minus 1/8 inch.

C.5.4 Gauge Transition: The plans shall outline the method for transitioning between gauges of different widths.

C.6 Alignment

C.6.1 Alignment consists of a series of straight lengths of track referred to as tangents, connected by simple, compound or reverse curves, with or without spirals.

C.6.2 The track shall be constructed to the alignment and profile indicated on the plans, within the tolerances specified below:

TRACK CONSTRUCTION TOLERANCES

Class and Type of Track	Gauge Variation	Cross Level and Superelevation Variation	Vertical Track Alignment		Horizontal Track Alignment	
			Total Deviation	Middle Ordinate In 62' Chord	Total Deviation	Middle Ordinate In 62' Chord
Direct Fixation and Paved Track	+1/8" - 1/16"	± 1/8"	± 1/4"	± 1/8"	± 1/8"	± 1/8"
Mainline Ballasted Track	± 1/8"	± 1/8"	± 1/2"	± 1/8"	± 1/2"	± 1/8"
Yard Ballasted Track	+3/16" - 1/8"	± 3/16"	± 3/8"	± 1/4"	± 3/8"	± 1/4"
Shop Track	± 1/8"	± 1/8"	± 1/4"	± 1/8"	± 1/4"	± 1/8"

Notes:
(1) Total deviation is measured between the theoretical and actual alignment centerline at any point in the track.
(2) Total horizontal and vertical deviation in road crossings ± 1/4".
(3) In the Station Platform areas: Total Horizontal deviation shall be 0" towards Platform and 1/8" away from platform; Total Vertical deviation shall be 0" above Platform and 1/8" below platform.

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C.6.3 Use outer rails of curves as the line rail. Either rail may be used as the line rail in tangent; however, use that same rail for the full length of that tangential segment of track.

C.6.4 The ends of the chord to be at points on the gauge side of the line rail 5/8 inch below the top of the rail head.

C.6.5 In addition to the requirements specified:

- Place the track in good alignment before the finishing lift is made.
- Follow immediately behind the finishing lift with a mechanical means of lining the track and line to accurate alignment. Typically line and surface in the same operation, but the finishing lift may include adjustments to ‘‘accurate alignment’’.

C.7 Superelevation, Spirals and Curves

C.7.1 Superelevation:

- Superelevate mainline track curves as indicated.
- Maintain superelevation uniformly over the length of curve or as otherwise shown.
- Superelevate the outer rail above the inner rail; install the inner rail at the required profile indicated.

C.7.2 Spirals: Establish the superelevation at the point of tangency at zero and increase the superelevation uniformly through the length of the spiral to full elevation of the outer rail at the spiral-to-curve point. Install the spiral at the ends of simple curves and segments of compound curves as indicated.

C.7.3 Curvature: Curve information shall be as shown. Shop fabricated rail shall be marked by the manufacturer for installation.

C.8 Track Surface

C.8.1 Track surface is the relationship of opposite rails to each other in profile and crosslevel:

- Track profile is the running surface along the top of the grade rail.
- The ideal surface is a uniform profile consisting of straight gradients connected by vertical curves, with zero crosslevel on tangents, and predetermined crosslevel on curves.
- Do not raise the profile of track being surfaced above established grades.

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- When surfacing or raising track, select one rail, usually the lower rail on curves and the line rail on tangents, as the grade rail. Bring the other rail to surface by adjusting the crosslevel as needed.

C.9 Subgrade Preparation

- Place and compact the required depth of subgrade material as specified in Wisconsin Department of Transportation Specification Section 305, ‘‘Dense Graded Bases”. Reference shall also be made to the project Geotechnical Report and details in the plans.

C.10 Concrete Placement

- Place concrete in accordance with the requirements of Wisconsin Department of Transportation Specification Section 415, ‘‘Concrete Pavement”.

- During placement of reinforcing steel and concrete use care to avoid disturbance of the support structure, rail, boot, track drains, and associated hardware. Contractor is to take measures to prevent uplift during the concrete pour.

C.11 Track Drains

- Install track drain components in accordance with the plans and/or supplier's recommendations.

- Brace track drains with temporary supports to maintain correct position during concrete placement.

- Cover track drains during concrete placement to prevent concrete from entering the trough.

C.12 Support Ties

- Install the rail support ties as recommended by the support tie supplier. Place a bearing plate below each adjusting screw. In areas of sloped subgrade, create a flat area in the subgrade slightly larger than the bearing plate.

- Space ties according to the details in the plans.

- Adjust the support ties to the required elevation prior to placing rail.

C.13 Rail Installation

- Place rail strings on the support beams and install the rail boot on the rail. Apply the rail clips loosely using procedures recommended by the supplier.

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- Where rail will require field welding, place rail boots no closer than ten feet to the proposed weld. Field weld CWR as specified in Field Rail Welding, Item SPV.0140.4600.

- Prior to placing concrete, join rail strings and adjust the jacking screws and tighten rail clips to bring rails to correct grade and alignment. Complete installation of the rail boot and verify the correct installation of all boot splices.

C.14 Rail

C.14.1 Follow plans or track charts in determining exact location and lengths of premium and standard rail.

C.14.2 Mechanical Properties and Electrical Resistance

C.14.2.1 Brinell Hardness will be measured on the running surface of the rail after the decarburized layer has been removed. The frequency of testing shall be once per heat and will be constructed in accordance with ASTM E10. For standard strength, the minimum hardness will be 220 BHN. For premium strength, the minimum hardness will be 260 BHN.

C.14.2.2 Tensile tests will be taken from the running surface corner of the rail. The frequency shall be once per heat and will be conducted in accordance with ASTM A370. Results will be determined by grade. For standard strength, the minimum tensile strength will be 113 ksi with a 12% elongation. For premium strength, the minimum tensile strength will be 128 ksi with a 10% elongation.

C.14.2.3 If any tests fail to meet the requirements of 2.3.A or 2.3.B, then two further tests shall be performed on samples from two other rails from the same heat. If those two tests are successful, the rails from the heat are acceptable.

C.14.2.4 Direct current resistance shall be measured on one rail per heat and shall not be more than 10.5 micro-ohms (x 10^{-6} ohms) per foot. Alternatively, the electrical resistance can be determined by calculating the electrical resistivity ratio in comparison to pure copper. The calculated resistivity ratio to Cu will be 15.0 maximum.

C.14.3 Dimensional Tolerances

C.14.3.1 The drawings of the rail along with the nominal dimensions are shown in the Contract Drawings.

C.14.3.2 Dimensional tolerances to nominal are as follows:

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Height of Rail (running or groove side)	-0.020”/ +0.040”
Width of Groove	-0.040”/ +0.040”
Depth of Groove	-0.040”/ +0.040”
Width of Running Rail Head	-0.040”/ +0.040”
Overall Top Width	-0.080”/ +0.060”
Base Width	-0.125”/ +0.125”
Base Concavity	-0.000”/ +0.040”
Twist	0.063” max

C.14.4 Identification

C.14.4.1 The rail will be cold stamped on the grooved head (not running surface) once on each end of the rail. The cold stamp will include manufacturer code, grade (standard or premium) and heat number (AM S x#### or AM P x####). The letter in the heat number specifies year produced.

C.14.5 Surface Imperfections

C.14.5.1 All rails shall undergo visual surface inspection to cull injurious imperfections.

C.14.5.2 Surface imperfections may be conditioned as long as the rail microstructure is not affected by the operation. This may be accomplished by using appropriate methods (lamellar flap tool, grinding belt, etc.)

C.14.5.3 Protrusions

- Protrusions on the running surface or underside of the base shall be dressed smooth.

- Protrusions on any other surface are allowed up to 0.060”. Protrusions higher than 0.060” may be conditioned down to 0.060”.

C.14.6 Depressions

C.14.6.1 Depressions in the base and rail body:

- Hot scratches, scratches, and grooves that are principally longitudinal to the rail axis shall not exceed a depth of 0.040”. Imperfections principally transverse to the rail axis shall not exceed 0.030”. Transverse imperfections greater than 0.020” but not less than 0.040” may be conditioned down to 0.030”.

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- Seams are allowed up to a depth of 0.040” and a surface area of 0.160” (transverse) by 1.180” (longitudinal).

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- Overlaps are allowed of up to 0.020” deep and can extend the full length of the rail.

- Cold marks are allowed up to 0.020”.

C.14.6.2 Depressions in the running surface:

- Imperfections in the running surface shall not exceed 0.020” in depth.

- Principally longitudinal defects shall be a maximum of 0.160” wide, and principally transverse defects shall not have an area exceeding 0.400” x 0.080”.

C.14.7 Straightness

C.14.7.1 The rail will be straightened in a roller straightening process.

C.14.7.2 End Straightness:

- The straightness of the ends of the rails shall be checked with a 3’ straightedge. Within this length, deviations from straightness in the vertical or horizontal directions shall not exceed 0.030”. The deviation in the vertical direction is only allowed if the end has a continual upsweep.

C.14.7.3 Line Straightness:

- Line straightness from end to end shall be checked with the naked eye. If there is a sharp kink, it shall be further examined and corrected. For general sweep, if an imaginary line was drawn from one end to the other of a 40’ rail, the maximum tolerable gap will be 1”.

C.14.8 Cold Sawing

C.14.8.1 The cut shall be square in both the vertical and horizontal directions with a maximum deviation of 0.30”.

C.14.8.2 Any excessive saw burr will be removed. No beveling of the end will be allowed.

C.14.9 Certification

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C.14.9.1 A certified mill test report will be issued with the results of the chemical and mechanical testing to confirm the product meets this specification.

C.15 Cutting and Drilling Rail

C.15.1 Use only the following tools for cutting rail:

- Rail saw.
- Abrasive cutting wheels.

C.15.2 Drill holes:

- When necessary, drill new holes; do not punch, slot, or burn with a torch.
- Drill holes 1-1/8 inch in diameter; locate as indicated.
- Drill with the joint bars removed or before their application. Mark the location of the center of the hole, or drill through an approved template. Do not drill bolt holes using the joint bars as a template.
- When bolt holes are drilled with a power track drill, maintain a uniform feeding pressure. Reduce pressure as the bit point breaks through the opposite side of the web. Do not force the drill.
- Remove all rough edges from drilled rail holes.
- Do not leave bolt holes in the ends of rail to be welded.
- Reaming or enlarging incorrectly drilled holes to allow joint bar bolts to be installed will not be permitted. Rejected holes shall be sawcut from the rail.
- Torch cuts or blown holes will not be acceptable.
- Rail strings have handling holes. These holes shall be cropped before welding.

C.16 Rail Joints

C.16.1 Either weld or bond rail joints as indicated.

C.16.2 Field weld rails in accordance with Section 34 11 16, "Trackwork - Field Rail Welding".

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C.16.3 Install bonded joints where indicated in accordance with the requirements of this section and Section 34 11 93, "Other Track Materials".

C.16.4 Install joints in track that is in final horizontal and vertical alignment with ballast tamping completed.

C.17 Laying Continuously Welded Rail

C.17.1 Unload and lay CWR in a place and in a manner that prevents damage to the ties, rails, and structures.

C.17.2 Lay opposite CWR strings in a manner which results in a 5 foot minimum stagger of welds.

C.17.3 Make every effort to minimize or eliminate field cuts and field welds in CWR. Designate location in finished track by route name, stations of ends of rail string, and right or left rail as determined by facing in the direction of increasing stationing. Place all rail numbers on the same side of the CWR string.

C.17.4 Record the following information at the time of laying the rails on the crossties or DF plinth and again at the time of anchoring CWR. Furnish copies of this documentation to the City.

C.17.4.1 Location by station, track designation, and rail.

C.17.4.2 Date and time.

C.17.4.3 Rail weight and section, mill brand, year rolled, and the heat number of the end rails in each CWR string.

C.17.4.4 Length of CWR string in feet.

C.17.4.5 The following temperatures, at the beginning of the activity and again at the end of the activity:

- Ambient temperature.
- Rail temperature.

C.17.4.6 Approximate weather conditions.

C.17.4.7 Adjustment applied (type and rail end movement).

C.17.5 Between the time of laying the rail (placement on the ties) and anchoring the rail, the Contractor shall monitor rail temperatures and adjust each Dutchman as required to avoid rail buckling or rail end batter.

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C.18 Rail Temperature

C.18.1 Determine rail temperature by means of an AREMA standard rail thermometer as specified in the AREMA Manual.

C.18.1.1 Place rail thermometers on the shaded side of the rail base next to the web and leave in place until no change in its reading is detected, but not less than five minutes.

C.18.1.2 Take rail temperature at the time of adjusting the gap between rail ends.

C.19 Destressing Rail

C.19.1 Rail zero stress (neutral) temperature at final closure and fastening shall be 75° F ± 10° F (24° C ± 5° C).

C.19.2 The rail shall have a uniform longitudinal stress along the entire fastened length (except at free ends).

C.19.3 The Contractor shall submit a detailed procedure for achieving uniform longitudinal rail stress for the zero stress temperature specified herein.

C.19.4 Final closure shall be by field weld with the rail fully fastened (except immediately adjacent to the field weld as necessary to perform the weld) near or at final elevation and alignment. If post closure rail realignment is required, the Contractor shall provide sufficient longitudinal restraint either side of the location of realignment to assure the rail stress state is not changed by the realignment Work.

C.20 Temporary Fastening

C.20.1 Temporarily fasten track for use of on-track equipment.

C.20.2 Prior to equipment being placed on newly laid rail, secure the rail in a manner that will prevent damage to the CWR, rail fasteners, and other track materials.

C.20.3 Move equipment over newly laid rail in such a manner as to prevent damage to trackwork materials.

C.20.4 Temporarily fasten newly laid rail on ballasted track at not less than:

- Every third tie on tangents and on curves having a radius greater than 1,900 feet.
- Every other tie on curves having a radius of 1,900 feet or less.

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C.20.5 Do not field weld or bond between contiguous CWR strings and between CWR strings and special trackwork units before the rail has been brought to final vertical and horizontal alignment, before the rail has been adjusted to the indicated zero thermal stress range, and before the rail has been fully fastened.

C.21 Permanent Rail Fastening

C.21.1 Adjust the CWR string lengths for the specified zero thermal stress temperature:

C.21.1.1 Adjust rail on DF bridges before adjusting ballasted track approaches. Anchor 300 track feet on each side at the temperature specified for DF track. When adjusting the approaches, unclip the 300 ballasted track feet up to the structure and adjust the ballasted track string to the appropriate temperature for ballasted track.

C.21.1.2 When closing on a fully anchored string, remove 300 feet of existing rail clips, readjust the existing string for temperature and refasten before executing the field weld.

C.21.1.3 Fasten the CWR strings in a manner which ensures that there is no unfastened portion of rail greater than 100 feet in length between fastened portions of the same string.

C.21.1.4 When joining newly constructed track to existing track in operation, adjust the adjacent 300 track feet of the existing track for zero thermal stress temperature in conjunction with the de-stressing of the new track.

C.21.1.5 Obtain approval of the City prior to de-stressing existing track in operation. De-stressing work of operating track shall not be scheduled during streetcar operating hours.

C.21.2 Vibrate the rail to relieve internal rail stresses and fully fasten the string. Record movement at quarter points and submit to the City daily.

C.21.2.1 Use vibrators, approved by the City, to relieve internal rail stresses.

C.21.2.2 Do not strike CWR with objects which might damage the rail surface.

C.21.3 Temperature of a rail, when being fastened opposite a previously fastened rail, shall be within 5 degrees F of the previously fastened rail's temperature at the time of its fastening.

C.21.4 Once the rail has been adjusted to achieve zero thermal stress at the specified temperature, maintain the correct rail gap until the rail is fully fastened.

C.22 Zero Thermal Stress

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C.22.1 Zero thermal stress at the specified temperature in CWR may be achieved by heating, cooling, or pulling the rails, or a combination thereof. When zero thermal stress at the specified temperature is obtained, begin fastening immediately.

C.22.2 Maintain the stress within the rail to achieve the specified zero thermal stress range during installation of joints.

C.23 Field Welding

C.23.1 Perform field welds in accordance with the requirements of Field Rail Welding, Item SPV.0140.4600.

C.24 Rail End-Hardening

C.24.1 End-harden standard rail ends in the field at all bonded joints. Remove joint bars from rail ends during the end-hardening process.

C.24 End-Hardening Tests

C.24.1 Personnel to perform end-hardening shall prepare two sample rails in accordance with the AREMA Manual.

C.24.1.1 Test the two samples through an independent laboratory approved by the City and submit the test results to the City.

C.24.1.2 Acceptance of the end-hardening procedure and personnel will depend on the samples passing the tests specified below.

C.24.2 Two samples of end-hardened rail shall be tested for Brinell hardness in accordance with ASTM E10 in a grid pattern of 1/4-inch increments for a distance of 6 inches from the end of the rail.

C.24.3 Record the Brinell hardness numbers and locations.

C.24.4 After the hardness test has been performed, section one sample longitudinally for 1 foot along the centerline of rail. The other sample shall be sectioned transversely 1/2 inch from the end of the rail. Etch both cross sections to facilitate the observation of the hardness pattern.

C.24.5 Attain a Brinell hardness number not less than 341 nor more than 401 when measured at a point on the centerline of rail 1/2" from the rail end. The decrease in hardness shall occur uniformly over a distance not less than two inches. The hardness pattern shall be uniform across the top surface of the rail head. Examine the etched cross sections of the rail to ensure that a uniformly distributed hardness

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pattern is evident. End hardening shall be performed only by personnel and with procedures which have been accepted in accordance with the above procedure.

C.25 Rail Bevel

C.25.1 Bevel rail ends at bonded joints in accordance with AREMA Standard Plan Basic Number 1005.

C.26 Rail Grinding

C.26.1 Upon completion of the track by the Contractor to the specified tolerances and after acceptance, rail grinding will be done by the City.

C.27 Final Alignment and Track Inspection

C.27.1 Survey the track in accordance with Wisconsin Department of Transportation Specification Section 105.6, ‘‘Construction Staking” to determine if the horizontal and vertical alignment, gauge, crosslevel, and superelevation are within the tolerances specified for each type of track construction.

C.27.2 Correct track deviations which exceed tolerances.

C.28 Electrical Tests

C.28.1 All rail boot shall be high voltage spark tested as specified by manufacturer.

C.28.2 Track-to-earth resistance tests will be performed by the Contractor.

C.28.2.1 Testing will be conducted, per ASTM-G165, by the Contractor as track construction progresses to ensure proper rail isolation is being achieved during construction.

C.28.3 The Contractor shall correct Contractor installations that fail the track-to-earth resistance tests, during construction testing or final acceptance testing. Following completion of these corrective measures, Contractor shall notify the City as specified herein for testing and the installations will be re-tested. All corrective measures shall be completed at the expense of the Contractor.

C.28.4 Final acceptance testing of track to earth resistance will be performed by Contractor and results shall be submitted to Engineer in a final report to demonstrate compliance with tolerances.

C.28.5 Acceptance criteria: Track-to-earth resistance shall be less than:

C.28.5.1 Embedded track: 100 ohms per 1000 linear feet of track.

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C.28.5.2 Special trackwork: 100 ohms per 1000 linear feet of track.

C.29 Precurved Rail

C.29.1 Precurved rail units shall be clearly labeled as shown on approved shop drawings. Labels must include the precurved unit number and must clearly indicate where individual rails are located within the unit. Loose tags or other easily removable labels are not acceptable.

C.29.2 The Contractor shall be responsible for all loading, unloading and hauling of the rail from the Project rail storage area to rail bending facility, and returning to the Project rail storage area or construction site.

C.30 Restraining Rail

C.30.1 Install fabricated restraining rail as shown and in accordance with the approved manufacturer's fabrication drawings.

C.31 Recycled Pavers

C.31.1 Place recycled pavers to match pattern and orientation of in-place pavers in the immediate area.

D Measurement

The City will measure General Track Construction (112 TRAM Rail), General Track Construction with Pre-Curved Rail (112 TRAM Rail), General Track Construction (115 RE Rail), General Track Construction with Pre-Curved Rail (115 RE Rail), General Track Construction with Recycled Pavers, General Track Construction with Bridge Track, General Track Construction with 115 RE Only and General Track Construction with 115 RE Rail in Pre-Constructed Trough in length by linear foot acceptably completed. The City will measure Furnish and Install Track Drain by each acceptably completed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.4500	General Track Construction (112 TRAM Rail)	LF
SPV.0090.4501	General Track Construction with Pre-Curved Rail (112 TRAM Rail)	LF
SPV.0090.4502	General Track Construction (115 RE Rail)	LF
SPV.0090.4503	General Track Construction with Pre-Curved Rail (115 RE Rail)	LF

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SPV.0090.4504	General Track Construction with Recycled Pavers	LF
SPV.0090.4505	General Track Construction with Bridge Track	LF
SPV.0090.4506	General Track Construction 115 RE Rail Only	LF
SPV.0090.4507	General Track Construction with 115 RE Rail in Pre-Constructed Trough	LF
SPV.0060.4508	Furnish and Install Track Drain	EA

Payment is full compensation for fine grading of aggregate base, distributing and installing rail, furnishing and installation of rail boot and cuffs, jointing of boot sections, support ties with nylon insulators, field rail welding and grinding, installation of reinforced concrete track slab, tie bars, and miscellaneous materials for conforming to all specified tolerances, for performing all tests, and for preparation and revision of all specified submittals and Work Plans; and cleanup. The Bid item price for "General Track Construction (112 TRAM Rail)", "General Track Construction with Pre-Curved Rail (112 TRAM Rail)", "General Track Construction (115 RE Rail)", "General Track Construction with Pre-Curved Rail (115 RE Rail)", "General Track Construction with Bridge Track" and "General Track Construction with Recycled Pavers", do not include sawcutting and excavation. Field rail welds, grinding and curving of the rail will be incidental to the installation of rail. The Contract unit price for each item will be payment in full for furnishing all labor, tools, Materials, equipment and incidentals, and doing all Work necessary to complete the Work specified. The Bid item price for "General Track Construction with Pre-Curved Rail (115 RE Rail)" also includes restraining rail on one or both rails depending on the radius of the rail.

Payment for "General Track Construction 115 RE Rail Only" is full compensation for furnishing and installing 115 RE rail only. Additional details related to the furnishing and installing of 115 RE rail are detailed in the OMF Contract Drawings and all payment for items aside from the furnishing and installing of 115 RE rail will be compensated as part of the OMF project costs. Field rail welds, grinding and curving of the rail will be incidental to the installation of rail. The Contract unit price for each item will be payment in full for furnishing all labor, tools, Materials, equipment and incidentals, and doing all Work necessary to complete the Work specified.

Payment for "General Track Construction with 115 RE Rail in Pre-Constructed Trough" is full compensation for distributing and installing rail, furnishing and installation of rail boot and cuffs, jointing of boot sections, field rail welding and grinding and miscellaneous materials for conforming to all specified tolerances, for performing all tests, and for preparation and revision of all specified submittals and Work Plans; and

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cleanup. Grout furnishing and installation shall be incidental to construction. Field rail welds, grinding and curving of the rail will be incidental to the installation of rail. The Contract unit price for each item will be payment in full for furnishing all labor, tools, Materials, equipment and incidentals, and doing all Work necessary to complete the Work specified.

Payment for "Furnish and Install Track Drain" is full compensation for furnishing and installing track drains, forming of concrete troughs, finishing and installation of sumps, angles and anchor bolts, furnishing and installation of metal grates, sealing around the drain pipe, PVC drain pipe and two 45º elbows to the designed invert elevation and forming of concrete inlet surface.

11.2 Field Rail Welding, Item SPV.0140.4600.

A Description

A.1 Summary

A.1.1 The work specified in this section shall include providing materials, equipment, laboratory and quality control testing of rail welds, and labor necessary to weld together the abutting ends of rail, and qualification of welding and welders. Rail welds shall be one of the two types indicated below:

- Pressure (Electric Flash-Butt) Welds: Tee rail and TRAM rail for ballasted mainline track, embedded/paved tracks, direct fixation (DF) tracks, and yard body tracks outside the limits of special trackwork shall be welded into continuous strings using the electric flash-butt pressure welding process.

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- Thermite Welds: Thermite welds shall be used to weld the strings together. String length shall be as long as possible but not be less than 150 feet without Engineers approval. Thermite welds shall be used in rail for use in embedded (paved) and ballasted track and within the limits of grade crossings. Shop pre-curved rail shall be thermite welded in place in the track.

A.1.2 Pressure welding shall be performed using mobile electric flash-butt welding machine designed for rail welding.

A.1.3 The Contractor shall make his own assessment as to the number of rails to be welded under this Contract, and the number of welds to be made by any one welding process, based on the information contained in these Specifications and the Contract Drawings.

A.2 References

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A.2.1 Association of American Railroads (AAR):

- AAR - Specification for Quality Assurance, M-1003.

A.2.2 American Railway Engineering and Maintenance-of-Way-Association (AREMA):

- AREMA - "Specifications for Fabrication of Continuous Welded Rail"
- AREMA - "Specifications for Steel Rails"
- AREMA - "Specifications for Thermite Welding Rail Joints"
- AREMA - " Specification for the Quality Assurance of Elastic Flash-Butt Welding of Rail "

A.2.3. American Welding Society (AWS):

- AWS D1.1/D1.1M - Structural Welding Code Steel

A.2.4 ASTM International (Formerly known as American Society for Testing and Materials) (ASTM):

- ASTM E10-12 - Standard Test Method for Brinell Hardness of Metallic Materials
- ASTM E94-04(2010) - Standard Guide for Radiographic Examination
- ASTM E164-13 - Standard Practice for Ultrasonic Contact Examination of Weldments
- ASTM E709-08 - Standard Guide for Magnetic Particle Testing

B Materials

B.1 Rail Welding

B.1.1. Perform field rail welds utilizing one of the following brands of rail welding or an approved equal. All field welds shall only be preheated type.

- Field Flash Butt Welding: Process by Holland or approved equal.
- Calorite: Standard preheat, as manufactured by Calorite Inc., Addison, Illinois.
- Boutet: As distributed by DuWel Steel Products Company, Chicago, Illinois.

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- Orgo-Thermit: As distributed by Orgo-Thermit Company, Lakehurst, New Jersey.

- Railwel Canada 175 boul J.F. Kennedy, St. Jerome, Quebec, Canada J7Y4B5

B.1.2 Unless otherwise shown or specified, conform to the rail welding kit manufacturer's recommended standards when welding high strength rail.

B.2 Rail

B.2.1 Rail for welding shall be as specified in General Track Construction, Item SPV.0090.4500.

C Construction

C.1 Submittals

C.1.1 Certification: Submit manufacturer's certification for foreman and crew.

C.1.2 Pressure (Electric Flash-Butt) Welds: Submit the following:

C.1.2.1 A written description of the welding procedure, including facilities, personnel and list of similar completed projects.

C.1.2.2 A list of equipment and calibration methods, method of rail end alignment, method of rail straightening.

C.1.2.3 Welding Machines Performance: Submit pressure welding machine performance standards as provided by the manufacturer. During welding production, a recorder shall be attached to each welding machine to record platen movement and current impulses on the form "Record of Field Welds". A record of machine performance for each weld shall be submitted to the Contracting Officer. If the record indicates performance which is not in conformance with the approved standards, the weld will be considered defective and shall be rejected.

C.1.2.4 Shop Drawings: Submit Shop Drawings for the pressure welding machine and Shop Drawings of the proposed method and equipment for handling and laying CWR. This submittal shall include reference data relating to where the proposed equipment and laying method were previously successfully used.

C.1.2.5 Details of the equipment and procedure proposed for straightening welds if required. The submittal shall include reference data relating to where

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the proposed straightening equipment and method were previously successfully used.

C.1.2.6 The manufacturer's recommended procedure for welding high strength rail if different from requirements for standard rail.

C.1.2.7 Pressure Weld Samples: Prior to beginning of production welding, two test welds shall be made using the welding machine and the procedures proposed in the Manufacturer's instructions for each type of rail used. The two welds shall be standard rail to standard rail. The welds shall be tested by the testing service. Certified test reports shall be submitted to the City. The test welds may be part of a continuously welded rail string at the contractor's discretion.

C.1.2.8 Proposed location for flash-butt welding plant including methods of transporting materials and equipment to the site, types and locations of environmental controls and duration of welding operations.

C.1.3 Thermite Welds: Submit the following:

C.1.3.1 Prepare a detailed description covering the step-by-step procedures to be employed in making the welds. Include a complete description of each of the following applicable items as well as any other characteristics essential to the welding procedures.

a. The manufacturer's trade name for the welding process.

b. The method used for cutting and cleaning of the rail ends. Flame cutting of rail ends will not be allowed.

c. The minimum and maximum spacing between rail ends.

d. The method used for maintaining the rails in alignment during welding.

e. The method used for preheating, including time and temperature.

f. The tapping procedure, including the minimum time required to cool the weld under the mold insulation.

g. The method used, including a description of special tools and equipment, for removing the upset metal and finishing the weld to the final contour.

h. The manufacturers recommended procedure for welding high strength rail if different from requirements for standard rail.

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i. Method for controlling smoke and fumes from field welding within indicated requirements.

j. The manufacturer's recommended procedure for welding block or girder rail if different from requirements for standard rail.

k. Quality control procedures.

C.1.3.2 Documentation: Prepare, maintain, and make available to the Contracting Officer a complete welding record indicating kit manufacturer, welding foreman, rail temperature, weather conditions, and station location.

C.1.4 Calibrations: Submit description of calibration equipment and calibration methods.

C.1.5 Testing Programs for Field Quality Control: Submit testing programs prepared by the radiographic, ultrasonic, and magnetic particle weld testing services for approval by the Contracting Officer. Each program shall include a description of the proposed procedures, materials, equipment, safety requirements, and report.

C.2 Quality Assurance

C.2.1 Welding Supervision:

- Perform welding under the direct supervision of an experienced rail welding supervisor or foreman.
- Qualify each field welding foreman and crew through a representative of the field rail welding process manufacturer.

C.3 Rail End Preparation

K. C.3.1 Clean the rails to be free of grease, oil, dirt, loose scale, and moisture to a minimum of six inches back from the rail ends, including the rail end surfaces, by use of a wire brush.

L. C.3.2 Align the faces of the rail ends.

M. C.3.3 Clean for 2 inches on each side of the weld, to remove scale and rust, using a power actuated grinder with abrasive wheel.

N. C.3.4 Rail ends shall show no steel defects, dents, or porosity before welding.

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O. C.3.5 If rail is required to be cut to length for any reason, cut it square and clean by means of rail saws or abrasive cutting wheels in accordance with AREMA, "Specifications for Steel Rails".

C.4 Rail

P. C.4.1 Straighten rail not meeting the requirements of AREMA, "Specifications for Fabrication of Continuous Welded Rail", shall be within the specified tolerance.

Q.

R. C.4.2 If any rail cannot be straightened, cut it back a sufficient distance to achieve the required alignment.

S.

T. C.4.3 Perform all straightening or cutting prior to welding.

U.

C.5 Rail Gap

C.5.1 Align and properly gap the ends of the rails to be welded to produce a weld which conforms to the alignment tolerances specified.

C.5.2 Hold the rail gap and alignment during field welding without change during the complete welding cycle.

C.5.2.1 Align rail on the head of the rail:

- Vertical alignment: To provide for a flat running surface. Any difference of height of the rails shall be in the base.
- Horizontal alignment: In such a manner that any difference in the width of heads of rails occurs on the field side.

C.5.2.2 Horizontal offsets: Not to exceed 0.040 inch in the head and 0.125 inch in the base.

C.5.2.3 Surface misalignment tolerance:

- Combined vertical offset and crown camber: Not to exceed 0.040 inch per foot.
- Combined vertical offset and dip camber: Not to exceed 0.010 inch per foot.

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C.5.2.4 Gauge misalignment tolerance: Combined horizontal offset and horizontal kink camber not to exceed 0.040 inch per foot.

C.6 Bolt Holes

C.6.1. One handling hole may be made in each end of a CWR string. Cut off rail ends containing such holes prior to welding.

C.7 Field Weld Postheating

C.7.1 Leave the molds in place after tapping for the time required to permit complete solidification of the molten metal and proper slow cooling to prevent cracking and provide a complete weld with proper hardness and ductility.

C.8 Pressure (Electric Flash-Butt) Welding

C.8.1 Pressure welding shall be in accordance with the AREMA Specification for, "Fabrication of Continuous Welded Rail" except as modified hereinafter.

C.8.2 Mismatched or jagged rail ends shall be either sawed or cut with an abrasive rail cutter. Mating rail ends by flashing shall not be accepted.

C.8.3 Rails shall have the scale removed down to bright metal in areas where the welding current-carrying electrodes contact the rail. Grind down raised rail brands in electrode areas. The weld and adjacent rail for a distance clearing the electrodes shall be rejected if in the areas of electrode contact there is not more than 95 percent of the mill scale removed. Electrode contact areas shall be examined for evidence of electrode burn. Where metal is displaced or where the oxidized areas exhibit checks or small cracks the weld shall be rejected and the rail cut back clear of the electrode burn.

C.8.4 Welds shall be forged to point of refusal to further plastic deformation and shall have a minimum upset of 1/2 inch, with 5/8 inch as standard.

C.8.5 If flashing on electric pressure (flash butt) welds is interrupted, because of malfunction or external reason, with less than 1/2 inch of flashing distance remaining before upsetting, rails shall be reclamped in the machine and flashing initiated again.

C.8.6. Whenever possible, grinding shall be accomplished immediately following welding at an elevated temperature. When grinding must be done at ambient temperature, avoid grinding burns and metallurgical damage.

C.8.7 Alignment of rail in the welding machine shall be at the head of the rail.

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C.8.7.1 Vertical alignment shall provide for a flat running surface. Any difference of height of the rail shall be in the base.

C.8.7.2 Horizontal alignment shall be accomplished in such a manner that any difference in the width of heads of rails shall be divided equally on both sides of the head. Where the difference, when divided, exceeds 0.040 inches, 0.020 inches of the difference shall be placed on the gauge side and the remaining differences in the width of heads shall be on the field side.

C.8.7.3 In any case horizontal offsets shall not exceed 0.040 inch at the head and/or 0.125 inch at the base.

C.8.8 Surface and Gauge Misalignment Tolerances: Shall meet the alignment tolerances given in the AREMA Manual, Chapter 4, Part 2, "Tolerances for Inspection of Welded Rail New and Mainline Relay Rail".

C.8.9 If, at any time, 7 or more of a series of 12 consecutive welds made on one machine exceed 75 percent of the stated surface misalignment tolerances that machine shall be shut down and adjusted before work continues.

C.8.10 Re-welds shall be cut out beyond the heat affected zone of the previous weld.

C.9 Weld Finishing and Tolerances

C.9.1 Bring rails and joints in the finished track to a true surface and alignment by means of an approved grinding machine.

C.9.2 Finish the completed weld for 112 TRAM rail by grinding to conform with the following requirements (Field Rail Welding, Item SPV.0140.4600, Figure C.8.2-1):

C.9.1 Finishing deviation shall not be more than plus 0.010 inch to minus 0.0 inch of the parent section of the rail head surface. Grinding of the parent rail metal is acceptable as long as the minimum rail cross section is maintained. Top of the head of the running rail will be checked with a 3 foot straight edge to verify that there are no low spots or valleys in the head of the finished weld/rail around the weld. If low spot/valley cannot be blended, weld will be rejected and cut out along with the heat affected zone of the rail.

C.9.2 Finish the sides of the 112 TRAM rail head to plus or minus 0.010 inch of the parent section. Grinding of the parent rail metal is acceptable as long as the minimum rail cross section is maintained.

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C.9.3 Finish the bottom of rail base, sides of the rail base, and outside faces of the rail flange and rail head to a finishing deviation of not more than plus 0.010 inch of the parent section and minus no more than the minimum 112 TRAM rail cross section (For example rail base minimum dimension is 5.875 inches, grinding on side of rail base cannot cause the rail base dimension of the weld or the rail around the weld to be less than 5.875 inches)..

C.9.4 Finish the web zone to within 1/8 inch of the parent contour but not deeper than the minimum 112 TRAM rail cross section (see Field Rail Welding, Item SPV.0140.4600, Figure C.8.2-1). Finishing shall eliminate all cracks.

C.9.5 Alignment tolerances to be as specified in AREMA specification Sec. 4.2.2 Specification for Fabrication of Continuous Welded Rail.

C.9.6 Notches created by minor offset conditions, twisted or misshaped rails shall be eliminated by minimum grinding to blend the variations.

C.9.7 Fins on the weld due to grinding or shear drag shall be removed prior to final inspection.

C.9.8 Grind marks can be blended into the parent metal as long as 112 TRAM rail minimum cross sections are maintained.

C.9.9 Grind all sharp edges from welds to prevent damage to rail boot.

C.9.10 Finishing of 115 RE welds will follow Field Rail Welding, Item SPV.0140.4600, Section C.10.2.

C.10 Weld Quality

C.10.1 Inspect each “test and pressure weld” using the dry powder magnetic particle method in accordance with ASTM E709.

C.10.2 Inspect each weld using a three foot straightedge along the centerline of the rail and 0.625 inch below top of rail on the gauge side of the rail head. Center the straightedge over the weld. The gap between the straightedge and the rail shall comply with the requirements of AREMA, Chapter 4.

C.10.3 Ensure that each completed weld has full penetration and complete fusion and is entirely free of cracks or fissures.

C.10.4 Porosity and slag-type defects will be acceptable provided that testing indicates that the largest defect does not exceed more than 3/16 inch in its largest

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dimension; the total area of the defect does not exceed 0.010 square inches, and the sum of the greatest dimension of defects in a line does not exceed 1/2 inch.

C.10.5 Weld Hardness: As specified for the sample welds herein.

C.11 Weld Numbering

C.11.1 Mark a sequential weld number on the rail immediately adjacent to the weld using a quality paint marker at the time the weld is made.

C.11.2 Number welds sequentially in the order in which they are made.

C.11.3 When defective welds are replaced assign a new sequential number to the new weld by adding a letter to the defective weld number.

C.12 Field Quality Control

C.12.1 General:

C.12.1.1 Ultrasonically test all welds at the time of welding. Ultrasonic testing of the rail is not required.

C.12.1.2 Use equipment which has a distance amplitude correction feature.

C.12.1.3 Calibrate the equipment daily using an 11W calibration block, also made of rail steel.

C.12.1.4 Inspection Personnel: Qualify all inspection personnel in accordance with AWS D1.1/D1.1M.

C.12.1.5 Cut out and re-weld all welds giving fault indication in ultrasonic inspection using a minimum 19 foot piece of rail or cut out heat affected zone and pull together and re-weld.

C.12.2 Ultrasonic Weld Testing:

C.12.2.1 Mainline and yard field welds shall be ultrasonically tested (UT) over the entire cross section of head, web, and base. The UT equipment shall meet the requirements of AWS D1.1/D1.1M, Paragraph 6.17. The procedure shall meet the requirements of ASTM E164. Prior to performing production UT of welds, UT technicians shall demonstrate to the satisfaction of the Contracting Officer that they can discern and identify indication produced by slag, porosity, lack of fusion, and cracks. a. Use ultrasonic test equipment capable of detecting a 3/64 inch discontinuity, 6-1/2 inches below the top of rail. At a minimum, scan the weld from the top and both sides of the rail head and the base. Scan the weld from both

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sides on the face for longitudinal and transverse discontinuities using the applicable scanning pattern or patterns.

C.12.2.2 Testing Procedures: In accordance with the approved submittal.

C.12.2.3 Acceptance criteria shall be as follows:

a. Welds showing a response at any level that is identified as a crack or lack of fusion will not be acceptable.

b. Welds showing a response that is less than 50 percent of the primary reference level will be acceptable.

c. Welds showing a response greater than 50 percent but that do not exceed the primary reference level are acceptable, providing that all of the following apply:

1) The defects are evaluated as slag or porosity.

2) The largest defect does not exceed 0.180 inch in its largest dimension.

3) The total area of the defects do not exceed 0.09 square inch.

4) The sum of the greatest dimension of defects in a line does not exceed 3/8 inch.

d. Welds showing a response that exceeds the primary reference level will not be acceptable.

C.12.3 Magnetic Particle Testing:

C.12.3.1 Main line and yard field "test and pressure welds" shall be magnetic particle tested (MT). The procedures used shall meet the requirements of ASTM E709. Welds surfaces shall be tested except the underside of the rail base. The magnetizing equipment shall be an electro-magnetic yoke meeting the following requirements: a. DC lift capacity of 40 pounds, and/or b. AC lift capacity of 10 pounds at the maximum pole spacing.

C.12.3.2 Testing Procedures: In accordance with the approved submittal.

C.12.3.3 Acceptance Criteria: The weld quality shall meet the requirements of Paragraph C.10.

C.13 Deficient Welds

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C.13.1 Replacement of Defective Welds:

C.13.1.1 When the Contracting Officer determines a weld is unacceptable, cut out the weld and replace it with a 19 foot (minimum) rail plug.

- Make saw cuts at least 6 inches from the centerline of the faulty weld.
- Renumber replacement welds as indicated.
- Ultrasonically test replacement welds made in rail as specified herein.

C.13.1.2 If one or both of the rails may be moved, cut out the weld, pull rails together to the indicated rail gap and reweld.

C.13.1.3 If neither rail may be moved, cut the weld out of the rail and replace with a section of new rail and with two new welds. Use a 19 foot minimum length of the new rail.

C.14 Protection of Rail Insulators

C.14.1 Rail insulators (pads, clips, insulators, and bushings) shall be covered/protected by a non-flammable material to prevent hot grinding fines from fusing into the rail insulating components.

C.15 Weld Slag

C.15.1 Welding fines and slag shall be removed from around the rails, insulating components, and the entire track area.

C.16 Thermite Weld Stagger

C.16.1 Field welds in opposite rails shall be staggered a minimum of 5’ for connecting CWR strings and a minimum of 2’ at all other locations.

C.16.2 Field welds shall not be located within 10’ of a bolted rail joint.

C.16.3 Field welds shall not be positioned within 3” of a support tie.

D (Vacant)

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0140.4600	Field Rail Welding	NONE

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The work specified in this section will not be measured separately for payment, but all costs in connection therewith will be considered incidental to track construction measured elsewhere.

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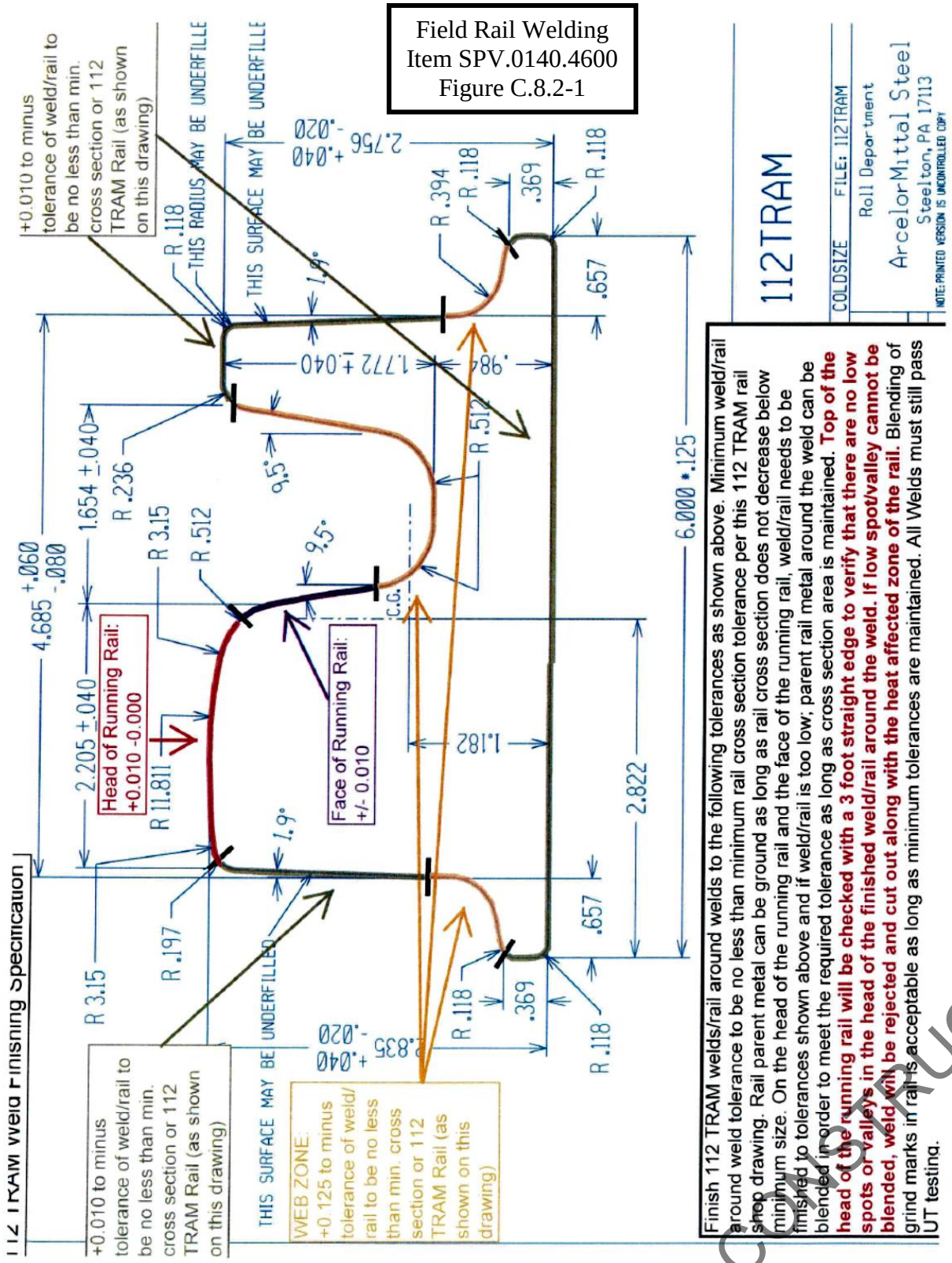
Field Rail Welding
Item SPV.0140.4600
Figure C.8.2-1



Finish 112 TRAM welds/rail around welds to the following tolerances as shown above. Minimum weld/rail around weld tolerance to be no less than minimum rail cross section tolerance per this 112 TRAM rail shop drawing. Rail parent metal can be ground as long as rail cross section does not decrease below minimum size. On the head of the running rail and the face of the running rail, weld/rail needs to be finished to tolerances shown above and if weld/rail is too low; parent rail metal around the weld can be blended in order to meet the required tolerance as long as cross section area is maintained. **Top of the head of the running rail will be checked with a 3 foot straight edge to verify that there are no low spots or valleys in the head of the finished weld/rail around the weld. If low spot/valley cannot be blended, weld will be rejected and cut out along with the heat affected zone of the rail.** Blending of grind marks in rail is acceptable as long as minimum tolerances are maintained. All Welds must still pass UT testing.

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11.3 25M Straight-Frog Turnout, Item SPV.0060.4700; 25M Curved-Frog Turnout, Item SPV.0060.4701; 25M Special Turnout, Item SPV.0060.4702; 50M Straight-Frog Turnout, Item SPV.0060.4703; Diamond, Item SPV.0060.4704.

A Description

This Specification defines the requirements for the design, detailing, manufacturing, fabricating, furnishing and delivery of the special trackwork.

Special trackwork for this project shall consist of turnouts and all related equipment including switches and other track materials. All special trackwork shall have high-strength, head-hardened AREMA 115 RE rail or 112 TRAM rail in embedded track or on concrete slabs. Special trackwork shall include the following:

- 25 M turnouts with straight and curved frogs in embedded track.
- 50 M turnout with a straight frog in embedded track.
- 25 M turnout with special configuration in embedded track

V.

- Diamond in embedded track

For Special Trackwork geometry and ties, see Contract Drawings.

The scope of work shall include all rail and associated components to include adapter plates for mounting switch machine rods. Supports and brackets for the switch machines shall be supplied by the switch machine manufacturer.

A.1 Related Sections

A.1.1 General Track Construction, Item SPV.0090.4500

A.1.2 Other Track Materials, Item SPV.0060.4700

A.2 References and Testing Requirements

AREMA	American Railway Engineering and Maintenance-of-Way Association Manual for Railway Engineering, 2007 Edition
AREMA	American Railway Engineering and Maintenance-of-Way Association Portfolio of Trackwork Plans, 2007 Edition
ASTM	ASTM International, Current Editions

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ANSI	American National Standards Institute, American National Standards Code, Current Edition	
NEMA	National Electrical Manufacturers Association, Industrial Laminate Section Codes, Current Edition	
AREMA	Spec. 100	Portfolio of Trackwork Plans
ASTM	A27	Steel Castings, Carbon for General Application
ASTM	A47	Ferrite Malleable Iron Castings
ASTM	A128	Steel Castings, Austenitic Manganese
ASTM	A325	High-Strength Bolts for Structural Steel Joints
ASTM	A490	Heat-Treated Steel Structural Bolts
ASTM	B633	Electroplated Coatings of Zinc on Iron and Steel
ASTM	D149 Rev A	Standard Test Method for Dielectric Breakdown Voltage and Dielectric Strength of Solid Electrical Insulating Materials at Commercial Power Frequencies
ASTM	D217	Standard Test Method for Cone Penetration of Lubricating Grease
ASTM	D257	DC Resistance or Conductance of Insulating Materials
ASTM	D395	Standard Test Method for Rubber Properties in Compression Set
ASTM	D429	Rubber Property-Adhesion to Rigid Substrates
ASTM	D445	Rubber Test Method for Kinematic Viscosity of Transparent and Opaque Liquids
ASTM	D471	Rubber Property – Effect of Liquids
ASTM	D543	Standard Practices for Evaluating the Resistance of Plastics to Chemical Reagents

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ASTM	D566	Standard Test Method for Dropping Paint of Lubricating Grease
ASTM	D575	Standard Test Method for Rubber Properties in Compression
ASTM	D751	Standard Test Method for Coated Fabrics E1-1997
ASTM	D792	Standard Test Method for Density and Specific Gravity (Relative Density) of Plastics by Displacement
ASTM	D814	Standard Test Method for Rubber Property – Vapor Transmission of Volatile Liquids
ASTM	D1004	Standard Test Method for Initial Tear Resistance of Plastic Film and Sheeting
ASTM	D2231	Standard Practice for Rubber Properties in Forced Vibration
ASTM	D2240	Standard Test method for Rubber Property-Durometer Hardness
ASTM	D3083	Standard Specification for Flexible Poly (Vinyl Chloride) Plastic Sheeting for Pond, Canal, and Reservoir Lining
ASTM	D4833	Standard Test Method for Index Puncture Resistance of Geotextiles, Geomembranes, and Related Products (E1-1996)
ANSI	B18.2.1	Square and Hex Bolts and Screws
ANSI	B18.21.1	Lock Washers
ANSI	B18.22.1	Plain Washers
NEMA	LI-1	Industrial Laminated Thermosetting Products

B Materials

B.1 Testing

B.1.1 Except where specifically stated otherwise, all testing specified shall be undertaken by the Manufacturer. If the Manufacturer has previous or existing test results or certifications that are applicable, it may supply those subject to Engineer approval.

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B.2 Submittals

B.2.2 Submit or retain the following:

- The Manufacturer shall submit separate shop drawings for each special trackwork turnout for review.

- Submit interface drawings addressing the attachment of the switch and detector rods to the special trackwork, prepared by the Manufacturer and approved by the Engineer.

- Retain full installation details and step-by-step procedures for installing the special trackwork in the field. The procedures also shall address the interface requirements for the installation of the switch machine.

W.

- The Manufacturer shall submit, for review by the Engineer, a Turnout Gauge & Flangeway Design Study for each different special trackwork geometry.

X.

- Any testing results or certifications that pertain to section B.1.1

Y.

B.3 Tolerances

B.3.1 All fabrication tolerances shall conform with the track gauge of 4’- 8 ½”, +/- 1/8", and a horizontal and vertical cross level tolerance of 1/16 inch.

B.3.2 All component and fit tolerances shall meet the applicable requirements of AREMA Portfolio Drawings 1010 and 1011, and AREMA Chapter 5, Part 4 “Track Construction”.

B.4 Compatibility with Switch Machines

B.4.1 Special trackwork and components shall be compatible with interface and operation of the designated switch machine manufacturer’s model. Compatibility shall be confirmed by design and testing as specified herein.

B.5 Special Trackwork Geometry

The following dimensions are fixed for each turnout as indicated on the Contract Drawings and may not be altered by the Manufacturer:

- Turnout Lead

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- Length of switch alignment
- Radius of switch points
- Frog number
- Throw at point of switch
- Spread at heel of switch

Z.

B.6 Rail

B.6.1 Rail for special trackwork, including stock rail and closure rail, shall be high strength and head hardened.

B.6.2 Stock rails shall vary in length according to Contract Drawings.

B.6.3 Rail shall meet all criteria in accordance with General Track Construction, Item SPV.0090.4500, Section B.4 “Rail”.

B.6.4 Track shall be constructed in accordance with General Track Construction, Item SPV.0090.4500.

B.7 Switch Points

B.7.1 Switch points shall be as per the Special Trackwork Contract Drawings. Switch points shall have reinforcing bars attached by square-head bolts and hex nuts. Reinforcing bars shall be 1/2 inch thick and double-reinforced, as per AREMA Portfolio Plan 221.

B.7.2 Alignment of switch points shall be as per AREMA drawings with extended length for the installation of floating heel blocks. Switch point length currently is set as per the Contract Drawings. Manufacturer may substitute alternatives subject to the Engineers approval.

B.7.3 Switch points shall have an undercut design in accordance with AREMA Plan Basic Number 221, Detail 5100. Switch point stops shall bear against the supporting stock rails when points are in the thrown positions.

B.8 Heel Blocks

B.8.1 AREMA 11' straight and 13' curved switch points shall have heel-joint assemblies as per AREMA Plan 221. AREMA switch points of 16'-6", 19'-6", and 26'-0" shall have floating heel block assemblies.

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B.8.2 The floating heel block on the straight side of the turnout (curved switch point) shall consist of cast steel, Class B.

B.8.3 At locations where a restraining rail in the crotch area between the stock rail and the closure rail extends to the heel block, the heel block shall incorporate a flangeway flare design to maintain the curve guarding for the longest possible distance. Material for such heel blocks shall be cast manganese steel.

B.9 Turnout Frogs

B.9.1 Turnout frogs shall be fabricated to the designated turnout number geometrics and shall be solid manganese steel frogs in accordance with AREMA Plans 622-03, 623-03 or 624-03; or spring frogs in accordance with AREMA Plan 401-03 or as applicable, and as designated on the Contract Drawings.

B.9.2 Austenitic manganese steel castings shall be of a heavy wall thickness design in accordance with the requirements of AREMA Plan Basic Number 100, Section M2.2, and ASTM A128, Grade A. Castings shall be explosive depth hardened in accordance with AREMA, *Specifications for Special Trackwork*, Article M2.7, with a minimum Brinell hardness of 350. Hardening shall project uniformly to 250 BHN at a depth of 11/8 inches.

B.9.3 The Manufacturer shall produce shop drawings to specify the procedures to be used for the depth hardening process, the portions of each frog which are to be depth hardened, and the Brinell hardness pattern which the Manufacturer anticipates to achieve with such procedures.

B.10 Frog Gaurdrail

B.10.1 Frog guardrail shall consist of a tee rail design with single piece construction and level guardrail height. The ends of the guardrail shall be beveled and milled. The flangeway shall be the minimum width specified in the Contract Drawings.

B.11 Leveling Beams

B.11.1 Leveling beams shall be designed to accommodate the required turnout geometry and for use with an elastic rail clip system with welded on shoulders. The beams shall be insulated as required to conform with system electrical isolation requirements.

B.12 Switch Rods

B.12.1 Switch rods shall be vertical insulated switch rods.

B.12.2 Prior to assembly of insulated joints, the mating surface and ends of switch rods, steel channel, and splice plates shall be coated with an approved insulation

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enamel. The assembled joints shall be dielectrically tested to verify that insulated joints can withstand a potential of 1,500 volts dc for one minute without evidence of flashover, pinholes, or fracture.

B.12.3 Switch Rod Insulation shall be as per AREMA C&S Requirement for insulation.

B.13 Lubrication

B.13.1 Lubricant for moving parts in turnouts shall meet the following requirements:

• Calcium soap	9%
• Graphite	11.5%
• Penetration, ASTM D 217 at 70^0 F worked	340
• Dropping Point, ASTM D 566 at 77^0 F	101/214
• Oil viscosity, ASTM D 445, cSt at 104^0 F	81.8

B.13.2 Other types of lubricants may be used providing that the lubricant has been used successfully by other rail agencies, and subject to the Engineers written statement of no objection.

B.14 Rail Joints

B.14.1 Rail joints for special trackwork shall be thermite welded or by means of joint bars. Where a joint occurs in a guarded rail section of the turnout, a separator block shall be provided for the full length of joint bar in between the two rails.

B.14.2 Bolted joints, joint bars and separator blocks shall meet the requirements specified in General Track Construction, Item SPV.0090.4500

B.14.3 Insulated joints shall meet the requirements specified in Other Track Materials, Item SPV.0060.4700

C Construction

C.1 Detailed Design

C.1.1 The Manufacturer shall develop all required details in accordance with these specifications and good practice. Detailed shop drawings shall be provided by the Contractor for all components including but not limited to frogs, switches, closure rails, restraining rails, rail fastener plates, and fastener layouts. The Contractor shall address the following considerations in the design of special trackwork:

- Rail Lengths - Design layouts with rails that are to be left longer than the theoretical length shown on the Contract drawings and with blank (non-drilled)

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ends so that such rails can be cut and drilled in the field to compensate for accumulated construction tolerance deviations in assembly of the layouts.

- Dimensions - All dimensions shall be confirmed in the field with respect to locations where the new special trackwork must tie into existing tracks. The location of existing joints and the amount of wear on existing rails shall be determined so that the location of joints can be detailed on the shop drawings.

C.2 Handling and Delivery

C.2.1 All rails and special trackwork shall be handled carefully and delivered in open top containers to avoid damage by kinking, bending, nicking, or other potential damage to the rail. Rails and special trackwork components shall not be dropped or struck sharply. Handling and delivery shall be in accordance with accepted industry practice.

C.2.2 Stock rails, closure rails, tongue rails, and frogs shall be delivered assembled with associated fasteners attached.

C.2.3 All bundles, boxes and kegs shall be clearly marked with the following information:

- Identification of items contained
- Supplier's name
- Delivery date
- Number of pieces
- Gross weight

C.3 Acceptance

C.3.1 Acceptance is subject to inspection upon delivery.

D Measurement

The City will measure Special Trackwork as each individual turnout and diamond acceptably completed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.4700	25 M straight-frog turnout	EACH

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SPV.0060.4701	25 M curved-frog turnout	EACH
SPV.0060.4702	25 M special turnout	EACH
SPV.0060.4703	50 M straight-frog turnout	EACH
SPV.0060.4704	Diamond	EACH

Payment is full compensation for all labor, materials, tools, equipment, incidentals necessary to complete the Work specified herein and as shown on the Contract Drawings, saw cutting, excavation, aggregate base, turnout support ties, reinforced concrete track slab, installation of turnout materials, installation of switch mechanism, elastomeric grout, insulated joints, rail welds and concrete infill.

11.4 Insulated Joint Bar, Item SPV.0060.4800; Transition Rail, Item SPV.0060.4801; Shim, Item SPV.0060.4802; Miscellaneous Hardware, Item SPV.0105.4803; Grout, Item SPV.0025.4804; Movable Rail Joint, Item SPV.0060.4805.

A Description

This Section defines the requirements for the manufacture, testing, and supply of insulated joint bars, compromise joints, shims, miscellaneous hardware for fastening of running rail and special trackwork and grout. All hardware shall be new and sized to match the fastener component for which they will be used. All materials shall meet Buy America. Example materials called out in specifications have not been confirmed as Buy America by the City.

A.1 Referenced Standards

A.1.1 Insulated Joints and Transition Rails

Sponsor	Number	Subject
AAR	Part 58	Signal Specification
AAR	Part 116	Signal Specification
AREMA	Chapter 4-Section 3.8	Specifications for Bonded Insulated Rail Joints
AREMA	Chapter 4-Section 3.4	Specifications for Quenched Carbon steel Joint Bars and Forged Compromise Joint Bars
ASTM	E165-02	Standard Test Method for Liquid Penetrant Examination
ASTM	A194/A194M-13	Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure and High-Temperature Service

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ASTM	F436-11	Standard Specification for Hardened Steel Washers
ASTM	A490-12	Standard Specification for Structural Bolts, Alloy Steel, Heat Treated, 150 ksi Minimum Tensile Strength
ASTM	A325-10e1	Standard Specifications for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength
ISO	9001:2008	Quality Management Systems-Requirements
ASTM	D1002-10	Standard Test Method for Apparent Shear Strength of Single-Lap-Joint Adhesively Bonded Metal Specimens by Tension Loading
SSPC	SP-10	Near-White Blast Cleaning

A.1.2 Shims

Sponsor	Number	Subject
ASTM	A653/A653M-11	Standard Specification for Steel Sheet, Zinc-Coated or Zinc-Iron Alloy-Coated by the Hot-Dip Process
CSA	G40.21-04	Structural Quality Steels General Instruction
CSA	G164-M92 (R2003)	Hot-Dip Galvanizing of Irregularly Shaped Articles
ISO	9001:2008	Quality Management Systems-Requirements

A.1.3 Miscellaneous Hardware

Sponsor	Number	Subject
ASTM		B633-13 Standard Specification for Electrodeposited Coatings of Zinc on Iron and Steel

A.1.3.1 Bolts and nuts shall conform to:

Sponsor	Number	Subject
AREMA	Chapter 4 Section 3.3	Rail Drillings, Bar Punching, and Track Bolts
AREMA	Chapter 4 Section 3.5	Specifications for Heat-Treated Carbon-Steel Track Bolts and Carbon-Steel Nuts

A.1.3.2 Spring washers shall conform to:

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Sponsor	Number	Subject
AREMA	Chapter 4 Section 3.6	Specifications for Spring Washers

A.1.4 Bumping Posts

Sponsor	Number	Subject
ISO	9001:2008	Quality Management Systems-Requirements
AWS		D1.1 Welded Steel Construction (Metal Arc Welding)

B Materials

B.1 Isolated Bonded Joint

Insulated Bonded Joints shall be in accordance with Section 2.8 and Section 2.11 of the AREMA Manual for Railway Engineering, Chapter 4 and as directed below. The Contractor shall furnish single bonded insulated rail joints, in kit form, of the epoxy bonded type as manufactured by L.B. Foster Allegheny Rail Products, Co., Portec Rail Products Inc., Railway Bonded insulated joints, or approved equal.

Joint bars for insulated bonded joints shall provide for full face contact, conforming to the shape of the designated TRAM or RE rail section, and shall be fabricated from quenched carbon steel as specified in the AREMA specifications, except as defined herein. The joint bars shall be smooth and straight for installation along tangent track, or pre-curved to match the rail radius at the connection point of special trackwork and in curves with a radius less than 400 feet.

The fishing height of the joint bars shall be within a tolerance of + 0 inches to $^{1}/_{32}$ inch of the dimensions defined in the AREMA specifications. The contact surface of the joint bars adjacent to the rail shall be smooth and straight within a tolerance of +/− $^{1}/_{32}$ inch using a 36 inch straight edge. The inside face of the joint bars shall be smooth, with no stamping or branding permitted.

Insulated bonded joints shall be complete with 3/16” thick high pressure laminated end posts, steel core bushings, and heat-treated oval neck track bolts, nuts, and washers. Nuts shall be designed with a locking feature to prevent loosening meeting Contract requirements.

Provide holes in the rail and joint bars as required. The size and location of deburred holes shall conform to the AREMA Manual for Railway Engineering, Volume 1, Chapter 4 Rail, Section 1.3 Rail Drillings, Bar Punchings and Bolts.

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The structural adhesive used as the bonding agent shall produce a minimum lap shear strength of 3,500 psi at 75 degrees F as per test prescribed in ASTM D1002. Adhesive and electrical insulation materials supplied with the joint bars shall have a shelf life of not less than one year when stored in a location protected from the weather. A corrosion inhibitor shall also be included in the adhesive formulation.

The insulating materials shall consist of a high pressure and laminated design; impervious to oil, grease, and water; and having electrical resistance characteristics equal to or greater than fiber insulation meeting the requirements of the AREMA Signal Manual of Recommended Practice, Sections 8.5.2 Recommended Developmental Criteria for Fabricated Insulating Parts for Track Insulation and 8.5.3 Recommended Developmental Criteria for Track Insulating Material; and the Electrical Resistance Test specified herein.

B.2 Transition Rail

New transition rail bars shall conform to the requirements of the "Specifications For Quenched Carbon-Steel Joint Bars and Forged Compromise Joint Bars" found in Chapter 4, Part 2 of the AREMA Manual for Railway Engineering.

Transition rail bars shall be of the size, shape, and punching pattern required to fit the rail sizes and sections being joined. Only factory designed and forged or cast transition rail bars shall be used.

TRAM rail transition pieces shall be machined to smoothly transition from an RE section to TRAM section. Contractor to submit shop drawings for review.

B.3 Shims

Regular and tapered steel shims used to adjust the elevation of the direct fixation fasteners shall be manufactured to the shape, size and configuration to accommodate the direct fixation fastener system. The tapered shims shall be used to adjust rail cant transition from 1:20 to zero at the special trackwork areas and to maintain the required rail cant at grade crossings.

Steel shims specified to the thickness of 20 gauge and 11 gauge shall be manufactured from galvanized steel, coating designation G90, meeting the requirements of ASTM A653M, lock forming quality or approved equivalent.

Steel shims specified to the thicknesses of ⅛ inch, ⅜ inch, ½ inch and all tapered shims shall be manufactured from hot-rolled plate steel meeting the requirements of CSA G40.21, Grade 260 or equal. The measured thickness shall be inclusive of galvanizing. Steel shims shall be hot-dip galvanized in accordance with the latest edition of CSA G164, or equal. Galvanizing of shims shall consist of a minimum coating of 2 ounces/ft^2 on each side after manufacture.

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Steel shims shall be sheared or cut by a method to obtain the required configuration, and which is acceptable to the buyer. Edges sheared, punched or cut during manufacture shall be ground to remove all sharp edges. Shims are to be hot dipped galvanized after all machining is complete. Slotted or circular holes shall be drilled, punched or cut at right angles to the shim surfaces.

Steel shims shall be smoothly finished and free from injurious warp and other surface imperfections due to projecting fins of metal caused by shearing, drilling or punching operations.

B.4 Grout

B.4.1 Elastomeric Grout

- Shall use Icosit KC 340/45 or approved equivalent.

B.4.2 Concrete Grout

- Shall use EUCO HI-FLOW GROUT or approved equivalent.

B.5 Miscellaneous Hardware

All miscellaneous hardware shall meet the physical dimensions, strength and properties and test requirements as defined herein.

The hex head bolts shall be used for embedding into concrete with or without epoxy grout and shall consist of the minimum dimensions required for the particular use. The hex head bolt shall be capable of withstanding the ultimate torque requirement necessary to destroy the diameter bolt as specified in ASTM A325. The ultimate tensile strength of the hex head bolt itself shall equal or exceed the tensile strength of 56,380 pounds as specified in ASTM A325.

Circular holes for joint bolts shall be drilled to conform to the drawings. A variation of nothing under and $^{1}/_{16}$ inch over in the size of the bolt holes will be permitted. A variation of $^{1}/_{32}$ inch in the location of the holes will be permitted. Chamfer the entrance and exit sides of the holes.

Miscellaneous heat-treated carbon-steel track bolts and carbon-steel nuts shall be in accordance with Section 2.9 of the 2006 AREMA Manual for Railway Engineering. Miscellaneous spring washers shall be in accordance with Section 2.10 of the 2006 AREMA Manual for Railway Engineering.

B.6 Movable Rail Joint

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The Contractor shall furnish and install the movable rail joints at the St. Paul Lift Bridge. This work consists of adding movable rail joints as shown in the Contract Drawings.

Rail material shall be 115RE head hardened or heat treated rail.

Rail bed plates, fills and shims must be drilled to fit the steel tie pattern and be bolted in place on the fixed and movable spans as shown in the Contract Drawings. Movable rail joints need not be insulated.

The movable rail joint supplier shall verify all dimensions and elevations as required to provide an adequate foundation for the fixed and lift rail bed plates of the movable rail joints.

C Construction

C.1 Submittals

C.1 Submit or retain the following:

C.1.1 Insulated Bonded Joints and Transition Rails

a. Submit detailed description of the adhesive to be used to bond the joint bars to the rail, and the method by which the quality of the adhesive formulation and preparation is regulated, maintained and monitored.

b. Retain drawings showing details of bolts, lock nuts and all other components of the assembly, including fully detailed step-by-step installation instructions.

c. Submit inspection and test plan

d. Retain packaging procedures

e. Retain most recent historical rolling load test records demonstrating adherence to these Specifications.

f. List of references and contact personnel of transit authorities that have qualified and accepted similar concrete guard rail ties for Contracts with similar technical specifications.

g. Statement of the manufacturer's capabilities to carry out the work in accordance with the technical and quality assurance/control requirements.

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h. Delivery procedures

i. Testing facilities certifications

j. Insulated rail joint electrical test procedures and equipment

k. Insulated rail joint electrical test results

C.1.2 Shims

a. Inspection and test plan and procedures

b. Retain packaging procedures

c. Delivery procedures

C.1.3 Miscellaneous Hardware

a. Retain shop drawings detailing the hardware to be furnished for the Work

b. Submit prequalification test results for review or prequalification test plans to include:

Test procedures

i. Schedule of qualification tests to be performed

ii. Name of independent test laboratory proposed to perform tests

c. Retain production run test plans to include:

i. Test procedures

ii. Test reporting procedures

d. Retain hardware manufacture quality assurance reports to include:

i. Production run test reports

ii. Packaging procedures

C.1.4 Movable Rail Joint

a. The Contractor shall submit shop drawings detailing the hardware to be furnished for the Work

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C.2 Quality Assurance/Quality Control

C.2.1 General

The Contractor shall include its inspection and testing plan for the work. The inspection and testing plan shall identify who, what, when and where in the process of design, production, assembly, shipment and acceptance that all inspections will be performed.

C.2.2 The Contractor shall conduct review of fabrication drawings, showing the details and procedures for the manufacture, cutting of the plates, machining of the inclined surfaces, drilling, punching or cutting of holes, and the finishing to specified tolerances prior to commencement of fabricated work.

C.3 Qualification Testing

C.3.1 Insulated Bonded Joint Bars

Six (6) samples of the designated RE rail section will be prepared for qualification testing. Four (4) of the pieces shall be 24 inches long and two (2) of the pieces shall be 36 inches. All qualification testing will be performed at the expense of the Contractor.

C.3.1.1 End Hardening Tests

All six (6) samples shall be end hardened in accordance with the Contractor's submitted procedure. Two (2) sample ends shall be selected and tested as specified below:

a. Brinell hardness readings will be taken at the centerline of the rail head longitudinally at ¼ inch intervals for a distance of one inch from the hardened end. The rail sample shall then be sawed longitudinally along the centerline and the Brinell hardness readings shall be taken at ¼ inch intervals, $^{3}/_{16}$ inch below head of rail, for a distance of 2 inches from the hardened end. The de-carburized surface on the rail head shall be removed before taking Brinell hardness readings.

b. Acceptance shall be based on a Brinell hardness measured at a spot on the center line of the head between 341 and 401 at all locations within ½ inch of the rail end. The heat-affected zone defined as the region in which the hardness is above that of the parent metal shall cover the full width of the rail head and extend longitudinally a minimum of 1.5 inches from the end of the rail. The effective hardness zone ½ inch from the end of the rail shall be at least ¼ inch deep.

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c. If either of the samples fails to meet the acceptance criteria, the procedure shall be modified and the tests repeated until acceptance hardness values have been achieved.

C.3.1.2 Longitudinal Compression Test

Two bonded joints shall be completely assembled, by others, from the four sample pieces of RE rail each 2 feet long. Each joint assembly shall then be sawn in half where the rails are butted together. The sawing shall be performed in a manner which will prevent overheating and damage to the epoxy bond, and the cut will be perpendicular to the centerline of the top of the rail with a tolerance of +/− one degree. The sawn ends of the bars at one end of the test piece, and the end of rail at the other, shall have fair bearing in the test machine to ensure that the loading and reaction are through the centroid of the rail, and parallel to its axis. Loads shall be applied longitudinally in increments of 25,000 pounds. Each load increment shall be maintained constant until the longitudinal deflection of the rail ceases before increasing the load to the next increment. The load will be increased in these designated increments until a total load of 600,000 pounds is attained, or failure occurs. At each increment of loading, the load and differential movement of the rail and joint bars, measured to 0.001 inch, shall be recorded.

The bonded joint shall be accepted based on the Longitudinal Compression Test when it is demonstrated that the joints have not slipped at any time during application of the incremental loads, up to 600,000 pounds, nor the magnitude of differential movement is $^{1}/_{16}$ inch in any direction. At the completion of the test, after the load on the rail has been released, the relative position of the rail and joint bar shall be within 0.020 inch of its original position.

If either sample fails to meet the above-defined requirements, the installation procedure shall be modified and the tests repeated.

C.3.1.3 Electrical Resistance Test:

a. Test Procedure:

i. Fully assemble an insulated rail joint consisting of two lengths of 115 RE rail; one 24 inches long and the other 42 inches long. The rail shall be supported on non-conducting material.

ii. 500 volts (DC) shall be applied to the rail across the insulated joint for a duration of 3 minutes, while the current

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flow through the joint is measured and recorded to the nearest 0.1 microampere.

b. Acceptance Criteria:

i. The minimum resistance shall be 10 megohms for 500 volts (DC).

C.3.1.4 Rolling Load Test:

After completion of the Electrical Resistance Test, the same bonded joint shall be subjected to the Rolling Load Test per Section 2.11.7.4 of the 2006 AREMA Manual for Railway Engineering.

If the sample fails to meet the above defined acceptance test requirements, the installation procedure shall be modified and the tests repeated.

C.3.1.5 Additional Follow-up Testing:

a. Test Procedure:

i. The bonded insulated joint shall be subjected to follow-up testing after it has passed the electrical resistance test, electrical impedance test and the rolling load test.

ii. Repeat the electrical resistance and impedance tests as specified above.

iii. Subject the joint assembly to the Longitudinal Compression Test after completion of the electrical resistance and impedance tests.

b. Acceptance Criteria:

i. The follow-up testing results shall follow the acceptance criteria previously established for each respective test.

C.3.2 Shims

C.3.2.1 Prototype Testing

Prototypes of each designated type of steel shim shall be manufactured, tested and supplied to the UTA for review and written statement of no objection prior to the start of production.

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The prototype testing shall include checks of all dimensions, coating thickness, and surface finish for each type of shim specified.

C.3.2.2 Production Testing

The Contractor shall submit mill certificates defining the chemical and mechanical properties of the material supplied for the manufacture of the steel shims.

Dimensional measurements shall be performed by the Contractor to ensure conformance with the specifications. At least 2% of all the shims manufactured for the project and not less than 2 shim types manufactured per production day. Test results shall be submitted to the UTA for review.

The coating thickness of shims galvanized by the Contractor or its agent shall be verified by the Contractor using magnetic gauges or by a procedure acceptable to UTA. Tests on the coating thicknesses shall be performed on at least 1% of all the shims produced for the project and on not less than 1 shim type per production day. Certified test results shall be submitted to the UTA for approval.

C.3.3 Miscellaneous Hardware

C.3.3.1 Hardware Production Test Requirements

The Contractor shall submit mill certificates on the chemical and mechanical properties of the material supplied for the manufacture of the hardware.

The hex head bolts and lag screws shall be subjected to and meet the pre-qualification test acceptance criteria as specified in ASTM A325.

The hex head bolts and lag screws shall be subjected to and meet the production run test acceptance criteria as specified in ASTM A325.

C.3.3.2 Coating

All hex head bolts shall be coated in accordance with ASTM B633, Type II (Olive Drab) Fe/Zn.

All other designated hardware shall be galvanized in accordance with the applicable ASTM specifications.

C.4 Packaging, Labeling and Storage

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C.4.1 Insulated Bonded Joint Bars

C.4.1.1 Packaging

All materials used for packaging and crating for delivery shall be new, robust and of equal quality to the best commercial packaging and delivery crating practices accepted in the industry.

The choice of packaging shall be based on the most severe operational and climatic conditions expected during transit and storage. Key factors to be considered shall include the following:

a. Possibility of rough handling during transit and storage from manufacturer to final destination.

b. Shock, vibrational and static impacts, and environmental exposure during loading, unloading and transit operations.

c. Geographic and climatic conditions at the final destination.

d. Handling facilities and practices used at points of loading and discharging of cargo.

C.4.1.2 Labeling

Each package unit shall be marked to identify contents, quantity, and gross weight.

C.4.2 Transition Rails

Transition rails shall be wired together in pairs and separated from the other bars.

C.4.3 Shims

Shims shall be packaged by the category of thickness, handled and stored in a manner that will prevent damage to the materials. The Contractor's commercial practice for preservation and packaging shall provide adequate protection against deterioration and physical damage during storage and handling.
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Shipment marking information shall be provided on the interior and exterior of delivery containers. The information shall include nomenclature, manufacturer's name and part catalog number, contract or order number, and destination.

C.4.4 Miscellaneous Hardware

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The hardware shall be manufactured, transported and stored so that no physical damage occurs to the threads. The hardware shall be packaged in equal quantities and in accordance with commercial practice for preservation and packaging.

Shipment marking information shall be provided on the exterior of delivery containers. The information shall include nomenclature, manufacturer's name and part catalog number, contract or order number, and destination. Each pallet shall not exceed 2000 pounds in weight and each pallet shall clearly show the quantities on each pallet.

C.4 Installation of Bonded Insulated Rail Joints

C.4.1 Each crew and its foreman shall be pre-qualified before installing each type of glued joint. In order to become pre-qualified, a crew must fabricate two joints in track to simulate actual joint installation and then cut the joints out of the track. The joint will then be tested in accordance with the Longitudinal Compression Test. Failure of a test sample disqualifies the foreman and, at the discretion of the Engineer, the entire crew.

C.4.2 All non-high strength 112 TRAM and 115 RE rail shall be hardened and all rail ends shall be beveled in accordance with AREMA Standard Plan No. 1005-40-Beveling of the Rail Ends for Special Trackwork. Remove all foreign materials, loose rust, and scale to near white metal on the end 21 inches of the web, bottom of head and top of base of each rail in accordance with SSPC SP-10.

C.4.3 Field fabricated single bonded insulated joints shall be installed at locations shown on the Contract drawings and in conformance with the manufacturer's recommended procedures. Two insulated joints, on opposite rails, shall be installed at each callout on the respective Plan, unless otherwise indicated.

C.4.4 The center of the joint shall be approximately centered between rail supports and the contractor shall alternate the direction of the bolt insertion.

C.4.5 The Engineer shall be notified 24 hours in advance of installation of all insulated joints.

C.4.6 Installation procedures shall be submitted for the Engineer's review at least 30 days prior to beginning Work and shall include at least the following items:

1. Care and storage of materials
2. Date of glue manufacture
3. Glue shelf life
4. Rail end preparation
5. Weather and temperature restrictions
6. Mixing and application of glue

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7. Installation of insulated joint bar and pin bolts
8. Curing restrictions
9. Detection of glue bond failures

C.4.7 Insulated Rail Joint Electrical Test

C.4.7.1 All insulated joints shall be tested after installation into track.

C.4.7.2 Electrical Test

a. The insulated joint assembly shall be dry. Apply 500 volts DC across the joint from rail to rail and from each rail to one bar, each arrangement for a duration of 5 seconds. Use a megohmmeter that reads directly in megohms to measure resistance.

b. The acceptance criterion for this test shall be a minimum resistance of 10 megohms.

C.4.7.3 The Contractor shall submit test procedures and equipment identification for the Engineer's review at least 30 Days prior to beginning Work. The electrical test shall be performed by a certified electrician employed by the Contractor and approved by the Engineer.

C.4.7.4 Results of the electrical test shall be submitted to the Engineer for approval.

C.4.7.5 Any single bonded insulated joint that fails the electrical test in track shall be removed, replaced and retested at Contractor's expense. Replacement procedure shall be approved by the Engineer.

C.4.8 Insulating paint shall be applied to the circumference of the rail head and post after assembly and curing of bonded insulated joint adhesive. The insulating paint shall be applied as a stripe centered on the end post 1", ± ¼" wide.

C.4.9. Rail cuts and end drilling shall conform to the requirements in General Track Construction, Item SPV.0090.4500.

C.5 Movable Rail Joint

C.5.1 The Contractor shall install the movable rail joints. The movable rail joint supplier must inspect the top flange angles of existing floor beams located within the movable rail joint limits to determine their adequacy for proper attachment of steel ties for the life of the movable rail joint sets. The Engineer, at the request of the movable rail joint supplier, may direct the Contractor to replace the deficient existing floor beam angles in kind. The movable rail joint supplier must also

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supply fill plates and shims, as required for proper installation of the steel plates and movable rail joint sets.

D Measurement

The City will measure Other Track Materials as each individual insulated joint bar, compromise joint, shim, miscellaneous hardware for fastening of running rail and special trackwork, movable rail joint and grout acceptably completed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.4800	Insulated Joint Bar	EACH
SPV.0060.4801	Transition Rail	EACH
SPV.0060.4802	Shim	EACH
SPV.0105.4803	Miscellaneous Hardware	LS
SPV.0025.4804	Grout	CF
SPV.0060.4805	Movable Rail Joint	EACH

Payment is full compensation for procurement and installation of all items identified here-in and shown in the Contract Drawings required for Other Track Materials.

12. Overhead Contact System (OCS).

12.1 Overhead Contact System General Description

A Description

This special provision describes the Overhead Contact System (OCS) which supplies power from the traction power substation to the streetcar current collectors through the contact wire and feeder tap system of the line along streets in the City of Milwaukee and outlines the requirements for design, supply, construction and testing of the OCS portion of the work. The line consists of pole supports, foundations, feeder taps, building attachments and other related components described herein and shown on the contract drawings along. The Contractor shall construct an OCS in the new maintenance facility yard and according to the requirements of the Contract Drawings and this specification.

The overhead system is comprised of approximately 2.0 miles of double track and single track OCS equipment with new poles and foundations. Some OCS poles will

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be combined with streetlights and/or traffic lights mounted on them and are so indicated on the contract drawings. Special poles shall be supplied to match the existing ornamental streetlight poles along St. Paul Street in the Historic Third Ward by the market but will be of sufficient strength to support the OCS. The overhead system will be an inclined pendulum suspension system supported from either span wire, bracket arms or elastic arms and shall be constant tensioned with automatic tensioning equipment. It is designed to operate normally with contact wire temperatures between -20°F to 120°F.

Supplementary feeder cables shall be installed in the track slab conduits from hand hole to handhole approximately every 400 feet and from the hand hole to the pole where it shall run in the pole and to the span wire. At the span wire, it will terminate in a small disconnect switch. Feeder taps will be run from the disconnect switches at the span wire level to the contact wire for increasing the line's electrical conductivity.

Streetcars running on the line will use a pantograph current collector for drawing power from the overhead trolley wire. New vehicles to be purchased will be equipped with a pantograph conforming to IEEE Standard P1629. The line is also designed for the use with heritage streetcar operation using trolley poles for current collectors and trolley frogs and crossing pans in the trolley wire at switches and crossings.

The Contractor shall utilize the design the of the OCS as shown on the Contract Plans and as described herein and shall construct the OCS using components illustrated and described but not limited to those on the Contract Documents for building the system to a fully operational streetcar line. The Contractor shall supply all necessary materials to construct the line including poles, foundations, building attachments, trolley wires, inclined pendulum suspension hangers, elastic arms, deadends, span wires, insulators, clamps, feeder taps, disconnect switches, surge arrestors, grounding equipment, section insulators, bracket arms and all other OCS equipment and associated components.

The height of contact wire over public thoroughfares and streets shall be no less than 18'- 0" at the middle of the trolley wire span between supports under worst case conditions as defined by the National Electric Safety Code (NESC) which includes wind and ice loading. The maximum operating height of the vehicle pantograph is 20'-6" and the minimum operating height is 13'-6". Contact wire height under the I-794 overpass on North Milwaukee Street and North Broadway will be less than 18'-0" due to the restrictive nature of the bridge structure. The contact wire must change height in a very short distance and it shall be held in place with Vertical Curve rails in both the pull up and push down variations. Arrangements of the OCS in these areas are shown on the Contract Drawings. The contact wire under the Historic Third Ward sign on the westbound track will be less than 18'0" due to the close proximity of the sign to the OCS. Special provisions utilizing an elastic arm will be used to prevent the pantographs from hitting the sign as shown on the Contract Drawings.

The contact wires will have feeder taps at every substation location rising from underground feeder cables to feed tap poles, terminating in a disconnect feeder switch

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(enclosed in a non-conducting enclosure) rising from the switch and connecting to each contact wire. At each feeder tap location, a surge arrestor shall be installed with separate ground wire and ground rod. Surge arrestors shall be installed along the lone between substations at intervals indicated on the Contract Drawings. At various locations along the line, the contact wires will have equalizing feeder taps between them.

At locations where there is a discontinuity in the overhead contact wires due to sectionalizing at the St. Paul Drawbridge and the I-794 overpass at North Milwaukee Street, by-pass feeder cables will carry electrical current between the special section insulators to provide a continuous current path when the contact wire section between the special section insulators is 'Dead'.

Substations, manholes, underground duct banks with cables, riser cables to disconnect switches, rail bonds and negative return cables with their connections to track rails shall be covered in a different section of the Specification.

The Contractor shall be responsible for a complete and fully operational overhead contact system as described herein including installation, testing and commissioning to the full and complete satisfaction of the Engineer. To achieve this goal, the Contractor shall employ journeymen linemen who are members of the International Brotherhood of Electrical Workers and are skilled, experienced and knowledgeable in trolley line work.

B Materials

Material described in this section shall be new and of recent manufacture and shall be purchased specifically for this project. The Contractor shall not reuse any material new or otherwise purchased for other projects. All material shall be transported and handled in accordance with the manufacturer's recommendations and instructions and as defined herein.

B.1 Delivery and Furnishing of Materials

This Section specifies furnishing, delivery and installation of ferrous, non-ferrous metal material, ceramic and composite insulators, hardware and fittings for an overhead contact wire system as shown on the Contract Drawings, including, but not limited to, the following:

- Hangers
- Insulators
- Wire splices
- Miscellaneous fittings
- Wire terminations
- Wire clamps and clips
- Nuts, bolts, washers and cotter pins
- Turnbuckles
- Double clevis end fittings

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- Thimbles
- Wire sleeves
- Span wire
- Trolley wire
- Registration fittings and components
- Feeder, suspension and supports
- Pendulums
- Elastic arms
- Curve rails
- Poles
- Clamps

B.2 References

The following references for material, codes and standards shall apply to this Section, except as modified herein, and are hereby made a part of this Specification to the extent required:

1. Ferrous Metals: American Society for Testing and Materials (ASTM)

A27 - Mild to Medium-Strength Carbon-Steel Castings

A36 - Structural Steel

A47 - Malleable Iron Castings

A153 - Zinc coating (Hot-Dip) on Iron and Steel Hardware

A167 - Stainless and Heat-Resisting Steel

A501- Hot-Formed Welded and Seamless Carbon Steel Structural Tubing

A518 - Corrosion-Resistant High Silicon Cast Iron

A536 - Ductile Iron Castings

A572-Structural Steel

A668 - Steel Forgings, Carbon and Alloy for General Industrial Use

A711 - Carbon and Alloy Steel Blooms, Billets and Slabs for Forgings

A747 - Steel Castings, Stainless, Precipitation Hardening

2.Non-Ferrous Metal: American Society for Testing and Materials (ASTM)

B26 - Specification for Aluminum-Alloy Sand Castings

B140 - Copper-Zinc-Lead (Leaded Rod Brass or Hardware Bronze) Rod, Bar

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and Shapes

B148 - Aluminum-Bronze Sand Castings

B179 - Aluminum Alloys in Ingot Form for Sand Castings, Permanent Mold Castings and Die Castings

B248 - General Requirements for Wrought Copper and Copper-Alloy Plate, Sheet, Strips and Rolled Bar

B249 - General Requirements for Wrought Copper and Copper-Alloy Rod, Bar and Shapes

B315 - Specification for Seamless Copper Alloy Pipe and Tube

B557 - Methods of Tension Testing Wrought and Cast Iron Aluminum - and Magnesium - Alloy

B584 - Copper Alloy Sand Castings for General Applications

B686 - Specification for Aluminum Alloy Castings - High Strength

3. Institute of Electrical and Electronic Engineers (IEEE)

   P1630 Standard for Supporting Structures for Overhead Contact Systems for Transit systems

   P1896 Contact Wire Identification for Use on Overhead Contact Systems

   IEEE/ANSI C2-2012 National Electrical Safety Code (NESC)

4. Society of Automotive Engineers (SAE)

   SAE J429 Mechanical and Material Requirements for Externally Threaded Fasteners

B.3 Submittals

The following information shall be submitted:

1. Shop Drawings: The Contractor shall submit Shop Drawings for all individual component and/or assembly drawings in detail of each component or assembly of proposed components for approval prior to manufacture. Shop Drawings shall show details and dimensions, and give designations of the materials comprising the various components together with technical, mechanical and electrical characteristics as appropriate.
2. Submit. Each component or assembly shall be on its own drawing. The Contractor may, if space provides, without cluttering or confusing the assembly, include several variations of the same assembly on one drawing. All assemblies and variations shall be clear. A parts list shall be provided on the drawing in an easily

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readable matrix fashion that clearly identifies:

- The part;
- The quantity for each assembly;
- The number it refers to on the drawing; and
- Where the part itself can be found to review for detail.

3. Parts, materials, components and all other hardware shall not be accepted without the submittal and approval of shop drawings. The City reserves the right to require the Contractor to remove any and all materials and methods that have not been approved before installation. Material shipments shall be promptly inspected to insure that products comply with requirements, that quantities are correct and material is undamaged and the Contractor shall provide equipment and personnel to handle products by methods which prevent soiling, disfigurement or damage.

4. The identification mark of the manufacturer or foundry and the pattern numbers assigned by the supplier shall be cast into all castings. Marks and numbers shall be a readable size, and placed in such a position that they will not affect the electrical or mechanical performance. Insulators, fittings and other OCS hardware shall have a manufacturer's identification to the extent that it is practical.

   The following information shall be submitted to the Engineer:

5. The Contractor shall submit to the Engineer, descriptions and sketches explaining proposed methods and procedures for new trolley wire and support system installation. These submittals shall include, but not be limited to, the following:

- Sequential phases of the work
- Equipment to be used
- Procedure for temporarily supporting new wire, if required.

6. The Contractor shall submit a detailed sequence of work at least one month in advance and updated as frequently as need be to keep one month in advance. The sequence shall show how many crews will be working, when, where and what equipment will be utilized, and define the area of work and the proposed limits. This will be reviewed by the Engineer for reasonableness so that requirements can be evaluated and set up. An alternate plan for work shall be submitted for the event that the Contractor is restricted from the planned location of work. The Engineer may change the required time notification as determined upon the start of the work.

B.4 Materials

1. In order to ensure design requirements for an operable overhead contact system and to provide continuity of hardware throughout the entire overhead network with proven interchangeability of hardware and a reduction of inventory, certain specific components of the overhead system have been specified by manufacturer's part

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number or as approved equal on the Contract Drawings. Because of the complexities and site specific design at restricted clearance areas that require detailed design, the Contractor shall not substitute manufacturer specific components with other manufacturer's components or types of overhead hardware. Contractor shall verify that indicated components function properly as indicated on the Contract Drawings. Substitutions of "as equal" shall be per approval of the Engineer.

a. Malleable Iron: Fittings or components made of malleable iron shall be Grade 32510 or better and shall conform to ASTM-A47. All components and fittings shall be galvanized in accordance with ASTM-A153.

b. Forged Steel: Material for forged steel shall comply with ASTM-A711 or A668. All components and fittings shall be galvanized in accordance with ASTM-A153.

c. Structural Steel Tubing: Structural steel tubing shall conform toASTM-A501 and galvanized in accordance with ASTM-A153.

d. Ductile Iron: Fittings or components requiring high yield strength shall be of ductile iron, Grade 60.40.18 or better and shall conform to ASTM-A536. All fittings shall be galvanized in accordance with ASTM-A153.

e. Stainless Steel: Stainless Steel hardware shall conform to ASTM-A747. Cotter pins shall be made of stainless steel.

f. Non-Ferrous Metals: Copper alloys for fittings and components shall conform to ASTM-B584 and B148.

g. Copper: All copper components shall conform to ASTM-B248 or B249.

h. Other applicable ASTM specifications as required.

B.5 General Delivery, Storage and Handling

1. Fittings and hardware shall be packed adequately to ensure acceptance and safe delivery, in accordance with the best commercial practice. Packaged materials shall be maintained with seals unbroken when delivered to the job site. Materials shall be stored and protected in accordance with manufacturer's instructions and project requirements with seals and labels intact and legible.

2. Sensitive products shall be stored in weather-tight climate controlled enclosures.

3. Each part shall be tagged with description, purchase order and line item numbers, as well as assembly and item number.

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4. Any damaged material shall be promptly removed and replaced with new identical material at no additional cost to the Engineer.

5. The Engineer may reject as non-compliant such materials and products that do not exhibit satisfactory identification as to manufacturer, grade, quality or other pertinent information.

6. The Contractor shall make off-site arrangements for storage and staging and deliver to the site as required so as to not affect progress of other contractors and create unsafe conditions.

7. The Contractor shall maintain finished surfaces and equipment clean, unmarred and suitably protected until final acceptance by the Engineer. Should equipment be damaged or have graffiti applied to them prior to acceptance by the Engineer, the Contractor shall be responsible to make repairs or clean off graffiti and restore the paint surface of the equipment or pole.

B.6 Repairs and replacements

1. In the event of damage, the Contractor shall promptly make replacements and repairs at the direction of the Engineer at no additional cost to the Project.

2. Additional time to secure replacements and to make repairs will not be considered by the Engineer as justification for extension of the contract duration.

B.7 Product Options

1. Where products are specified by naming three or more specific manufacturers, the Contractor shall purchase that piece of equipment from any of the named manufacturers only.

2. Material and products that are specifically designated in the Specifications, Design Criteria or Contract Drawings by manufacturer and part number shall be supplied by the Contractor with no substitutions as that part is critical to the operation of the OCS.

3. Where specific manufacturers are named or catalog part numbers stated and "or as equal" is stated, the Contractor may use either the stated items or one from a different manufacturer that is equal in performance and capability.

4. For submitted "as equal" items, the Contractor shall submit documentation of the product's ability to perform the intended function in the same manner as the stated items and shall provide proof that the proposed items have been successfully used for at least five years in other transit and streetcar systems.

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5. OCS Components including poles, concrete, foundation materials, clamps, insulators and all else included in the OCS shall be manufactured and assembled by companies utilizing union shops and the Contractor shall indicate in the shop drawing proposals which unions and affiliations the manufacturer adheres to. The Contractor shall make every attempt to utilize union shops and where this is not possible, the Contractor shall provide proof that material cannot be secured from said union shop sources. As OCS is electrical in nature, preference shall be given to manufacturers utilizing IBEW union workers.

6. All OCS components and parts thereof shall be time proven and in use in other transit systems and railroads utilizing overhead catenary systems. Manufacturers providing equipment and parts shall have been doing business in the OCS industry for a minimum of 20 years and have a reputable reputation of providing quality products and service with reasonable delivery times.

7. Material for hardware and fittings shall comply with these Specifications, the Contract Drawings, and applicable referenced standards. Substitutions may be submitted to the Engineer for consideration unless stated as manufacturer specific. The Contractor shall be responsible for form and fit of all components and hardware, as shown on the Contract Drawings and shall consider maximum interchangeability of components to reduce inventory.

B.8 Fabrication and Casting

1. Material for Castings shall be of uniform quality and shall be made in such a manner that the material of the casting conforms to the chemical and mechanical properties prescribed in the referenced ASTM standards. Castings shall be tested for anomalies, inclusions, cold forming, warping, distortion and other defects that could affect the performance and safety of the component. The Contractor shall provide an adequate supply of parts, equipment, materials and required tools available at the site for orderly installation and testing of equipment without delay.

2. Material to be fabricated shall be constructed in a manner consistent with best practices. Formed steel pieces shall be heated and bent while red hot. Cold bending of components for overhead components will not be accepted.

B.9 Quality Assurance

1. Examine the condition of the overhead components and/or assemblies for condition and completeness. Parts shall be examined for missing components, broken hardware, cracks, for quality workmanship, bad galvanizing, bolt and nut thread interface, lockwasher construction, shipping damage, improperly constructed components and all else that would be considered not acceptable for use in an overhead contact system. Any and all bad parts shall be returned to the

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manufacturer for new parts which shall then be examined as stated herein.

2. General: Examine the conditions under which the components of the overhead contact system are to be installed.

3. Notify the Engineer of conditions encountered or foreseen, which could affect the proper and correct installation of the overhead contact system.

4. The Contractor shall submit certification to the Engineer verifying that all hardware items are in conformance with all applicable standards or codes stated herein and on the Contract Drawings.

B.10 Technical Support Equipment

1. The Contractor shall provide an adequate supply of parts, equipment, materials and required tools available at the site for orderly installation and testing of equipment without delay.

2. Requirements for Installation: An additional quantity of ten (10) percent or two of each item of fittings and hardware, whichever is greater, shall be provided at no additional cost to the Authority and shall be made available for use after the installation. These items shall be turned over to the City.

3. Special Tools: If any special tools are required for installation, the Contractor shall furnish two sets of each, to be turned over to the City upon Contract completion.

C Construction

C.1 Description of Work

This section and other sections specifies the furnishing and installation of an overhead contact system (OCS) over all tracks as shown on the Contract Drawings and as specified herein. The work consists of the following:

1. Installation of a new overhead system which shall include poles, pole foundations, assemblies, bracket arms, pulloffs, elastic arms, elastic hangers, inclined pendulum hangers, stitch supports, section insulators, disconnect switches, lightning arrestors, feeder cables, crossarms, feeder taps, lightning arrestors with associated grounding, bridge supports, contact wire, span wire, spring tension devices, trolley frogs, crossover pans, feeder taps, disconnect switches, section insulators, contact wire feeding controllers and deadend assemblies and all else associated with the OCS system shown and described in the Specifications and Contract Drawings.

2. Installation of new traction power disconnect switches and associated 750 Vdc distribution system providing power to the OCS. Work pertaining to the 750 Vdc aerial distribution and switching system as shown on the Contract Drawings and specified herein. Underground cables and conduits are covered in the traction power section of the specifications.

3. Testing of the OCS for alignment, stagger, tension and pantograph and trolley

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pole operational performance as described herein and indicated on the Contract Drawings.

4. Testing of the OCS for electrical continuity, integrity of insulation and isolation between power sections as described herein and as indicated on the Contract Drawings.

C.2 References

Codes and Standards

1. Standards applicable to the overhead contact system installation that have been listed in other sections of this Specification also apply here.
2. Comply with the most current provisions of the following, except as otherwise indicated. If there is a conflict between specifications and standards or between the various standards, then the most stringent requirement shall apply.

a. American National Standards Institute (ANSI)

b. National Electrical Safety Code (NESC)

c. Occupational Safety and Health Act of 1970 (OSHA)

d. National Electrical Manufacturers' Association (NEMA)

e. Institute of Electrical and Electronics Engineers (IEEE)

f. American Railway Engineering and Maintenance-of-Way Association (AREMA)

g. Rules and regulations of the City of Milwaukee for performing work on Milwaukee Public streets and property.

D Measurement

The City will measure items for payment by the method described in the associated sections and the payment will be on measured quantities at the contract unit price as stated therein.

E Payment

The City will pay for measured quantities at the contract unit price under the associated bid item. Payment will be full compensation for furnishing and installing the item including all work to acquire, store, install, tension, finalize, adjust, attach, use of tools, use of equipment and all else required for a complete and thorough installation.

12.2 OCS Poles Three Section Embedded, SPV.0060.1000; OCS Poles Tapered 9-Inch Embedded, SPV.0060.1001; OCS Poles Tapered 10-Inch Embedded, SPV.0060.1002; OCS Poles Tapered 11-Inch Embedded, SPV.0060.1003; OCS Poles Tapered 12-Inch Embedded, SPV.0060.1004; OCS Poles Tapered 14-Inch Embedded, SPV.0060.1005; OCS Pole Anchor Base,

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SPV.0060.1006; OCS Pole Foundation Type 1, SPV.0060.1007; OCS Pole Foundation Type 2, SPV.0060.1008; OCS Pole Foundation Type 3, SPV.0060.1009; OCS Pole Foundation Type 4, SPV.0060.1010; Pole Clamp Split No. 3, SPV.0060.1011; Pole Clamp Split No. 4, SPV.0060.1012; Pole Clamp Split No. 5, SPV.0060.1013; Pole Clamp Split No. 6, SPV.0060.1014; Pole Clamp Split No. 7, SPV.0060.1015; Pole Clamp Split No. 8, SPV.0060.1016; Pole Camp Multiple No. 3, SPV.0060.1017; Pole Camp Multiple No. 4, SPV.0060.1018; Pole Camp Multiple No. 5, SPV.0060.1019; Pole Camp Multiple No. 6, SPV.0060.1020; Pole Camp Multiple No. 7, SPV.0060.1021; Pole Camp Multiple No. 8, SPV.0060.1022; Tangent Pendulum Suspension Assembly, SPV.0060.1023; Curve Pendulum Suspension Assembly, SPV.0060.1024; Surge Arrestor Assembly, SPV.0060.1025; Feeder Tap Assembly, SPV.0090.1026; Contact Wire Jumper Assembly, SPV.0060.1027; Section Insulator Assembly Bridging, SPV.0060.1028; Section Insulator Assembly Diode, SPV.0060.1029; Bracket Arm Single Pipe, SPV.0060.1030; Bracket Arm Double Pipe, SPV.0060.1031; Disconnect Switch Two Point Common Top Buss, SPV.0060.1032; Disconnect Switch One Point, SPV.0060.1033; Trolley Contactor Pantograph, SPV.0060.1034; Trolley Contactor Pole, SPV.0060.1035; Trolley Controller Drawbridge, SPV.0060.1036; Trolley Controller Interstate Bridge, SPV.0060.1037.

A Description

Poles are used to support the contact wire and is attached to either poles, buildings or structures.

B Materials

B.1 Poles

1. Poles for supporting the overhead system shall be tubular steel poles, either three section tubes or tapered tubes per ATEA D11-39, D125-41 and IEEE Standard P1630. Type of pole to be set at particular locations along the line will be as stated in the Contract Drawings. Sectional poles will consist of three sections of steel pipe inserted into each section and swaged or welded having a minimum steel strength at yield of 50,000 psi. Tapered poles shall have minimum yield strength of 55,000 psi.

2. Tapered poles shall be formed over a tapered round mandrel and be perfectly round after forming and welding. The taper of decreasing diameter shall be 0.14 inches per foot. To achieve required section

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modulus, deflection rate and minimum diameter, tapered poles will have plys. Maximum number of plys is to be six. Upon completion of tapered pole fabrication, poles with plys shall perform as if the pole were a solid unit and there shall be no slippage or separating of the plys.

3. After rough forming of the tapered steel poles, the longitudinal welded seam shall be ground or rolled smooth. After forming and welding, the tube shall be longitudinally cold-rolled on a hardened steel mandrel to the finished shape. All welds shall conform to AWS Specification D1.1, Structural Welding Code-Steel.

4. Poles shall be hot dipped galvanized unless stated otherwise in the Contract Drawings. If poles are required to be painted, such as those in the Historic Third Ward area, they shall have a primer coat of a zinc-rich or epoxy based primer to provide the maximum corrosion protection and shall have an epoxy based finish coat of a color determined by the Engineer. All paint applications shall be done according to the manufacturer's recommendations.

5. All poles that are direct embedment shall have a corrosion collar 24 inches in length and 3/8 inches thick. The collar shall have the top seam welded at a 45 degree angle to the pole for water runoff.

6. Where poles require a handhole, it shall be a reinforced opening 4 inches by 6 inches. The hole shall be reinforced to provide shaft strength equal to or exceeding that of a similar pole with no handhole opening. The handhole shall be parallel to the curb.

B.2 Pole Foundation Steel

1. Direct embedded foundations shall consist of an excavated hole with a steel pipe inner casing. The casing shall be a galvanized steel round HSS conforming to ASTM A500 3/8 inch thick. Where the pole excavation hole is in unstable soil or deep, a hole liner shall be employed during the excavation process and may be used as a drill. The liner casing will be removed after the initial concrete pour. Thickness, diameter and length of the liner shall be determined by the Contractor.

2. Foundation requiring steel reinforcing bars placed in the hole prior to the pour shall be arranged as shown on the Contract Drawings. They shall conform to ASTM A615, Grade 60 and be epoxy coated. Anchor rods shall be placed in the hole prior to the pour and shall conform to ASTM F1554, Grade 55 and shall not be welded. The diameter of the rod shall be as indicated on the drawings but shall not be less than 1-3/4 inches. Each rod shall have three hex head heavy nuts for securing the pole anchor base. The rod shall protrude above the top of the pour by 10 inches and the top of foundation shall be at sidewalk elevation where such style foundations are indicated on the Contract Drawings.

3. Where foundation locations not requiring reinforcing steel cages are to be constructed, they shall consist of a 10 x 49 steel wide flange section

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conforming to ASTM A36 with a flat 1-1/2 inch anchor base plate welded to it. The plate shall conform to ASTM A529 Grade 50 steel. The "Foundation Insertion Piece" (FIP) The FIP shall be inserted in the hole and shall either protrude above the top of the foundation or below it as shown in the Contract drawings. It shall be pressed into the bottom of the hole to a depth of 6 inches with the strong axis of the beam in the direction of the resultant moment and made plumb. Concrete shall be poured as described herein after the FIP has been installed.

B.3 Pole Foundation Concrete

1. Concrete for pole foundations shall consist of 4,000 psi 28 day cure with an aggregate of 3/4 inch. Slump shall be 4-6 inches. Concrete installation and pours shall conform to ACI-305 Recommended Practice for Hot Weather Concreting and ACI-306 Recommended Practice for Cold Weather Concreting.

B.4 Overhead Fittings

1. Pendulum suspension hangers

   a. Pendulum hangers shall be either tangent for curves up to 4° and curve pullovers for line angles between 4° and 20°. Tangent pendulum hangers shall consist of a line insulator, hanger wire with sleeves, synthetic J thimbles, pulloff bow and contact wire clamps. Curve pendulum hangers shall consist of a line insulator, hanger wire(s), J thimbles, Pullover rod(s) and contact wire clamp(s). The line insulator shall be composed of a synthetic insulating material and a combination of aluminum and stainless steel components. Hanger wires shall be solid stainless steel wire, 4 mm in diameter with sliding sleeves and formed end loops where the J thimbles are to be inserted. The J thimble will provide additional insulation. Curve bows shall be formed as indicated in the Contract Drawings and of stainless steel rod 8mm in diameter. The ends for contact wire clamp attachment shall be knurled.

   b. Pendulum hangers shall be further composed of a lever arm and hanger bow with a loop insulator, pulloff bow and contact wire clamps and shall be designed for low profile locations.

   c. Pullover rods shall be stainless steel rod 18mm in diameter with a threaded end bent 90° and threaded to 5/8-11 for attachment of the contact wire clamp. The rod shall be curved as shown in the Contract Drawings and have the other end formed to an eye with an interior radius designed for insertion of the J thimble. The rod shall be attached to line insulators with a 4mm diameter hanger wire with J thimbles and hanger wire with sleeves and it shall be used as a flying pulloff without a line insulator as shown on the Contract Drawings.

   d. Pullover rods shall have a contact wire clamp screwed onto it and it shall not be completely turned on but shall be able to turn on the pullover rod threads to allow for along-track movement of the contact wire. The clamp shall have two flat head hollow hex screws for tightening it to the

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contact wire. When used for pullovers, the clamp body shall be on the inside of the curve and the detachable clamp portion shall be on the outside of the curve when attached to the contact wire. The boss of the clamp shall have a liberal coating of lubricating grease as recommended by the manufacturer.

2. Cross Contact Wire Clamp

   a. Cross Contact Wire Clamps shall consist of a solid stainless steel 7/16" square bar 30 inches long with upset ends and two contact wire clamps at each end of the bar. The bar shall be stainless steel grade 304. The center of the bar shall be placed over the contact wire crossing point when the contact wire is at 70°F. If attached at different temperatures, the center of the bar shall be placed according to the contact wire movement according to the wire movement chart in the Contract Plans.

   b. The contact wire clamps shall be bronze designed to attach to the bar flat surfaces when they are rotated 45° and as indicated in the Contract Drawings.

3. Contact Wire Splice

   a. The splice shall be composed of Beryllium Copper bar, with the groove milled out of the bottom of the splice. Eight set screws shall hold the contact wire in place and be comprised of socket head pointed set screws that are 90° to the contact wire. The screws shall be of such length that when completely tightened, they bottom out against the top of the splice and penetrate into the upper lobe of the contact wire.

   b. The splice shall be able to withstand all forces applied to it and shall not allow the contact wire to slip under tension. The contact wire shall break and not slip out of the splice. The contact wire shall break outside of the splice when destruction tests are performed.

   c. The splice shall have blunt ends for striking with a hammer to move it onto the wire during the installation process.

4. Tangent Line Insulators

   a. Tangent and light curves up to 4° shall utilize a Type G1 synthetic line insulator as shown in the Contract Drawings. It shall be modular in that the attachment component part can be changed out to various suspension parts. Pendulum hangers suspension shall use an eye fitting, section insulator suspension shall use a double eye and direct clamp ear attachment shall use a 5/8" stud that is adjustable to the plane of the track.

   b. All modular attachments shall be secured into the body of the insulator which has a conical insertion for the matching conical attachment and shall have a bolt for tightening it.

   c. The insulator shall have a clamping arrangement which is also modular in that various attachment pieces can be used on the top of the

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insulator body. Attachment pieces shall comprise a span wire clamp, span wire clamp with suspension eye, clamp for synthetic span rope, clamp for pipe attachment to different size pipes and adaptability for attachment to an insulated bar for Unistrut attachment.

5. Curve Line Insulators

   a. Curve pullovers shall utilize a Type G2 synthetic line insulator as shown on the Contract Drawings. Curve line insulators shall be used for curves greater than 4° and shall have pullover rods attached to them. They shall also be used to support other suspensions as shown in the Contract Drawings. It shall be modular in that the attachment component part can be changed out to various suspension parts. Curve pendulum hanger suspension shall use an eye fitting and direct clamp ear attachment shall use a 5/8-11 stud that is adjustable to the plane of the track. The insulator body shall have a shaft protruding from the bottom to which a series of various modular attachments can be applied ranging from a link bracket, hanger eye and threaded bolt.

   b. The insulator shall have a clamping arrangement which is also modular in that various attachment pieces can be used on the top of the insulator body. Attachment pieces shall comprise a span wire clamp, span wire clamp with suspension eye, clamp for synthetic span rope, clamp for pipe attachment to different size pipes and adaptability for attachment to an insulated bar for Unistrut attachment.

6. Pole Clamps

   a. Pole clamps shall be either the split type or the multiple span wire type. They shall be comprised and fabricated of steel according to ASTM A572, grade 42 steel, heated until red hot and formed to the dimensions and configuration indicated on the Contract Drawings and hot dipped galvanized. Bolting hardware shall be grade 8 steel, hot dipped galvanized.

7. Surge Arrestors

   a. Arrestors shall be metal oxide varistors type with an explosion proof silicon rubber housing. Rating shall be 3 kV with a maximum continuous operating voltage (MCOV) of 2.55 kV. They shall conform to IEEE Standard PC62.11-2006 for Metal Oxide Arrestors. Arrestors shall be Hubbell/Ohio Brass PDV-65 Surge Arrestor Part No. 217253 for attachment with a bracket to a pole clamp or approved equal.

   b. The positive wire lead shall be as short as possible and shall be connected to the feeder tap at the pole. The lead shall be a No. 2 AWG 2 kV insulated 7 strand copper wire and be between 12-18 inches in length from the arrestor top stud to the feeder cable connection point. The connection shall be with a Fargo Vise Type Connector and the connection shall be fully insulated after connection.

8. Cross Contact Wire Jumpers and Feeder Tap Cables

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a. Jumpers shall be 250 kcmil copper cable with Class D stranding for both stiffness and flexibility. Jumpers shall be jacketed for additional stiffness to prevent them from flopping over.

b. Jumper cables shall be connected into a feed tap bronze hollow clamp ear with two flat head stainless steel hollow hex screws. The clamp shall be so constructed that the jumper cable can be inserted into the clamp without a secondary cable lug and tightened into the clamp by tightening two separate bolts on the hollow hex screw clamp. They shall conform to the dimensions and criteria as shown on the Contract Drawings and be MAC/K+M Part No, D0445-02.

c. Feeder tap cables and connections to the contact wire shall consist of 250 kcmil 2 kV cable with Class D stranding, insulated and jacketed feeder cables without shielding. They shall run from the disconnect switch, up the pole, across the span wire and drop to the contact wire. The contact wire clamp shall be as described as described herein. The connection at the disconnect switch shall be by mechanical cable terminal lug, Trego JXXX or approved equal as shown on the Contract Drawings.

10. Insulators

a. Span wire insulators shall be porcelain, fiberglass or Kevlar synthetic rope location dependent as shown on the Contract Drawings or indicated herein. They shall conform to ANSI testing standards and have a minimum BIL of 30 kV for a 1.5 kV rated insulator.

b. Porcelain insulators are to be a type JB strain insulators and shall be of the highest grade wet ware porcelain, glazed to a color of light gray. They shall conform to ANSI standard C29.4. The end of the insulator with the non-glazed ring shall be placed facing the downward slope of the span wire.

c. Fiberglass insulators are to be of two types as indicated on the Contract Drawings: Loop Insulators and rod insulators. They shall have an epoxy resin base with glass mat fibers conforming to NEMA Grade GPO-10. The surface of the fiberglass portion of the loop insulator shall be covered with a silicon rubber coating and the rod insulator with a heat shrink Teflon tube for ultra violet ray protection. Rod insulators shall have malleable or ductile iron end fittings swaged onto the fiberglass rod and be hot dipped galvanized. End fittings shall be clevis or eye as called out in the Contract Drawings and rated for a minimum working load of 5,000 pounds.

11. Section Insulators

a. Section insulators shall allow trolley poles and pantographs to operate through them and be non-bridging diode equipped for constant current to the current collector as shown on the Contract Drawings or indicated herein. They shall conform to ANSI testing standards and have a minimum BIL of 30 kV for a 1.5 kV rated insulator.

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b. The insulator shall be constructed with double tension beams of GPO-10, a suspension yoke and contact wire anchor tips of the same material and configuration as the contact wire splice described herein. The insulator shall have sufficient strength to break the contact wire before damage to the insulator occurs.

c. Section insulators at section break boundaries such as at the feeding points for the DPW Traction Power Substation shall be non-bridging, constant current diode section insulators designed for pantograph and trolley pole operation. Other locations requiring section insulators such as the OMF and LMS substation feeding locations, St. Paul drawbridge and I-794 overpasses shall utilize bridging section insulators. The gliders and underrun shall allow the pantographs and trolley pole shoes to pass through with full uninterrupted power being supplied to the car.

d. Section Insulators shall be suspended with inclined pendulum suspension hangers of the double hanger wire type to allow freedom of movement in all directions but have the unit rise and lower with collector passage in a parallel to track plane. They shall not tip. Hanger wires shall be solid 4mm diameter steel wires as described herein and as shown on the Contract Drawings. Length of the insulator shall allow the edge to edge distance of the collector carbons to not bridge the adjacent power sections. The span wire suspension shall be as shown on the Contract Drawings.

12. Bracket Arms

a. Bracket arms shall consist of HSS hollow seamless tubes conforming to ASTM A500, Grade C. Size shall be 2-3/8” O.D. with a wall thickness of 0.218” conforming to 2 inch extra heavy pipe. Tubes shall be cut to length and hot dipped galvanized. Lengths shall be as shown on the Contract Drawings.

b. Tubes shall be cut with ends square and burrs removed to achieve smooth edges. Bracket arms shall have an insulator inserted into the end of the tube that attaches to the pole or pier. The insulator shall be secured in the end of the tube with a 1/2 “ diameter bolt passing through both the insulator and the tube as shown on the Contract Drawings.

13. Trolley Contactor

a. Trolley Contactors shall be comprised of spool insulators, clamp ears and two flexible stainless steel runners. The runners shall be configured in such a way that they shall be separated by a distance of 4.33 inches.

C Construction

C.1 Installation of Poles and Foundations

This Section specifies the furnishing and installation of an overhead contact system (OCS) for all tracks as shown on the Contract Drawings and as specified herein.

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The work consists of the following:

1. Pole foundation holes shall typically be three (3) feet in diameter and be excavated by hand or with an auger or circular steel pipe drill bit to the depths indicated in the Contract Drawings. The outer casing shall be left in place during the concrete pour but pulled out after the initial pour has been completed if an inner casing is utilized. After the hole has been dug and the soil excavated, an inner liner casing shall be inserted into the hole and pressed into the soil at least six (6) inches. The inner casing shall be plumb. Once inserted, concrete shall be poured around the outer walls of the hole and the inner casing and into the inner casing if it is deeper than the length of the pole butt that is to be placed into the hole and allowed to cure for no less than 7 days before the pole is inserted into the hole.

2. Where the pole is to be placed in the hole without an inner casing, the outer casing shall be removed prior to the pole being placed into the hole. The outer casing shall only be left in place if the surrounding soil is unstable and there is a possibility if the walls caving in.

3. Poles shall be either three section tubular steel poles or tapered steel poles as shown on the Contract Drawings. Poles shall be direct embedment with corrosion collars conforming to IEEE Standard P1630 and herein and the Contract Drawings. Where anchor base poles for specific locations are required, they will be indicated on the Contract Drawings and shall also conform to IEEE Standard P1630 and the Contract Drawings. Poles shall have a coating of hot dip galvanizing unless stated otherwise as having a painted finish.

4. Poles shall be lifted and placed into the pole hole with a nylon sling to avoid damaging the surface of the pole. When inserted into the hole, the pole bottom shall be in the middle of the hole and then oriented for raking as indicated on the Contract Drawings. It shall be raked by an amount given on the pole installation table in the drawings and secured with a jig to prevent movement. Where rake is not indicated and rake is required, the pole shall be raked to an amount of 6 inches in 24 feet. Where no rake is required, the pole shall be set plumb. Concrete shall be poured into the hole and vibrated to ensure complete compaction. At the top of the sidewalk the concrete shall be flush with the sidewalk with a slight crown at the pole edge for water runoff. Where the pole is installed in an area without a concrete sidewalk but the walk is of other materials, the area shall be restored with those materials up to and around the pole but the pole shall have a concrete water runoff mound as shown on the Contract Drawings. Where the pole is set in the earth with no finished surface, the top of the concrete foundation shall be 6 inches below grade and a small mound of concrete shall be poured around the pole for water runoff as shown on the Contract Drawings.

5. The placement of the pole in the hole shall have the bottom surface of it bearing directly into the earth causing the pole to be electrically grounded. Where foundation types require an anchor base pole, a foundation section pipe with an anchor plate shall be inserted into the hole so that the plate is 12 inches below

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the top of the foundation as shown on the Contract Drawings. The plate is to have anchor bolts attached for the mating of the pole anchor plate. Concrete shall be poured to a level just below the foundation plate in the same manner as an embedded pole. When the concrete is stable, the pole will be mounted to the foundation base plate, raked, nuts tightened and the remaining void filled with concrete.

6. Excavation of the pole hole shall not be undertaken until all utilities have been identified. Holes in concrete sidewalks shall be saw-cut either as square or circle and the cut piece removed and disposed of. The hole shall be hand excavated to a depth of 3 feet when in the vicinity of utilities and then a power auger may be used to complete the hole if no utilities are encountered. This shall not relieve the Contractor from the responsibility of avoiding striking of utilities and the Contractor may complete the excavation by hand if so desired.

7. Where soil conditions are such that the excavated hole will collapse, a steel pipe liner shall be used to maintain the integrity of the soil walls. This may be used as a drill and if so, it shall be turned to a depth consistent with the required depth of each foundation. The diameter of the liner pipe shall be indicated on the Contract Drawings and the liner shall remain in place after installation. When the pipe liner has been installed to the required depth, the soil shall be excavated from it either by hand, mechanically or vacuum method.

C.2 Installation of Span Wires and Bracket Arms

C.2.1 Description of Work

1. Span Wire

   Span wires shall be of the type and size indicated on the Contract Drawings. Span wire shall be run between poles and pulled up tight with a four part block and tackle to keep it from sagging. The span network shall be in place and adjusted with the proper location and offsets for the bull rings and attachment hardware prior to stringing the trolley wire. Terminations shall not be permanently made up during installation but shall be made up after all trolley wire has been installed, tensioned and adjusted and tested for proper alignment and height.

2. Bracket Arms

   Bracket arms shall be installed at the locations shown on the Contract Drawings.

C.3 Installation of Feeder cables and Disconnect Switches

1. Feeder Cables

   Feeder cables shall be installed at locations shown on the Contract Drawings.

2. Disconnect Switches

   Disconnect switches shall be installed at locations shown on the Contract Drawings.

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C.4 Installation of Insulators and Hardware

1. General

   Deadends shall be attached to poles prior to contact wire and aerial feeder cable stringing operations to prevent overstress or damage to the contact wires.

   All span wires, bracket arms and supports shall be installed, complete and ready to receive the OCS hardware and devices that will support the conductors in their final position. Care shall be exercised in joining individual hardware components in forming assemblies so damage to equipment does not occur.

2. Insulators

   Insulators shall be cleaned before installation according to the manufacturer's recommendations. Protective coverings shall be removed and properly disposed of after the unit is installed. Only clean rags, free from abrasive material, shall be used for cleaning insulators. Wire brushes shall not be used for cleaning parts, metal or non-metal unless used for preparing connection of conductors and corrosion has to be cleaned off. After installation, insulator assemblies and hardware shall be clean, bright and free from nicks, dents or damage.

3. Hardware:

   Hardware shall be inspected for quality of construction and damage. Any item that does not fit, creates damage to the galvanizing during installation, or is found defective shall be rejected.

   All hardware shall be installed as shown on the Contract Drawings using tools and methods as recommended by the manufacturer. Bolts and nuts shall be properly tightened or torqued in accordance with the manufacturer's recommendations. All bolts, excluding foundation bolts, shall be of sufficient length to protrude at least two full threads, but not more than 1/4 inch beyond the nut or locknut. Bolt ends shall not be cut off. Where locknuts are not used, standard split lockwashers shall be provided. Loctite 242 compound shall be used as directed in the Contract Drawings.

   All cotter pins should have each leg-opened 45˚ after installation unless they are humped back type in which they shall be completely inserted through the clevis pin so that the hump it from backing out.

4. Connectors:

   Current-carrying connectors shall be as shown on the Contract Drawings and shall be installed in accordance with the manufacturer's recommendations. Connectors for copper or bronze wire shall be bronze and utilize either silicon bronze or stainless steel bolts.

   Bolts in bolt-type connectors shall be lubricated as recommended by the manufacturer and torqued to the manufacturer's recommendation using a calibrated torque wrench.

   The connectors where possible, shall be factory-loaded with a corrosion

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inhibitor, which is made for the specific purpose.

Wire surfaces which are in contact with conducting surfaces of the connector shall be thoroughly wire brushed or chemically cleaned to bright metal prior to makeup and shall have an inhibitor applied. Where connectors are not factory-loaded, the same inhibitor shall be applied in the field to the connector.

Corrosion inhibitors shall be stable over a wide temperature range, able to adhere to cold or hot metal surfaces, water-repellent, weather resistant, and inert to copper, aluminum, zinc, tin, cadmium, steel, and neoprene rubber. Silver-bearing inhibitors shall be used except for flat lugs, sliding surfaces or where the connector manufacturer recommends omission. Silver bearing inhibitors shall be compatible with the connector and wire metal. Inhibitor for copper and bronze shall be T&B "Kopr Shield", Fargo "Fargolene", Penn-Union "Cual-Aid", Burndy "Penetrox A", or approved equivalent.

C.5 Equipment and Hardware Installation

As far as practical, bolts shall be installed in the various clips so that the nuts are on the same side giving uniform appearance. On curves, the nuts shall be placed to the inside of the curve to provide the best clearance to the pantograph.

All clamp ears and feed tap clamp ears shall utilize flat head stainless steel hollow hex screws to allow the passage of a trolley pole current collector shoe.

As the contact wire clips are fastened to the wire, any twist in the trolley wire shall be removed by rolling the wire from one termination deadend to the next. The upper lobe shall be on top and there shall be no roll in the wire.

All bolts and nuts shall be torqued according to the manufacturer’s recommendations or, if not available, SAE J429 shall be used.

C.6 Final Adjustments

After support suspensions and termination assemblies have been installed, a final check of the construction and adjustment to final position shall be made. Height and lateral position of wire shall be checked and adjusted where necessary. The contact wire heights given in the Contract Drawings and Specifications are the heights after final tensioning and proper alignment has been done.

The stagger of the contact wire shown in the Contract Drawings is relative to the centerline of the track. The stagger is measured in inches to left or right of this centerline in the direction of the stagger arrow. Tolerances shall be as follows:

- Stagger of trolley wire: plus or minus 1/2 inch.
- Height trolley wire: plus or minus one inch.

C.7 Contact Wire Safety Interlocks

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Two separate safety interlock locations will be installed for de-energizing the contact wire. One is at the St. Paul Street Drawbridge and the other is under the I-794 Interstate Highway bridges on North Milwaukee Street. The circuit diagram and details for the two interlocking systems are shown on the Contract Drawings.

1. St. Paul Street Drawbridge

   The contact wire over the lift section of the draw will be sectionalized using bridging sectionners as shown on the Contract Drawings and shall be normally ***alive*** until the lift section starts to rise when the contact wires will go ***dead***. The contact wires will be fed through feeder taps connected to them which will run into a controller cabinet on an adjacent OCS pole. The controller cabinet will be fed through a feeder tap running from the abutment side contact wires which are always ***alive***. The lift section contact wires will have by-pass feeder cables to allow continuous feeding of the line between the OMF substation and the DPW substation. The controller cabinet interlocking relay will be controlled through a set of contacts mounted at the lift and stationary deck railing gap.

   The Contractor shall install the contact wires, sectionners, feeder taps, feeder cables, pole to pole bracket arms, controller cabinet, conduits and interlock connections as shown on the Contract Drawings. The interlock contact posts shall be bolted to the sidewalk railings using stainless steel bolting hardware and all surfaces shall be smooth and free from burrs or sharp edges so that pedestrians running their hands along the railing will not be physically hurt from the material.

2. I-794 Bridges

   The contact wire along North Milwaukee Street from St. Paul to Clybourn Streets will be sectionalized using sectionners as shown on Contract Drawings and shall normally be ***dead*** until a streetcar approaches the sectioned wire at the curve entering North Milwaukee Street. The contact wire will be fed through feeder taps connected to it which will run into a controller cabinet on an adjacent OCS pole. The controller cabinet will be fed through a feeder tap running from the entering side the bridge contact wires which are normally ***dead***. As the streetcar approaches the first sectionner, the pantograph will pass through a trolley contactor on the contact wire which will cause the controller relay to close allowing the bridge contact wire to go ***alive***. The wire will remain alive as the streetcar passes along the street under the bridges and as it passes the last bridge at Clybourn Street, the pantograph will pass through the leaving sectionner and then pass through a second trolley contactor. This contactor, when engaged, will cause the controller contactor to open causing the bridge contact wire to go ***dead***.

   The Contractor shall install the contact wires, feeder cables, sectionners, feeder taps, feeder cables, pole to pole bracket arms, controller cabinet, conduits, bracket arms, elastic arms, trolley contactors, and controller cabinet wiring as shown on the Contract Drawings and as described herein.

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C.8 Quality Assurance/Installation

1. Examine the condition of the overhead components and/or assemblies for condition and completeness. Parts shall be examined for missing components, broken hardware, cracks, for quality workmanship, bad galvanizing, bolt and nut thread interface, lockwasher construction, shipping damage, improperly constructed components and all else that would be considered not acceptable for use in an overhead contact system. Any and all bad parts shall be returned to the manufacturer for new parts which shall then be examined as stated herein.
2. Notify the Engineer of conditions encountered or foreseen, which could affect the proper and correct installation of the overhead contact system.

D.1 Measurement

The City will measure OCS Poles by type by the unit Each acceptably completed.

E.1 Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1000	OCS Poles Three Section Embedded	Each
SPV.0060. 1001	OCS Poles Tapered 9-Inch Embedded	Each
SPV.0060. 1002	OCS Poles Tapered 10-Inch Embedded	Each
SPV.0060. 1003	OCS Poles Tapered 11-Inch Embedded	Each
SPV.0060. 1004	OCS Poles Tapered 12-Inch Embedded	Each
SPV.0060. 1005	OCS Poles Tapered 14-Inch Embedded	Each
SPV.0060. 1006	OCS Pole Anchor Base	Each

Payment is full compensation for furnishing and installing poles including all work to acquire, store, install, adjust, rake, finalize, and all else required for a complete and thorough installation.

D.2 Measurement

The City will measure OCS Pole Foundations by type and by the unit Each acceptably completed.

E.2 Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1007	OCS Pole Foundation Type 1	Each
SPV.0060. 1008	OCS Pole Foundation Type 2	Each
SPV.0060. 1009	OCS Pole Foundation Type 3	Each
SPV.0060. 1010	OCS Pole Foundation Type 4	Each

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Payment is full compensation for furnishing and installing pole foundations including all work to acquire, store, install, tension, finalize, adjust, and all else required for a complete and thorough installation.

D.3 Measurement
The City will measure Pole Clamps by type and by the unit Each acceptably completed.

E.3 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1011	Pole Clamp Split No. 3	Each
SPV.0060. 1012	Pole Clamp Split No. 4	Each
SPV.0060. 1013	Pole Clamp Split No. 5	Each
SPV.0060. 1014	Pole Clamp Split No. 6	Each
SPV.0060. 1015	Pole Clamp Split No. 7	Each
SPV.0060. 1016	Pole Clamp Split No. 8	Each
SPV.0060. 1017	Pole Camp Multiple No. 3	Each
SPV.0060. 1018	Pole Camp Multiple No. 4	Each
SPV.0060. 1019	Pole Camp Multiple No. 5	Each
SPV.0060. 1020	Pole Camp Multiple No. 6	Each
SPV.0060. 1021	Pole Camp Multiple No. 7	Each
SPV.0060. 1022	Pole Camp Multiple No. 8	Each

Payment is full compensation for furnishing and installing pole clamps including all work to acquire, store, install, tension, finalize, adjust, and all else required for a complete and thorough installation.

D.4 Measurement
The City will measure Pendulum Suspension Assemblies by type and by the unit Each acceptably completed.

E.4 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1023	Tangent Pendulum Suspension Assembly	Each
SPV.0060. 1024	Curve Pendulum Suspension Assembly	Each

Payment is full compensation for furnishing and installing pendulum assemblies including all work to acquire, store, install, tension, finalize, adjust, and all else required for a complete and thorough installation.

D.5 Measurement

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The City will measure Surge Arrestor Assemblies by type and by the unit Each acceptably completed.

E.5 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1025	Surge Arrestor Assembly	Each

Payment is full compensation for furnishing and installing surge arrestor assemblies including all work to acquire, store, install, finalize, adjust, test and all else required for a complete and thorough installation.

D.6 Measurement
The City will measure Feeder Tap Assemblies and Contact Wire Jumpers by type and by the unit Each or Linear Foot, acceptably completed.

E.6 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090. 1026	Feeder Tap Assembly	LF
SPV.0060. 1027	Contact Wire Jumper Assembly	Each

Payment is full compensation for furnishing and installing feeder tap and contact wire jumper assemblies including all work to acquire, store, install, finalize, adjust, and all else required for a complete and thorough installation.

D.7 Measurement
The City will measure Section Insulator Assemblies by type and by the unit Each acceptably completed.

E.7 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1028	Section Insulator Assembly Bridging	Each
SPV.0060. 1029	Section Insulator Assembly Diode	Each

Payment is full compensation for furnishing and installing section insulator assemblies including all work to acquire, store, install, tension, finalize, adjust, and all else required for a complete and thorough installation.

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D.8 Measurement
The City will measure Bracket Arms by type and by the unit Each acceptably completed.

E.8 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1030	Bracket Arm Single Pipe	Each
SPV.0060. 1031	Bracket Arm Double Pipe	Each

Payment is full compensation for furnishing and installing bracket arms including all work to acquire, store, install, tension, finalize, adjust, and all else required for a complete and thorough installation.

D.9 Measurement
The City will measure Disconnect Switches by type and by the unit Each acceptably completed.

E.9 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060. 1032	Disconnect Switch Two Point Common Top Buss	Each
SPV.0060. 1033	Disconnect Switch One Point	Each

Payment is full compensation for furnishing and installing disconnect switches including all work to acquire, store, install, , adjust, connect cables, provide jumpers, identification signs, conduits, mounting, and all else required for a complete and thorough installation.

D.10 Measurement
The City will measure Trolley Contactors by type and by the unit Each acceptably completed.

E.10 Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.1034	Trolley Contactor Pantograph	Each
SPV.0060.1035	Trolley Contactor Pole	Each

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Payment is full compensation for furnishing and installing trolley contactors including all work to acquire, store, install, wiring, finalize, adjust, and all else required for a complete and thorough installation.

D.11 Measurement

The City will measure Trolley Controllers by type and by the unit Each acceptably completed.

E.11 Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.1036	Trolley Controller Drawbridge	Each
SPV.0060.1037	Trolley Controller Interstate Bridge	Each

Payment is full compensation for furnishing and installing trolley controllers including all work to acquire, store, install, test, connect wiring, finalize, adjust, and all else required for a complete and thorough installation.

12.3 OCS Contact Wire, Item SPV.0090.1040.

A Description

Contact wire is used to transmit power along the line from the wire to the vehicle through the vehicle's pantograph.

B Materials

B.1 Material Components

B.1.1 Contact Wire

1. Contact wire shall be 350 kcmil alloy 80 Cadmium Copper Bronze grooved trolley wire, per ASTM B9. The wire, when wound on the trolley reel shall have its vertical axis perpendicular to the reel and deviations shall not exceed 5°. The wire length may vary on each reel to accommodate different tension lengths along the line but the entire length on a reel shall not exceed one mile (5,280 feet). Trolley wire reels shall conform to ATEA Recommended Design D109-31.
2. The wire rods drawn down during the wire drawing process may be spliced to achieve the one mile length but only by the silver solder technique. All factory splices shall have a blue dye applied to the wire at the splice location and be smooth and seamless when the wire drawing process is complete.

B.2 Delivery, Storage and Handling of Trolley Wire

1. Shipping shall take place in conformance with appropriate industry standards for packing, sealing and shipping. The Contractor shall ensure that all trolley wire

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furnished is suitably packaged and protected against damage during delivery and transportation. The wire shall be wound on the reel without crossing itself and shall lay parallel and tight against each coil. The vertical axis of the trolley wire, when installed on the reel shall be at 90˚ to the axis of the reel with the small lobe on the outside facing up. Vertical axis deviation in excess of 5˚ will be cause for rejection of the wire and reel. All trolley wire shall be shipped on reels with designated lengths and shall be protected from damage. Reels shall conform to the American Transit Engineering Association standards (ATEA) and be constructed of wood for insulation purpose and the diameter of reel rims shall be 46 inches and have sufficient clearance between the top of the rim and the top coil of wire to prevent damage to the wire when the reels are rolled about and shall have sufficient strength to prevent the reel from bulging out or collapsing. Each disc or head of the reel shall be provided with an iron plate or cast iron bushing in the center of which shall be a circular hole not less than 2-1/8" in diameter. The plates or bushings shall be fastened to the head of the reel by means of bolts through the head. The contact wire on the reel shall be electrically insulated by the construction of the reel from any metallic hardware used in the reel construction. The inner end of the wire shall be securely fastened to the reel so that it will not loosen when the inner layers of wire are being strung out during installation.

2. Trolley wire reel lengths shall be determined by the Contractor so that during installation these reel lengths may be cut without waste. Each reel shall have the length of contact wire on it marked clearly and in indelible ink or paint on the side of the reel.

3. The contact wire shall be handled and otherwise used in accordance with the manufacturer's instructions, so as to ensure that the products are not damaged or misused prior to installation.

4. Trolley wire shall have identifying marks placed on the upper lobe as spelled out in IEEE Draft Standard P1896. The agency mark shall be: MSC. This is included for the identification of the type of wire and for theft prevention.

5. A stripe in any contrasting color approximately one inch wide shall be painted across the outermost layer on each reel prior to shipping from manufacturing plant. Any visible conductor shift at this line, upon receipt at the job site, will be treated as indicating relative wire movement during shipment, and is cause for wire and reel rejection. Each reel shall have a strong, weatherproof tag or marker securely fastened to it, showing the wire number, length of wire on the reel and type of conductor as well as the ASTM designation, name and mark of the manufacturer, total reel weight, manufacturer's special instructions, and project number.

C Construction

C.1 Installation of Trolley Wires

C.1.1 Description of Work

The method of erecting the wires shall be submitted to and approved by the Engineer prior to any wire stringing operations. Care shall be taken to prevent

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kinks in the trolley wires during installation. The Project reserves the right to reject any wire in its entirety if it is judged that any kink is non-removable and will prejudice current-collection performance.

1. Trolley Wire Reels

For each length of wire installed, a record shall be kept of the reel number from which the wire was taken. Partly used reels shall be recorded as such.

The wire shall be not be ordered with several lengths of wires on one reel to satisfy several runs. Wire runs shall be from a continuous length of wire on the reel. As each length is cut and removed, the length remaining on the reel shall be recomputed and properly recorded both on the reel and on substantiating documentation.

Care must be taken with reels so as not to disrupt the stringing operation. Damaged reels shall be set aside for repair or replacement before use.

2. Precautions in Handling Trolley Wires

The wire shall be handled in such a manner that it shall not be scratched, cut, or nicked with tools or clamps. The wire shall not lie upon or be dragged across, sharp or rough surfaces. Wire shall not be annealed. Sharp bends shall not be put in the wires. The wire shall not be marred with temporary wire or hook hangers.

Only approved parallel jaw clamps shall be used in tensioning all wire. The grooves of the clamps must be free from burrs, fins or roughness and the ends of the grooves must be flared (bell-shaped). Acceptable trolley wire pulling grips are MAC Products E0205-04, Brecknell-Willis Come-Along Clamp Number D7068 or approved equal. Upon removal of the grip from the contact wire after pulling, there shall be no kinks, gouges, scrapes or other damage to the contact wire.

Vertical and lateral kinks in the wire shall be removed. Kinks shall be removed with a specific tool designed to remove kinks such as Arthur Flury Kink Remover Type XDH41, Brecknell-Willis trolley Wire Straightener Number D7252 or other approved device. In the event the device cannot completely remove the kink or wave, a rubber hammer shall be used, beating against an 18 inch long steel block with a smooth semi-circular groove, ½” radius milled out for the length of the bar. The bar shall be held to underside of the contact wire and the top shall be beaten with the hammer until the wire is straight. The deviation from the straight bottom of the contact wire over the length of the bar shall not exceed 1/16”.

3. Splicing of Trolley Wires

Splices in the contact wire may be made with the approval of the Engineer and shall be the type as shown on the Contract Drawings and stated herein. Trolley wire splices shall be constructed of an extruded metal bar of beryllium copper conforming to UNS C1700, ASTM B196-84 BAR (TD04) (H) hard with high strength steel set screws conforming to ASTM F912 having a tensile strength of 212,000 psi. Set screws shall be oriented vertically so that when tightened

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completely until bottoming out, they shall be properly inserted. The groove way shall have sufficient clearance so that the contact wire can be inserted without undo effort. Splices shall be the type as shown on the Contract Drawings.

Joining and splicing of two separate pieces of contact wire shall be done as follows:

-Cut the wire with a bolt cutter or special cutting device designed for cutting contact wire.

-Cut approximately ½" of the end of the wire off using a hack saw.

-File the ends smooth so that no burrs or sharp edges are present.

-Straighten ends of wire a distance of 8" from the end.

-Slide the splice over one contact wire a distance where there is approximately 1/4" of groove extending beyond the wire.

-Insert the other contact wire into the splice and push down on the splice until the wires slide into the splice and butts up against the other contact wire.

-Push the splice or strike the end with a hammer until the center of the splice coincides with the ends of the two contact wires.

-Apply "blue Loctite" to the set screw threads and then tighten the set screws until they bottom out.

4. Stringing of Trolley Wires

Stringing of the wires shall start from one deadend and run to the next deadend. The wires shall be pulled from the reel and lifted into position. Sufficient tension must be maintained in each wire during stringing to ensure that under no circumstances will the wires touch the track, road or ground between support points.

When the termination location is reached, each wire shall be tensioned above the specified final tension by 15%. This tension can slackened to the specified erection tension right after pre-stressing the wire. Tension measuring device shall be installed at both ends of the wire during installation and tensioning. The wire shall be terminated and made up at one end onto the spring tension device and then clipped in from that point along the line at each suspension or pulloff point to the next deadend termination. The Contractor shall check the roll of the contact wire as they proceed along the line ensuring that the upper lobe remains on top and that no rolls occur.

Erection tensions shall be in accordance with tables furnished for the purpose, based on the span and temperature of the wire, as shown on the Contract Drawings.

Wire temperatures shall be measured by digital thermometer. The probe of the thermometer shall be in intimate contact with the wire when read. A record of temperature and tension measured at both ends of the tension lengths shall be submitted to the Engineer.

NOT FOR CONSTRUCTION

Any damage to the wires and cables shall be reported to the Engineer. Remedial action shall be indicated and recorded.

D Measurement

The City will measure Contact Wire in length by the linear foot acceptably completed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.1040	OCS Contact Wire	LF

Payment is full compensation for furnishing and installing the Contact Wire including all work to acquire, store, install, tension, finalize, adjust, attach, and use of wire stringing apparatus, temporary ties, contact wire splices, rollers, tension devices for installation and all else required for a complete and thorough installation.

12.4 OCS Span Wire 5/16", Item SPV.0090.1045; OCS Span Wire 3/8", Item SPV.0090.1046.

A Description

Span wire is used to support the contact wire and is attached to either poles, buildings or structures.

B Materials

B.1 Span Wire

1. Span wire shall be of the sizes and types indicated on the Contract Drawings, per ASTM A475. It shall be 7 Strand Extra High Strength and galvanized with a Class C coat of zinc galvanizing. Lengths of span wire shall be supplied on either reels or hand coils as preference by the Contractor.. Overall properties shall be as stated in Table 1 of Specification A475. The wire may be supplied either in coils or on reels.
2. Span wire shall be 7 strand guy wire conforming to ASTM A475. Sizes shall be as shown on the Contract Drawings and be either extra high strength, galvanized with a Class C coat

C Construction

1. Span Wire Fittings Attachments

   a. Span wire attachments for terminating span wire in fittings and clamps shall be Preformed End Products fittings for all terminations except where there is restricted clearance and they cannot fit the location. The preform shall be designed to fit the sized span (guy) wire to which it is attached. All preforms shall use a steel thimble of the appropriate size of the guy wire, i.e. 5/16" thimble for a 5/16" span wire. They shall be installed according to the manufacturer's recommendation.

NOT FOR CONSTRUCTION

b. Where a preformed end fitting is too long for a particular application, a crimp sleeve thimble shall be used and shall provide maximum holding power and exceed the breaking strength of the span wire without slipping.

c. Span wire splicing may be accomplished with the use of a MacLean Power Systems Strandlink Guy Wire Splice for the appropriately sized guy wire.

D Measurement

The City will measure Span Wire in length and size by the linear foot acceptably completed.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.1045	OCS Span Wire 5/16”	LF
SPV.0090.1046	OCS Span Wire 3/8”	LF

Payment is full compensation for furnishing and installing the Span Wire including all work to acquire, store, install, tension, finalize, adjust, attach, and use of wire stringing apparatus, temporary ties, rollers, tension devices, bull rings, crimp sleeves, preformed end fittings, strandlinks, thimbles, in line insulators and all else required for a complete and thorough installation.

13. City Underground Communications.

City Underground Communications specifications are under development and will be provided at a later time.

14. Lighting/Electrical.

Lighting and Electrical specifications are under development and will be provided at a later time.

15. Signals.

Traffic Signals specifications are under development and will be provided at a later time.

16. Traction Power.

16.1 Traction Power Project, Item SPV.0105.5000

A Description

NOT FOR CONSTRUCTION

This special provision describes furnishing all labor, material, and tools required for the satisfactory completion of the Traction Power Project in accordance with the drawings and as set forth in these specifications.

The work under this item shall be in accordance to the requirements of the referenced standards indicated in the subsequent articles:

1. Identification Devices
2. Fire Extinguisher
3. Electrical: Basic Requirements
4. Medium Voltage Cable
5. Wire and Cable, 600V and Below
6. Grounding and Bonding
7. Raceways and Boxes
8. Electrical: Exterior Underground
9. Acceptance Testing
10. Dry-Type Transformers
11. TPSS Substations
12. Panelboards
13. Central Emergency Lighting Inverter

and as shown on the plans, or as approved by the engineer, except as hereinafter set forth.

B Materials

Furnish materials that are in accordance with the plans and as indicated in the subsequent articles:

1. Identification Devices
2. Fire Extinguisher
3. Electrical: Basic Requirements
4. Medium Voltage Cable
5. Wire and Cable, 600V and Below
6. Grounding and Bonding
7. Raceways and Boxes
8. Electrical: Exterior Underground
9. Acceptance Testing
10. Dry-Type Transformers
11. TPSS Substations
12. Panelboards
13. Central Emergency Lighting Inverter

C Construction

NOT FOR CONSTRUCTION

Install traction power materials that are in accordance with the plans and as indicated in the subsequent articles:

1. Identification Devices
2. Fire Extinguisher
3. Electrical: Basic Requirements
4. Medium Voltage Cable
5. Wire and Cable, 600V and Below
6. Grounding and Bonding
7. Raceways and Boxes
8. Electrical: Exterior Underground
9. Acceptance Testing
10. Dry-Type Transformers
11. TPSS Substations
12. Panelboards
13. Central Emergency Lighting Inverter

D Measurement

The City will measure Traction Power Project, completed in accordance to the contract and accepted, as a single complete unit of work.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.5000	Traction Power Project	LS

Payment is full compensation for all materials, labor and incidentals for Traction Power Project, including but not limited to Traction Power Substations (TPSS), Grounding Grids, DC Feeder Cables, Duct Bank Assemblies and Manholes, DC Neutral Cables, Duct Bank assemblies and Manholes, DC Utility Drain Cables, and Duct Bank assemblies and Manholes in accordance with the drawings and as set forth in these specifications.

16.2 Summary of Work

A Description

1.1. DESCRIPTION

AA. General:

1. Furnish all labor, materials, tools, equipment and services as indicated in accord with provisions of Contract Documents.

NOT FOR CONSTRUCTION

2. It is the intent of the Contract Documents to describe a functionally complete project. Furnish and install all supplementary or miscellaneous items, appurtenances, and devices incidental to or necessary for a sound, secure, complete, and functional installation.

1.2. WORK COVERED BY CONTRACT

A. The Work of this Contract under the Base Bid generally includes the following:

1. Furnish and install three (3) Traction Power Substations (TPSS). The TPSS include AC Medium Voltage Switchgear, Rectifier Transformer, Rectifier, DC Switchgear and accessories as shown on the Drawings and described in the Specifications.
2. Furnish and install Grounding Grids as specified and as shown on the Drawings.
3. Furnish and install DC Feeder Cables, Duct Bank Assemblies and Manholes as specified and as shown on the Drawings.
4. Furnish and install DC Neutral Cables, Duct Bank assemblies and Manholes as specified and as shown on the Drawings
5. Furnish and install DC Utility Drain Cables, Duct Bank assemblies and Manholes as specified and as shown on the Drawings

1.3. WORK BY OTHERS

A. Some of the structures involved in this construction are used by electric and communications utilities. The electric and communications utilities will be responsible for work associated with their respective facilities. The Contractor shall coordinate the construction with the utilities and shall provide adequate notice to the utilities of any work required in advance or requiring presence of their personnel. Contacts for coordination with the utilities are as follows:

1.4. WORK SEQUENCE

A. The Contractor shall organize and plan the construction activities to assure safety and reliability and to minimize the interruption to the electric system and all other utilities.

B. The Proposed Work Sequence shall be submitted to the Engineer along with the Schedule of Construction.

1.5. CONTRACTOR-FURNISHED PRODUCTS

A. Contractor shall furnish all products as specified and shown on the Drawings.

B. Components required to be supplied in quantity within a specification section shall all be the same and shall be interchangeable.

1.6. PERMITS AND LICENSES

NOT FOR CONSTRUCTION

A. Contractor shall obtain, at his expense, all permits and licenses necessary for the construction of the Work in accordance the General Terms and Conditions of the Contract.

B (Vacant)

C (Vacant)

D (Vacant)

E (Vacant)

16.3 Identification Devices

A Description

1.1 SUMMARY
- A. Section Includes:
  - 1. Tag, tape and stenciling systems for equipment, piping, valves, pumps, ductwork and similar items, and hazard and safety signs.
- B. Related Specification Sections include but are not necessarily limited to:
  - 1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
  - 2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE
- A. Referenced Standards:
  - 1. American Society of Mechanical Engineers (ASME):
    - a. A13.1, Scheme for the Identification of Piping Systems.
  - 2. The International Society of Automation (ISA).
  - 3. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
    - a. Z535.1, Safety Color Code.
    - b. Z535.2, Environmental and Facility Safety Signs.
    - c. Z535.3, Criteria for Safety Symbols.
    - d. Z535.4, Product Safety Signs and Labels.
  - 4. National Fire Protection Association (NFPA):
    - a. 70, National Electrical Code (NEC).
  - 5. Occupational Safety and Health Administration (OSHA):
    - a. 29 CFR 1910.145, Specification for Accident Prevention Signs and Tags.

1.3 SUBMITTALS
- A. Shop Drawings:
  - 1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
  - 2. Product technical data including:
    - a. Catalog information for all identification systems.

NOT FOR CONSTRUCTION

b. Acknowledgement that products submitted meet requirements of standards referenced.

3. Identification register, listing all items in PART 3 of this Specification Section to be identified, type of identification system to be used, lettering, location and color.

B Materials

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. W.H. Brady Co.
2. Panduit.
3. Seton.
4. National Band and Tag Co.
5. Carlton Industries, Inc.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 MANUFACTURED UNITS

A. Type A1 - Round Metal Tags:

1. Materials:
   a. Aluminum or stainless steel.
   b. Stainless steel shall be used in corrosive environments.
2. Size:
   a. Diameter: 1-1/2 IN minimum.
   b. Thickness: 0.035 IN (20 GA) minimum.
3. Fabrication:
   a. 3/16 IN minimum mounting hole.
   b. Legend: Stamped and filled with black coloring.
4. Color: Natural.

B. Type A2 - Rectangle Metal Tags:

1. Materials: Stainless steel.
2. Size:
   a. 3-1/2 IN x 1-1/2 IN minimum.
   b. Thickness: 0.036 IN (20 GA) minimum.
3. Fabrication:
   a. 3/16 IN minimum mounting hole.
   b. Legend: Stamped and filled with black coloring.
4. Color: Natural.

C. Type A3 - Metal Tape Tags:

1. Materials: Aluminum or stainless steel.
2. Size:
   a. Width 1/2 IN minimum.
   b. Length as required by text.
3. Fabrication:

NOT FOR CONSTRUCTION

a. 3/16 IN minimum mounting hole.
b. Legend: Embossed.

4. Color: Natural.

D. Type B1- Square Nonmetallic Tags:

1. Materials: Fiberglass reinforced plastic.
2. Size:
   a. Surface: 2 x 2 IN minimum.
   b. Thickness: 100 mils.
3. Fabrication:
   a. 3/16 IN mounting hole with metal eyelet.
   b. Legend: Preprinted and permanently embedded and fade resistant.
4. Color:
   a. Background: Manufacturer standard or as specified.
   b. Lettering: Black.

E. Type B2 - Nonmetallic Signs:

1. Materials: Fiberglass reinforced or durable plastic.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 60 mils minimum.
3. Fabrication:
   a. Rounded corners.
   b. Drilled holes in corners with grommets.
   c. Legend: Preprinted, permanently embedded and fade resistant for a 10 year minimum outdoor durability.
4. Color:
   a. Background: Manufacturer standard or as specified.
   b. Lettering: Black.
5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

F. Type C - Laminated Name Plates:

1. Materials: Phenolic or DR (high impact) acrylic.
2. Size:
   a. Surface: As required by text.
   b. Thickness: 1/16 IN.
3. Fabrication:
   a. Outdoor rated and UV resistant when installed outdoors.
   b. Two (2) layers laminated.
   c. Legend: Engraved through top lamination into bottom lamination.
   d. Two (2) drilled side holes, for screw mounting.
4. Color: Black top surface, white core, unless otherwise indicated.

G. Type D - Self-Adhesive Tape Tags and Signs:

1. Materials: Vinyl tape or vinyl cloth.
2. Size:

NOT FOR CONSTRUCTION

a. Surface: As required by text.
b. Thickness: 5 mils minimum.

3. Fabrication:
a. Indoor/Outdoor grade.
b. Weather and UV resistant inks.
c. Permanent adhesive.
d. Legend: Preprinted.
e. Wire markers to be self-laminating.

4. Color: White with black lettering or as specified.

5. Standards for OSHA signs: NEMA/ANSI Z535.1, NEMA/ANSI Z535.2, NEMA/ANSI Z535.3, NEMA/ANSI Z535.4, OSHA 29 CFR 1910.145.

H. Type E - Heat Shrinkable Tape Tags:
1. Materials: Polyolefin.
2. Size: As required by text.
3. Fabrication:
a. Legend: Preprinted.

4. Color: White background, black printing.

I. Type F - Underground Warning Tape:
1. Materials: Polyethylene.
2. Size:
a. 6 IN wide (minimum).
b. Thickness: 3.5 mils.

3. Fabrication:
a. Legend: Preprinted and permanently imbedded.
b. Message continuous printed.
c. Tensile strength: 1750 psi.

4. Color: As specified.

J. Type G - Stenciling System:
1. Materials:
a. Exterior type stenciling enamel.
b. Either brushing grade or pressurized spray can form and grade.

2. Size: As required.
3. Fabrication:
a. Legend: As required.

4. Color: Black or white for best contrast.

K. Underground Tracer Wire:
1. Materials:
a. Wire:
1) 12 GA AWG.
2) Solid.

b. Wire nuts: Waterproof type.
c. Split bolts: Brass.

2.3 ACCESSORIES
A. Fasteners:

NOT FOR CONSTRUCTION

1. Bead chain: #6 brass, aluminum or stainless steel.
2. Plastic strap: Nylon, urethane or polypropylene.
3. Screws: Self-tapping, stainless steel.
4. Adhesive, solvent activated.

2.4 MAINTENANCE MATERIALS

A. Where stenciled markers are provided, clean and retain stencils after completion and include in extra stock, along with required stock of paints and applicators.

C Construction

3.1 GENERAL INSTALLATION

A. Install identification devices at specified locations.

B. All identification devices to be printed by mechanical process, hand printing is not acceptable.

C. Attach tags to equipment with sufficient surface or body area with solvent activated adhesive applied to back of each tag.

D. Attach tags with 1/8 IN round or flat head screws to equipment without sufficient surface or body area, or porous surfaces.

1. Where attachment with screws should not or cannot penetrate substrate, attach with plastic strap.

E. Single items of equipment enclosed in a housing or compartment to be tagged on outside of housing.

1. Several items of equipment mounted in housing to be individually tagged inside the compartment.

F. Tracer Wire:

1. Attach to pipe at a maximum of 10 FT intervals with tape or tie-wraps.
2. Continuous pass from each valve box and above grade at each structure.
3. Coil enough wire at each valve box to extend wire a foot above the ground surface.
4. 1,000 FT maximum spacing between valve boxes.
5. If split bolts are used for splicing, wrap with electrical tape.
6. If wire nuts are used for splicing, knot wire at each splice point leaving 6 IN of wire for splicing.
7. Use continuous strand of wire between valve box where possible.
   a. Continuous length shall be no shorter than 100 FT.

3.2 SCHEDULES

A. Electrical Systems:

1. Trenches with ductbanks, direct-buried conduit, or direct-buried wire and cable.
   a. Tag type: Type F - Underground Warning Tape.
   b. Letter height: 1-1/4 IN minimum.
   c. Location:

NOT FOR CONSTRUCTION

1) Where trench is 12 IN or more below finished grade: In trench 6 IN below finished grade.

2) Where trench is less than 12 IN below finished grade: In trench 3 IN below finished grade.

d. Electrical power (e.g., low and medium voltage):

1) Color: Red with black letters.

2) Legend:

a) First line: “CAUTION CAUTION CAUTION”.

b) Second line: “BURIED ELECTRIC LINE BELOW”.

e. Communications (e.g., telephone, instrumentation, LAN, SCADA):

1) Color: Orange with black letters.

2) Legend:

a) First line: “CAUTION CAUTION CAUTION”.

b) Second line: “BURIED COMMUNICATION LINE BELOW”.

2. Switchgear, switchboards and motor control centers:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Main equipment legend:

1) Letter height:

a) First line: 1 IN minimum.

b) Subsequent lines: 3/8 IN minimum.

2) First line: Equipment name (e.g., "MAIN SWITCHBOARD MSBxxx").

3) Second line:

a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").

b) Include the building name or number if the source is in another building.

4) Third line: System voltage and phase (e.g., “480/277 V, 3PH”).

d. Main and feeder device legend:

1) Letter height: 3/8 IN minimum.

2) Description of load (e.g., “MAIN DISCONNECT”, "PUMP Pxxx" or "PANELBOARD HP?").

3. Panelboards and transformers:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height:

a) First line: 3/8 IN minimum.

b) Subsequent lines: 3/16 IN minimum.

NOT FOR CONSTRUCTION

2) First line: Equipment name (e.g., "PANELBOARD LPxxx" or "TRANSFORMER Txxx").

3) Second line (panelboards only): System voltage and phase (e.g., “208/120V, 3PH”).

4) Third line:

a) Source of power (e.g., "FED FROM MCCxxx LOCATED IN ROOM xxx").

b) Include the building name or number if the source is in another building.

4. Transfer switches:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height:

a) First line: 3/8 IN minimum.

b) Subsequent lines: 3/16 IN minimum.

2) First line: Equipment name (e.g., "AUTOMATIC TRANSFER SWITCH ATSxxx").

5. Safety switches, separately mounted circuit breakers and motor starters, VFD’s, etc.:

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/4 IN minimum.

2) First line: Description of load equipment is connected to (e.g., "PUMP Pxxx").

6. Enclosure for instrumentation and control equipment, (e.g., lighting control panels, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

c. Legend:

1) Letter height: 1/2 IN minimum.

2) Equipment name (e.g., "LIGHTING CONTROL PANEL LCPxxx").

7. Components inside equipment enclosures (e.g., circuit breakers, fuses, control power transformers, control relays, contactors, timers, etc.):

a. Tag type: Type D - Self-Adhesive Tape Tags and Signs.

b. Fastener: Self.

c. Legend:

1) Letter height: 3/16 IN minimum.

2) Description or function of component (e.g., "M-xxx”, “CR-xxx” or “TR-xxx").

8. Through enclosure door mounted equipment (e.g., selector switches, controller digital displays, etc.):

a. Tag type: Type C - Phenolic Name Plates.

b. Fastener: Screws.

NOT FOR CONSTRUCTION

c. Legend:

1) Letter height: 1/4 IN minimum.

2) Component tag number as indicated on the Drawings or as defined by contractor (e.g., “HS-xxx”).

9. Conductors in control panels and in pull or junction boxes where multiple circuits exist.

a. Tag type: Type D - Self-Adhesive Tape Tags.

b. Fastener: Self.

c. Tag conductor at both ends.

d. Legend:

1) Letter height: 1/8 IN minimum.

2) Circuit number or wire number as scheduled on the Drawings or as furnished with the equipment.

10. Conductors in handholes and manholes.

a. Tag type: Type A3 - Metal Tape Tags.

b. Fastener: Nylon strap.

c. Tag conductor at both ends.

d. Legend:

1) Letter height: 1/8 IN minimum.

2) Circuit number or wire number as scheduled on the Drawings.

11. Grounding conductors associated with grounding electrode system in accordance with the following:

a. Tag type: Type D - Self-Adhesive Tape Tags.

b. Fastener: Self.

c. Legend:

1) Letter height: 1/8 IN minimum.

2) Function of conductor (e.g., "MAIN BONDING JUMPER", "TO GROUND RING", "TO MAIN WATER PIPE").

12. Arc Flash protection for switchboards, panelboards, industrial control panels and motor control centers:

a. Tag type: Type D - Self-Adhesive Tape Signs.

b. Fastener: Self.

c. Legend: Per NFPA 70E.

13. Entrances to electrical rooms:

a. Tag type: Type B2 - Nonmetallic Signs.

b. Fastener: Screw or adhesive.

c. Size: 5 IN x 7 IN.

d. Location: Each door to room.

e. Legend:

1) OSHA Danger Sign.

2) Description of Danger: “HIGH VOLTAGE, AUTHORIZED PERSONNEL ONLY”.

14. Equipment where more than one (1) voltage source is present:

a. Tag type:

1) Type B2 - Nonmetallic Signs.

NOT FOR CONSTRUCTION

2) Type D - Self-Adhesive Tape Signs.

b. Fastener:

1) Screw or adhesive.

2) Self.

c. Size: 1-3/4 IN x 2-1/2 IN.

d. Location: Exterior face of enclosure or cubical.

e. Legend:

1) OSHA Danger Sign.

2) Description of Danger: "MULTIPLE VOLTAGE SOURCES".

3.3 HAZARD AND SAFETY SIGNS

A. Provide Hazard and Safety Signs as required.

1. Inscription as directed by Owner.

D (Vacant)

E (Vacant)

16.4 Fire Extinguisher

A Description

1.1 SUMMARY

A. Section Includes:

1. Fire extinguishers.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Fire Protection Association (NFPA):

a. 10, Standard for Portable Fire Extinguishers.

2. Underwriters Laboratories, Inc. (UL):

a. Building Materials Directory.

1.3 DEFINITIONS

A. Authority Having Jurisdiction (AHJ): Building official, fire chief, fire marshal or other individual having statutory authority.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data including:

a. Acknowledgement that products submitted meet requirements of standards referenced.

b. Manufacturer's installation instructions.

B. Contract Closeout Information:

NOT FOR CONSTRUCTION

1. Operation and Maintenance Data:
   a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Deliver and install filled and charged extinguishers just prior to building occupancy.

B Materials

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
   1. Fire extinguishers:
      a. Amerex Corporation.
      b. Ansul Fire Protection.
      c. Walter Kidde.
      d. Potter - Roemer Inc.
   2. Fire extinguisher signs:
      a. Seton.

B. Submit request for substitution in accordance with Specification Section 01 25 13.

2.2 MANUFACTURED UNITS

A. Fire Extinguisher (FEXT):
   1. Steel bodied, all metal top (head) and valves.
   2. Multi-purpose dry chemical with hose and horn.
   3. Provide one (1) UL rated 10A-120BC extinguisher for each fire extinguisher location (FEXT) indicated on Drawings.
   4. Finish: Red with epoxy finish coat.

B. Wall Brackets:
   1. Bracket type to fit specified extinguisher.
   2. Furnish bracket for each extinguisher not in cabinet.
   3. Bracket to be finished in red or black enamel.

C. Fire Extinguisher Signage:
   1. Single faced: SETON #21999.
   2. Double faced: SETON #22001.

C Construction

3.1 INSTALLATION

A. Install products in accordance with manufacturer's instructions and NFPA 10.
   1. Install units with extinguisher top not over 48 IN above floor.
   2. Install wall brackets to concrete or masonry substrate with self-tapping concrete anchors.

B. Fire extinguisher locations shown on Drawings are approximate locations.
   1. Verify all extinguisher mounting locations with the AHJ.

C. Provide "FIRE EXTINGUISHER" sign for each extinguisher location.

NOT FOR CONSTRUCTION

1. Provide single or double faced sign to provide optimum visibility for extinguisher location.

D (Vacant)

E (Vacant)

16.5 Electrical: Basic Requirements

A Description

1.1 SUMMARY

A. Section Includes:

1. Basic requirements for electrical systems.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

3. Section 10 14 00 Identification Devices.

4. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

5. Section 26 05 33 - Raceways and Boxes.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Aluminum Association (AA).

2. American Iron and Steel Institute (AISI).

3. ASTM International (ASTM):

a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.

b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.

4. ETL Testing Laboratories (ETL).

5. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

a. C2, National Electrical Safety Code (NESC).

6. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

7. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

8. Underwriters Laboratories, Inc. (UL).

B. Where UL test procedures have been established for the product type, use UL or ETL approved electrical equipment and provide with the UL or ETL label.

1.3 DEFINITIONS

A. For the purposes of providing materials and installing electrical work the following definitions shall be used.

1. Outdoor area: Exterior locations where the equipment is normally exposed to the weather and including below grade structures, such as vaults, manholes, hand holes and in-ground pump stations.

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2. Architecturally finished interior area: Offices, laboratories, conference rooms, restrooms, corridors and other similar occupied spaces.
3. Non-architecturally finished interior area: Pump, chemical, mechanical, electrical rooms and other similar process type rooms.
4. Highly corrosive and corrosive area: Areas identified on the Drawings where there is a varying degree of spillage or splashing of corrosive materials such as water, wastewater or chemical solutions; or chronic exposure to corrosive, caustic or acidic agents, chemicals, chemical fumes or chemical mixtures.
5. Hazardous areas: Class I, II or III areas as defined in NFPA 70.
6. Shop fabricated: Manufactured or assembled equipment for which a UL test procedure has not been established.

1.4 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of submittal process.
2. See Specification Section 01 61 03 and individual specification sections for submittal requirements for products defined as equipment.
3. General requirements:
a. Provide manufacturer's technical information on products to be used, including product descriptive bulletin.
b. Include data sheets that include manufacturer's name and product model number.
1) Clearly identify all optional accessories.
c. Acknowledgement that products are UL or ETL listed or are constructed utilizing UL or ETL recognized components.
d. Manufacturer's delivery, storage, handling and installation instructions.
e. Product installation details.
f. See individual specification sections for any additional requirements.

B. Operation and Maintenance Manuals:
1. See Specification Section 01 33 04 for requirements for:
a. The mechanics and administration of the submittal process.
b. The content process of Operation and Maintenance Manuals.

C. When a Specification Section includes products specified in another Specification Section, each Specification Section shall have the required Shop Drawing transmittal form per Specification Section 01 33 00 and all Specification Sections shall be submitted simultaneously.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Protect nameplates on electrical equipment to prevent defacing.

1.6 AREA DESIGNATIONS

A. Designation of an area will determine the NEMA rating of the electrical equipment enclosures, types of conduits and installation methods to be used in that area.
1. Outdoor areas:
a. Wet.
b. Also, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

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2. Indoor areas:
a. Dry.
b. Also, wet, corrosive and/or hazardous when specifically designated on the Drawings or in the Specifications.

B Materials

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, refer to specific Electrical Specification Sections and specific material paragraphs below for acceptable manufacturers.
B. Submit request for substitution in accordance with Specification Section 01 25 13.
C. Provide all components of a similar type by one (1) manufacturer.
2.2 MATERIALS
A. Electrical Equipment Support Pedestals and/or Racks:
1. Approved manufacturers:
a. Modular strut:
1) Unistrut Building Systems.
2) Eaton B-Line.
3) Globe Strut.
4) Thomas & Betts Superstrut.
2. Material requirements:
a. Modular strut:
1) Galvanized steel: ASTM A123/123M or ASTM A153/A153M.
2) Stainless steel: AISI Type 316.
3) PVC coated galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.
4) Aluminum: AA Type 6063-T6.
b. Mounting hardware:
1) Galvanized steel.
2) Stainless steel.
B. Field touch-up of galvanized surfaces.
1. Zinc-rich primer.
a. One (1) coat, 3.0 mils, ZRC by ZRC Products.

C Construction

3.1 INSTALLATION
A. Install and wire all equipment, including pre-purchased equipment, and perform all tests necessary to assure conformance to the Drawings and Specification Sections and ensure that equipment is ready and safe for energization.
B. Install equipment in accordance with the requirements of:
1. NFPA 70.
2. IEEE C2.
3. The manufacturer's instructions.
C. In general, conduit routing is not shown on the Drawings.

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1. The Contractor is responsible for routing all conduits including those shown on one-line and control block diagrams and home runs shown on floor plans.
2. Conduit routings and stub-up locations that are shown are approximate; exact routing to be as required for equipment furnished and field conditions.
D. When complete branch circuiting is not shown on the Drawings:
1. A homerun indicating panel board name and circuit number will be shown and the circuit number will be shown adjacent to the additional devices (e.g., light fixture and receptacles) on the same circuit.
2. The Contractor is to furnish and install all conduit and conductors required for proper operation of the circuit.
3. The indicated home run conduit and conductor size shall be used for the entire branch circuit.
4. See Specification Section 26 05 19 for combining multiple branch circuits in a common conduit.
E. Do not use equipment that exceed dimensions or reduce clearances indicated on the Drawings or as required by the NFPA 70.
F. Install equipment plumb, square and true with construction features and securely fastened.
G. Install electrical equipment, including pull and junction boxes, minimum of 6 IN from process, gas, air and water piping and equipment.
H. Install equipment so it is readily accessible for operation and maintenance, is not blocked or concealed and does not interfere with normal operation and maintenance requirements of other equipment.
I. Device Mounting Schedule:
1. Unless indicated otherwise on the Drawings, mounting heights are as indicated below:
a. Light switch (to center): 48 IN.
b. Receptacle in architecturally finished areas (to center): 18 IN.
c. Receptacle on exterior wall of building (to center): 18 IN.
d. Receptacle in non-architecturally finished areas (to center): 48 IN.
e. Telephone outlet in architecturally finished areas (to center): 18 IN.
f. Telephone outlet for wall-mounted phone (to center): 54 IN.
g. Safety switch (to center of operating handle): 54 IN.
h. Separately mounted motor starter (to center of operating handle): 54 IN.
i. Pushbutton or selector switch control station (to center): 48 IN.
j. Panel board (to top): 72 IN.
J. Avoid interference of electrical equipment operation and maintenance with structural members, building features and equipment of other trades.
1. When it is necessary to adjust the intended location of electrical equipment, unless specifically dimensioned or detailed, the Contractor may make adjustments in equipment locations in accordance with the following without obtaining the Engineer's approval:
a. 1 FT at grade, floor and roof level in any direction in the horizontal plane.
b. 1 FT for equipment other than lighting at ceiling level in any direction in the horizontal plane.

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c. 1 FT for lighting fixtures at ceiling level in any direction in the horizontal plane.
d. 1 FT on walls in a horizontal direction within the vertical plane.
e. Changes in equipment location exceeding those defined above require the Engineer's approval.
K. Provide electrical equipment support system per the following area designations:
1. Dry areas:
a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
2. Wet areas:
a. Galvanized system consisting of galvanized steel channels and fittings, nuts and hardware.
b. Field touch-up cut ends and scratches of galvanized components with the specified primer during the installation, before rust appears.
3. Corrosive areas:
a. Aluminum system consisting of aluminum channels and fittings with stainless steel nuts and hardware.
4. Highly corrosive areas:
a. PVC coated steel system consisting of PVC coated steel channels and fittings with stainless steel nuts and hardware.
L. Provide all necessary anchoring devices and supports rated for the equipment load based on dimensions and weights verified from approved submittals, or as recommended by the manufacturer.
1. Do not cut, or weld to, building structural members.
2. Do not mount safety switches or other equipment to equipment enclosures, unless enclosure mounting surface is properly braced to accept mounting of external equipment.
M. Provide corrosion resistant spacers to maintain 1/4 IN separation between metallic equipment and/or metallic equipment supports and mounting surface in wet areas.
N. Do not place equipment fabricated from aluminum in direct contact with earth or concrete.
O. Screen or seal all openings into equipment mounted outdoors to prevent the entrance of rodents and insects.
P. Do not use materials that may cause the walls or roof of a building to discolor or rust.
Q. Identify electrical equipment and components in accordance with Specification Section 10 14 00.
3.2 FIELD QUALITY CONTROL
A. Verify exact rough-in location and dimensions for connection to electrified equipment, provided by others.
B. Replace equipment and systems found inoperative or defective and re-test.

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C. The protective coating integrity of support structures and equipment enclosures shall be maintained.
1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the component.
4. Repair surfaces which will be inaccessible after installation prior to installation.
5. See Specification Section 26 05 33 for requirements for conduits and associated accessories.
D. Replace nameplates damaged during installation.

D (Vacant)

E (Vacant)

16.6 Medium Voltage Cable

A Description

1.1 SUMMARY
A. Section Includes:
1. Material and installation requirements for:
a. Medium voltage cable (601 V and above).
b. Cable terminations and splices.
B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical: Basic Requirements.
4. Section 26 05 19 - Wire and Cable: 600 Volt and Below.
5. Section 26 08 13 - Acceptance Testing.
6. Section 26 23 40 – Traction Power Substation
1.2 QUALITY ASSURANCE
A. Referenced Standards:
1. Association of Edison Illuminating Companies (AEIC).
a. CS8, Specification for Extruded Dielectric Shielded Power Cables Rated 5 Through 46kV.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
a. 48, Standard for Test Procedures and Requirements for Alternating-Current Cable Terminations Used on Shielded Cables Having Laminated Insulation Rated 2.5kV Through 756kV or Extruded Insulation Rated 2.5 kV through 500 kV.
b. 386, Standard for Separable Insulated Connector Systems for Power Distribution Systems Above 600V.
c. 404, Standard for Extruded and Laminated Dielectric Shielded Cable Joints Rated 2500 V to 500,000 V.

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3. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
a. WC 74/S-93-639, 5-46 kV Shielded Power Cable for Use in the Transmission and Distribution of Electric Energy.
b. Standard S-68-516/ WC8-1976 type II and ASTM Specification D-3802-78 for DC power cables.
4. National Fire Protection Association (NFPA):
a. 70, National Electrical Code (NEC).
5. Underwriters Laboratories, Inc. (UL):
a. 1072, Standard for Safety Medium Voltage Power Cables.
B. Qualifications:
1. Cable technician:
a. Three (3) years experience in handling, terminating and splicing medium voltage cables.
b. Specifically trained by a factory representative on the terminations and splices to be used on the project.
1) If not trained on the products to be used, on-site training by the factory representative shall be performed before any terminations or splices are made.
1.3 SUBMITTALS
A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product data:
a. Provide submittal data for all products specified in PART 2 of this Specification Section.
b. Provide submittal data for TPSS DC power cables.
c. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
a. Cable pulling plan.
B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Cable pulling tension measurements.
3. Submit the following before terminating cables:
a. Cable Technician qualifications.
1.4 DELIVERY, STORAGE, AND HANDLING
A. Ship cable with removable watertight end seals, and store in dry place.

B Materials

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Wire and cable:
a. Aetna Insulated Wire.
b. General Cable.
c. The Kerite Company.

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d. The Okonite Company.
e. Prysmian Cable Corporation.
f. Southwire Company.
2. Lugs, connectors and terminations:
a. 3M Company.
b. Elastimold, a Thomas and Betts Company.
c. Joslyn.
d. Raychem.
e. Eaton Cooper Power Systems.

2.2 MEDIUM VOLTAGE CABLES

A. Ratings:
1. Voltage class as indicated on the Drawings.
B. Standards:
1. NEMA/ICEA WC 74/S-93-639.
2. AEIC CS8.
3. UL 1072.
C. Conductor Material:
1. Compact stranded copper.
D. Insulation:
1. Temperature rating: Type MV-90 or MV-105 per NFPA 70.
2. Insulation class as indicated on the Drawings.
3. 133 percent insulation level.
E. Shielding:
1. Shielding on cables rated above 2 kV consists of:
a. Semiconductor conductor screen.
b. Semiconductor insulation screen.
c. Copper tape or copper wire.
F. Neutrals:
1. Neutral conductors of grounded neutral systems indicated on the drawings, shall be of the same insulation materials as the phase conductors, except with a 600 V insulation rating.
G. Grounds:
1. Insulated copper per Specification Section 26 05 19.
H. Jackets:
1. Direct buried cables shall be rated for direct bury.
2. Jacket: PVC

2.3 CABLE ACCESSORIES

A. Lugs and Connectors:
1. Lugs:
a. Compression type.
b. Standard: UL 486A for copper cables.
c. Voltage rating: Up to 35 kV.
d. Current rating: Continuous operation at the rating of the cable.
e. Material: Tin-plated copper.
f. Number of holes: Two (2), except one (1) on motor leads.
B. Terminations:

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1. End caps:
a. Cold or hot shrink.
b. Used to environmentally seal and mechanically protect exposed cable ends.
2. Cold shrink kits:
a. Standard: IEEE 48, Class 1 termination.
b. Voltage rating: Same as the cable rating.
c. Current rating: Continuous operation at the rating of the cable.
d. One-piece design, where high-dielectric constant stress control is integrated within a skirted insulator made of silicone rubber.
e. Suitable for contaminated indoor and outdoor locations.
3. Molded rubber kit:
a. Standard: IEEE 48.
b. Voltage rating: Same as the cable rating.
c. Current rating: Continuous operation at the rating of the cable.
d. One-piece design or modular with stress cone and skirts, where high-dielectric constant stress control is integrated within a skirted insulator made of EPDM rubber.
e. Suitable for contaminated indoor and outdoor locations.
4. Elbow connectors:
a. Standard: IEEE 386.
b. Voltage rating: Same as the cable rating.
c. Current rating: 200A.
d. One-piece design, comprised of an insulation shield, insulation layer and an outer shield constructed of EPDM rubber.
e. Dead front, load break type with:
1) Hot stick pulling eye.
2) Grounding tab.
3) Test point.
f. Accessories to be constructed in a similar manner as the elbow connector:
1) Bushing inserts.
2) Bushing well plugs.
3) Feed thru inserts.
4) Protective caps.
C. Cable Shield Grounding Adapters:
1. Type: Molded rubber with constant force spring and solder-blocked tinned copper braid pigtail.
2. Waterproof, providing a positive seal for the cable jacket.
3. May be integral with termination of splice device with Engineer's approval.

C Construction

3.1 INSTALLATION
A. Do not install cable during wet conditions.
1. Prior to pulling cables, drain or pump out manholes and other low points if standing water is present.

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2. Blow out conduits with dried compressed air if moisture is present in conduits.
3. Install end caps immediately on all cut ends of cable prior to pulling, and maintain end caps while pulling in cable.
a. If end caps are damaged, remove and install new end caps.
b. Do not remove end caps until ready to terminate or splice cable.
B. Cable Installation in Manholes:
1. Provide enough cable slack in each manhole for a complete loop around the manhole.
a. When cable is spliced in a manhole, provide enough cable slack for a complete loop around the manhole.
b. The loop will provide slack to facilitate future cable repairs.
2. Arc-proof all cables in manholes.
a. Apply in spiral, half-overlap fashion to full exposed length of each cable in manhole.
b. Secure in place with glass cloth electrical tape.
1) Apply in reverse spiral to arc-proofing tape, at maximum interval of 9 IN and double wrapped at each end.
3. DC cables in manholes shall be supported with non-metallic cable racks only.
C. Do not install conductors when ambient temperature is near minimum as recommended by manufacturer for installation of the type of conductor insulation.
D. Provide components in kit form, complete with instructions, supplied by a single approved manufacturer and suitable for each shielded cable termination.
1. Select correct termination to match cable diameter and construction.
2. Form and install terminations in strict accordance with instructions of cable manufacturer and termination manufacturer.
E. The ground shield grounding adaptors shall be grounded:
1. Shirted and elbow terminators: Grounded to ground bar or cable loop in equipment.
2. Splices: Grounded to ground bar or rod in manhole.
3. Connect with insulated, stranded #6 AWG wire.
3.2 FIELD QUALITY CONTROL
A. Provide cable pulling plan showing all proposed splice points and cable pulling direction for each pull.
B. Provide measurement of tensions during the pull.
C. See Specification Section 26 08 13 for acceptance testing requirements.

D (Vacant)

E (Vacant)

16.7 Wire and Cable, 600V and Below

A Description

1.1 SUMMARY

NOT FOR CONSTRUCTION

A. Section Includes:
1. Material and installation requirements for:
a. Building wire.
b. Power cable.
c. Control cable.
d. Instrumentation cable.
e. Wire connectors.
f. Insulating tape.
g. Pulling lubricant.
B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical: Basic Requirements.
4. Section 26 05 26 – Grounding and Bonding
5. Section 26 08 13 - Acceptance Testing.
1.2 QUALITY ASSURANCE
A. Referenced Standards:
1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
a. 1202, Standard for Flame-Propagation Testing of Wire and Cable.
2. Insulated Cable Engineers Association (ICEA):
a. S-58-679, Standard for Control Cable Conductor Identification.
3. National Electrical Manufacturers Association (NEMA):
a. ICS 4, Industrial Control and Systems: Terminal Blocks.
4. National Electrical Manufacturers Association/Insulated Cable Engineers Association (NEMA/ICEA):
a. WC 57/S-73-532, Standard for Control Cables.
b. WC 70/S-95-658, Non-Shielded Power Cables Rated 2000 Volts or Less for the Distribution of Electrical Energy.
5. National Fire Protection Association (NFPA):
a. 70, National Electrical Code (NEC).
b. 262, Standard Method of Test for Flame Travel and Smoke of Wires and Cables for Use in Air-Handling Spaces.
6. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):
a. 568, Commercial Building Telecommunications Cabling Standard.
7. Underwriters Laboratories, Inc. (UL):
a. 44, Standard for Safety Thermoset-Insulated Wires and Cables.
b. 83, Standard for Safety Thermoplastic-Insulated Wires and Cables.
c. 467, Standard for Safety Grounding and Bonding Equipment.
d. 486A, Standard for Safety Wire Connectors and Soldering Lugs for use with Copper Conductors.
e. 486C, Standard for Safety Splicing Wire Connections.
f. 510, Standard for Safety Polyvinyl Chloride, Polyethylene and Rubber Insulating Tape.

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g. 1277, Standard for Safety Electrical Power and Control Tray Cables with Optional Optical-Fiber Members.
h. 1581, Standard for Safety Reference Standard for Electrical Wires, Cables, and Flexible Cords.
i. 2250, Standard for Safety Instrumentation Tray Cable.
1.3 DEFINITIONS
A. Cable: Multi-conductor, insulated, with outer sheath containing either building wire or instrumentation wire.
B. Instrumentation Cable:
1. Multiple conductor, insulated, twisted or untwisted, with outer sheath.
2. The following are specific types of instrumentation cables:
a. Analog signal cable:
1) Used for the transmission of low current (e.g., 4-20mA DC) or low voltage (e.g., 0-10 DC) signals, using No. 16 AWG and smaller conductors.
2) Commonly used types are defined in the following:
a) TSP: Twisted shielded pair.
b) TST: Twisted shielded triad.
b. Digital signal cable: Used for the transmission of digital signals between computers, PLC's, RTU's, etc.
C. Power Cable: Multi-conductor, insulated, with outer sheath containing building wire, No. 8 AWG and larger.
D. Control Cable: Multi-conductor, insulated, with outer sheath containing building wires, No. 14, No. 12 or No. 10 AWG.
E. Building Wire: Single conductor, insulated, with or without outer jacket depending upon type.
1.4 SUBMITTALS
A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
1) Wire connectors.
2) Insulating tape.
b. See Specification Section 26 05 00 for additional requirements.
1.5 DELIVERY, STORAGE, AND HANDLING
A. See Specification Section 26 05 00.

B Materials

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Building wire, power and control cable:
a. Aetna Insulated Wire.
b. Alphawire.
c. Cerrowire.

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d. Encore Wire Corporation.
e. General Cable.
f. Okonite Company.
g. Southwire Company.
2. Instrumentation cable:
a. Analog cable:
1) Alphawire.
2) Belden Inc.
3) General Cable.
3. Wire connectors:
a. Burndy Corporation.
b. Buchanan.
c. Ideal.
d. Ilsco.
e. 3M Co.
f. Teledyne Penn Union.
g. Thomas and Betts.
h. Phoenix Contact.
4. Insulating and color coding tape:
a. 3M Co.
b. Plymouth Bishop Tapes.
c. Red Seal Electric Co.
5. Cable lubricant:
a. American Polywater Corporation
b. 3M Co.

2.2 MANUFACTURED UNITS

A. Building Wire:

1. Conductor shall be copper with 600 V rated insulation.
2. Conductors shall be stranded, except for conductors used in lighting and receptacle circuits which may be stranded or solid.
3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
4. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 for type THHN/THWN and THHN/THWN-2 insulation.
5. Conform to NEMA/ICEA WC 70/S-95-658 and UL 44 for type XHHW-2 insulation.

B. Power Cable:

1. Conductor shall be copper with 600 V rated insulation.
2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.
3. Conform to NEMA/ICEA WC 70/S-95-658 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.
4. Number of conductors as required, including a bare ground conductor.
5. Individual conductor color coding:
a. ICEA S-58-679, Method 4.
b. See PART 3 of this Specification Section for additional requirements.

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6. Conform to NFPA 70 Type TC.

C. Control Cable:

1. Conductor shall be copper with 600 V rated insulation.

2. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

3. Conform to NEMA/ICEA WC 57/S-73-532 and UL 83 and UL 1277 for type THHN/THWN insulation with an overall PVC jacket.

4. Number of conductors as required, provided with or without bare ground conductor of the same AWG size.

a. When a bare ground conductor is not provided, an additional insulated conductor shall be provided and used as the ground conductor (e.g., 6/c No. 14 w/g and 7/c No. 14 are equal).

5. Individual conductor color coding:

a. ICEA S-58-679, Method 1, Table E-2.

b. See PART 3 of this Specification Section for additional requirements.

6. Conform to NFPA 70 Type TC and IEEE 1202, CSA FT-4 or NFPA 262.

D. Electrical Equipment Control Wire:

1. Conductor shall be copper with 600 V rated insulation.

2. Conductors shall be stranded.

3. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

4. Conform to UL 44 for Type SIS insulation.

5. Conform to UL 83 for Type MTW insulation.

E. Instrumentation Cable:

1. Surface mark with manufacturer's name or trademark, conductor size, insulation type and UL label.

2. Analog cable:

a. Tinned copper conductors.

b. 300 V or 600 V PVC insulation with PVC jacket.

c. Twisted with 100 percent foil shield coverage with drain wire.

d. Six (6) twists per foot minimum.

e. Individual conductor color coding: ICEA S-58-679, Method 1, Table E-2.

f. Conform to IEEE 1202 or CSA FT-4 or NFPA 262, UL 2250, UL 1581 and NFPA 70 Type ITC.

3. Digital cable:

a. As recommended by equipment (e.g., PLC, RTU) manufacturer.

b. Horizontal voice and data cable:

1) Category 6 per TIA/EIA/ANSI 568.

2) Cable shall be label-verified.

3) Cable jacket shall be factory marked at regular intervals indicating verifying organization and performance level.

4) Conductors: No. 24 AWG solid untinned copper.

5) Rated CMP per NFPA 70.

c. Conform to IEEE 1202 or CSA FT-4 or NFPA 262 and NFPA 70 Type ITC.

F. Wire Connectors:

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1. Twist/screw on type:
a. Insulated pressure or spring type solderless connector.
b. 600 V rated.
c. Ground conductors: Conform to UL 486C and/or UL 467 when required by local codes.
d. Phase and neutral conductors: Conform to UL 486C.
2. Compression and mechanical screw type:
a. 600 V rated.
b. Ground conductors: Conform to UL 467.
c. Phase and neutral conductors: Conform to UL 486A.
3. Terminal block type:
a. High density, screw-post barrier-type with white center marker strip.
b. 600 V and ampere rating as required, for power circuits.
c. 600 V, 20 ampere rated for control circuits.
d. 300 V, 15 ampere rated for instrumentation circuits.
e. Conform to NEMA ICS 4 and UL 486A.
G. Insulating and Color Coding Tape:
1. Pressure sensitive vinyl.
2. Premium grade.
3. Heat, cold, moisture, and sunlight resistant.
4. Thickness, depending on use conditions: 7, 8.5, or 10 mil.
5. For cold weather or outdoor location, tape must also be all-weather.
6. Color:
a. Insulating tape: Black.
b. Color coding tape: Fade-resistant color as specified herein.
7. Comply with UL 510.
H. Pulling Lubricant: Cable manufacturer's standard containing no petroleum or other products which will deteriorate insulation.

C Construction

3.1 INSTALLATION
A. Permitted Usage of Insulation Types:
1. Type XHHW-2:
a. Building wire and power and control cable in architectural and non-architectural finished areas.
b. Building wire and power and control cable in conduit below grade.
2. Type THHN/THWN and THHN/THWN-2:
a. Building wire and power and control cable No. 8 AWG and smaller in architectural and non-architectural finished areas.
3. Type SIS and MTW:
a. For the wiring of control equipment within control panels and field wiring of control equipment within switchgear, switchboards, motor control centers.
B. Conductor Size Limitations:
1. Feeder and branch power conductors shall not be smaller than No. 12 AWG unless otherwise indicated on the Drawings.

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2. Control conductors shall not be smaller than No. 14 AWG unless otherwise indicated on the Drawings.
3. Instrumentation conductors shall not be smaller than No. 18 AWG unless otherwise indicated on the Drawings.
C. Color Code All Wiring as Follows:
1. Building wire:

	240 V, 208 V, 240/120 V, 208/120 V	480 V, 480/277 V
Phase 1	Black	Brown
Phase 2	Red *	Orange
Phase 3	Blue	Yellow
Neutral	White	White or Gray
Ground	Green	Green

* Orange when it is a high leg of a 120/240 V Delta system.

a. Conductors No. 6 AWG and smaller: Insulated phase, neutral and ground conductors shall be identified by a continuous colored outer finish along its entire length.
b. Conductors larger than No. 6 AWG:
1) Insulated phase and neutral conductors shall be identified by one (1) of the following methods:
a) Continuous colored outer finish along its entire length.
b) 3 IN of colored tape applied at the termination.
2) Insulated grounding conductor shall be identified by one (1) of the following methods:
a) Continuous green outer finish along its entire length.
b) Stripping the insulation from the entire exposed length.
c) Using green tape to cover the entire exposed length.
3) The color coding shall be applied at all accessible locations, including but not limited to: Junction and pull boxes, wire ways, manholes and hand holes.
2. Power cables ICEA S-58-679, Method 4 with:
a. Phase and neutral conductors identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
b. Ground conductor: Bare.
3. Control cables ICEA S-58-679, Method 1, Table E-2:
a. When a bare ground is not provided, one (1) of the colored insulated conductors shall be re-identified by stripping the insulation from the entire exposed length or using green tape to cover the entire exposed length.
b. When used in power applications the colored insulated conductors used as phase and neutral conductors may have to be re-identified with 3 IN of colored tape, per the Table herein, applied at the terminations.
D. Install all wiring in raceway unless otherwise indicated on the Drawings.
E. Feeder, branch, control and instrumentation circuits shall not be combined in a raceway, cable tray, junction or pull box, except as permitted in the following:
1. Where specifically indicated on the Drawings.

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2. Where field conditions dictate and written permission is obtained from the Engineer.
3. Control circuits shall be isolated from feeder and branch power and instrumentation circuits but combining of control circuits is permitted.
a. The combinations shall comply with the following:
1) 12 Vdc, 24 Vdc and 48 Vdc may be combined.
2) 125 Vdc shall be isolated from all other AC and DC circuits.
3) AC control circuits shall be isolated from all DC circuits.
4. Instrumentation circuits shall be isolated from feeder and branch power and control circuits but combining of instrumentation circuits is permitted.
a. The combinations shall comply with the following:
1) Analog signal circuits may be combined.
2) Digital signal circuits may be combined but isolated from analog signal circuits.
5. Multiple branch circuits for lighting, receptacle and other 120 Vac circuits are allowed to be combined into a common raceway.
a. Contractor is responsible for making the required adjustments in conductor and raceway size, in accordance with all requirements of the NFPA 70, including but not limited to:
1) Up sizing conductor size for required ampacity de-ratings for the number of current carrying conductors in the raceway.
2) The neutral conductors may not be shared.
3) Up sizing raceway size for the size and quantity of conductors.
F. Ground the drain wire of shielded instrumentation cables at one (1) end only.
1. The preferred grounding location is at the load (e.g., control panel), not at the source (e.g., field mounted instrument).
G. Splices and terminations for the following circuit types shall be made in the indicated enclosure type using the indicated method.
1. Feeder and branch power circuits:
a. Device outlet boxes:
1) Twist/screw on type connectors.
b. Junction and pull boxes and wire ways:
1) Twist/screw on type connectors for use on No. 8 and smaller wire.
2) Compression, mechanical screw or terminal block or terminal strip type connectors for use on No. 6 AWG and larger wire.
c. Motor terminal boxes:
1) Twist/screw on type connectors for use on No. 10 AWG and smaller wire.
2) Insulated mechanical screw type connectors for use on No. 8 AWG and larger wire.
d. Manholes or hand holes:
1) Twist/screw on type connectors pre-filled with epoxy for use on No. 8 AWG and smaller wire.
2) Watertight compression or mechanical screw type connectors for use on No. 6 AWG and larger wire.
2. Control circuits:

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a. Junction and pull boxes: Terminal block type connector.
b. Manholes or hand holes: Twist/screw on type connectors pre-filled with epoxy.
c. Control panels and motor control centers: Terminal block or strips provided within the equipment or field installed within the equipment by the Contractor.
3. Instrumentation circuits can be spliced where field conditions dictate and written permission is obtained from the Engineer.
a. Maintain electrical continuity of the shield when splicing twisted shielded conductors.
b. Junction and pull boxes: Terminal block type connector.
c. Control panels and motor control centers: Terminal block or strip provided within the equipment or field installed within the equipment by the Contractor.
4. Non-insulated compression and mechanical screw type connectors shall be insulated with tape or hot or cold shrink type insulation to the insulation level of the conductors.
H. Insulating Tape Usage:
1. For insulating connections of No. 8 AWG wire and smaller: 7 mil vinyl tape.
2. For insulating splices and taps of No. 6 AWG wire or larger: 10 mil vinyl tape.
3. For insulating connections made in cold weather or in outdoor locations: 8.5 mil, all weather vinyl tape.
I. Color Coding Tape Usage: For color coding of conductors.
3.2 FIELD QUALITY CONTROL
A. Acceptance Testing:
1. See Specification Section 26 08 13.

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16.8 Grounding and Bonding

A Description

1.1 SUMMARY
A. Section Includes:
1. Material and installation requirements for grounding and bonding system(s).
B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical: Basic Requirements.
4. Section 26 05 19 - Wire and Cable - 600 Volt and Below.

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5. Section 26 05 33 - Raceways and Boxes.
6. Section 26 08 13 - Acceptance Testing.
7. Section 26 23 40 – Traction Power Substation.
C. DC equipment enclosures shall be left ungrounded. Refer to Section 26 23 40.
1.2 QUALITY ASSURANCE
A. Referenced Standards:
1. ASTM International (ASTM):
a. B8, Standard Specification for Concentric-Lay-Stranded Copper Conductors, Hard, Medium-Hard, or Soft.
2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):
a. 837, Standard for Qualifying Permanent Connections Used in Substation Grounding.
3. National Fire Protection Association (NFPA):
a. 70, National Electrical Code (NEC).
4. Underwriters Laboratories, Inc. (UL):
a. 467, Grounding and Bonding Equipment.
B. Assure ground continuity is continuous throughout the entire Project.
1.3 SUBMITTALS
A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data.
a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
1) Conduit
b. See Specification Section 26 05 00 for additional requirements.

B Materials

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Ground rods and bars and grounding clamps, connectors and terminals:
a. Erico Products, Inc.
b. Harger Lightning & Grounding.
c. Heary Brothers.
d. Hubbell - Burndy.
e. Robbins Lightning Protection.
f. Thomas & Betts - Blackburn.
g. Thompson Lightning Protection.
2. Exothermic weld connections:
a. Erico Products Inc., Cadweld.
b. Harger Lightning & Grounding - Ultraweld.
c. Hubbell - Burndy (Thermoweld).
d. Thomas & Betts - Furseweld.
2.2 COMPONENTS

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A. Wire and Cable:
1. Bare conductors: Soft drawn stranded copper meeting ASTM B8.
2. Insulated conductors: Color coded green, per Specification Section 26 05 19.
B. Conduit: As specified in Specification Section 26 05 33.
C. Ground Bars:
1. Solid copper:
a. 1/4 IN thick.
b. 2 or 4 IN wide.
c. 24 IN long minimum in main service entrance electrical rooms, 12 IN long elsewhere.
2. Predrilled grounding lug mounting holes.
3. Stainless steel or galvanized steel mounting brackets.
4. Insulated standoffs.
D. Ground Rods:
1. As indicated on the Drawings.
2. Copper-clad:
a. 10 mil minimum uniform coating of electrolytic copper molecularly bonded to a rigid steel core.
b. Corrosion resistant bond between the copper and steel.
c. Hard drawn for a scar-resistant surface.
E. Grounding Clamps, Connectors and Terminals:
1. Mechanical type:
a. Standards: UL 467.
b. High copper alloy content.
2. Compression type for interior locations:
a. Standards: UL 467.
b. High copper alloy content.
c. Non-reversible.
d. Terminals for connection to bus bars shall have two bolt holes.
3. Compression type suitable for direct burial in earth or concrete:
a. Standards: UL 467, IEEE 837.
b. High copper alloy content.
c. Non-reversible.
d. Factory filled with oxide inhibiting compound.
F. Exothermic Weld Connections:
1. Copper oxide reduction by aluminum process.
2. Molds properly sized for each application.

C Construction

3.1 INSTALLATION
A. General:
1. Install products in accordance with manufacturer's instructions.
2. Size grounding conductors and bonding jumpers in accordance with NFPA 70, Article 250, except where larger sizes are indicated on the Drawings.

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3. Remove paint, rust, or other non-conducting material from contact surfaces before making ground connections.
4. Where ground conductors pass through floor slabs or building walls provide nonmetallic sleeves.
5. Do not splice grounding conductors except at ground rods.
6. Install ground rods and grounding conductors in undisturbed, firm soil.
a. Provide excavation required for installation of ground rods and ground conductors.
b. Use driving studs or other suitable means to prevent damage to threaded ends of sectional rods.
c. Unless otherwise specified, connect conductors to ground rods with compressor type connectors or exothermic weld as indicated on the Drawings.
d. Provide sufficient slack in grounding conductor to prevent conductor breakage during backfill or due to ground movement.
e. Backfill excavation completely, thoroughly tamping to provide good contact between backfill materials and ground rods and conductors.
7. Do not use exothermic welding if it will damage the structure the grounding conductor is being welded to.
B. Grounding Electrode System:
1. Provide a grounding electrode system in accordance with NFPA 70, Article 250 and as indicated on the Drawings.
2. Grounding conductor terminations:
a. Ground bars mounted on wall, use compression type terminal and bolt it to the ground bar with two bolts.
b. Ground bars in electrical equipment, use compression type terminal and bolt it to the ground bar.
c. Piping systems use mechanical type connections.
d. Building steel, below grade and encased in concrete, use compression type connector or exothermic weld.
3. Ground ring grounding system:
a. Ground ring consists of ground rods and a grounding conductor looped around the structure.
b. Placed at 2 FT-6 IN below grade as indicated on the Drawings.
c. Provide a minimum of four (4) ground rods placed at the corners of the structure and additional rods as indicated on the Drawings, so that the maximum distance between ground rods does not exceed 50 FT.
d. Building/Structure grounding:
1) Bond building/structure metal support columns to the ground ring at all corners of the structure.
e. Grounding conductor: Bare conductor, size as indicated on the Drawings but not less than 4/0 AWG copper.
C. Supplemental Grounding Electrode:
1. Provide the following grounding in addition to the equipment ground conductor supplied with the feeder conductors whether or not shown on the Drawings.
2. Metal light poles:

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a. Connect metal pole to a ground rod.
b. Grounding conductor: Bare #6 AWG minimum.
3. Equipment support rack and pedestals mounted outdoors:
a. Connect metallic structure to a ground rod.
b. Grounding conductor: #6 AWG minimum.
D. Low Voltage Transformer Separately Derived Grounding System:
1. Ground separately mounted step-down transformers XO terminal to one of the following:
a. Closest building steel using mechanical type terminal bolted to the steel, compression type connection or exothermic weld.
b. Closest water pipe using a mechanical type connection.
2. Ground step-down transformer integrally mounted in motor control center to motor control center ground bus.
E. Raceway Bonding/Grounding:
1. All metallic conduit shall be installed so that it is electrically continuous.
2. All conduits to contain a grounding conductor with insulation identical to the phase conductors, unless otherwise indicated on the Drawings.
3. NFPA 70 required grounding bushings shall be of the insulating type.
4. Provide double locknuts at all panels.
5. Bond all conduit, at entrance and exit of equipment, to the equipment ground bus or lug.
6. Provide bonding jumpers if conduits are installed in concentric knockouts.
7. Make all metallic raceway fittings and grounding clamps tight to ensure equipment grounding system will operate continuously at ground potential to provide low impedance current path for proper operation of overcurrent devices during possible ground fault conditions.
F. Equipment Grounding:
1. All utilization equipment shall be grounded with an equipment ground conductor.
G. Manhole and Handhole Grounding:
1. Provide a ground rod and ground bar, when indicated or as needed, in each manhole and handhole with exposed metal parts.
a. Expose a minimum of 4 IN of the rod above the floor for field connections to the rod.
2. Connect all exposed metal parts (e.g., conduits and cable racks) to the ground rod.
3. Provide a ground rod in each electric traction (ET) power manhole with the following feature. Enclose the top 4 IN of the rod in a non-metallic test box with a non-metallic cover that fits flush with the floor of the manhole. No exposed metal of any kind within the ET manhole is to be connected to the ground rod which is furnished for corrosion and stray current testing purposes only.
3.2 FIELD QUALITY CONTROL
A. Leave grounding system uncovered until observed by Owner.
B. Acceptance testing:
1. See Specification Section 26 08 13.

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16.9 Raceways and Boxes

A Description

1.1 SUMMARY
A. Section Includes:
1. Material and installation requirements for:
a. Conduits.
b. Conduit fittings.
c. Conduit supports.
d. Wire ways.
e. Outlet boxes.
f. Pull and junction boxes.
B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical: Basic Requirements.
4. Section 26 05 43 - Electrical: Exterior Underground.
1.2 QUALITY ASSURANCE
A. Referenced Standards:
1. American Iron and Steel Institute (AISI).
2. ASTM International (ASTM):
a. A123/A123M, Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
b. A153/A153M, Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
c. D2564, Standard Specification for Solvent Cements for Poly (Vinyl Chloride) (PVC) Plastic Piping Systems.
3. National Electrical Manufacturers Association (NEMA):
a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
b. RN 1, Polyvinyl Chloride (PVC) Externally Coated Galvanized Rigid Steel Conduit and Intermediate Metal Conduit (IMC).
c. TC 2, Electrical Polyvinyl Chloride (PVC) Tubing and Conduit.
d. TC 3, Polyvinyl Chloride (PVC) Fittings for Use with Rigid PVC Conduit and Tubing.
4. National Electrical Manufacturers Association/American National Standards Institute (NEMA/ANSI):
a. C80.1, Electric Rigid Steel Conduit (ERSC).
b. C80.3, Steel Electrical Metallic Tubing (EMT).
c. OS 1, Sheet-Steel Outlet Boxes, Device Boxes, Covers, and Box Supports.
5. National Fire Protection Association (NFPA):

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a. 70, National Electrical Code (NEC).
6. Underwriters Laboratories, Inc. (UL):
a. 1, Standard for Flexible Metal Conduit.
b. 6, Standard for Electrical Rigid Metal Conduit - Steel.
c. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
d. 360, Standard for Liquid-Tight Flexible Steel Conduit.
e. 467, Grounding and Bonding Equipment.
f. 514A, Metallic Outlet Boxes.
g. 514B, Conduit, Tubing, and Cable Fittings.
h. 651, Standard for Schedule 40 and 80 Rigid PVC Conduit and Fittings.
i. 797, Electrical Metallic Tubing - Steel.
j. 870, Standard for Wire ways, Auxiliary Gutters, and Associated Fittings.
k. 886, Standard for Outlet Boxes and Fittings for Use in Hazardous (Classified) Locations.
1.3 SUBMITTALS
A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
a. Provide submittal data for all products specified in PART 2 of this Specification Section except:
1) Conduit fittings.
2) Support systems.
b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
a. Identify dimensional size of pull and junction boxes to be used.
1.4 DELIVERY, STORAGE, AND HANDLING
A. See Specification Section 26 05 00.

B Materials

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Rigid metallic conduits:
a. Allied Tube and Conduit Corporation.
b. Triangle PWC Inc.
c. Western Tube and Conduit Corporation.
d. Wheatland Tube Company.
e. LTV Steel Company.
2. PVC coated rigid metallic conduits:
a. Thomas & Betts Ocal.
b. Rob-Roy Ind.
3. Rigid nonmetallic conduit:
a. Prime Conduit (Carlon).
b. Cantex.

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c. Osburn Associates.
4. Flexible conduit:
a. AFC Cable Systems.
b. Anamet, Inc.
c. Electri-Flex.
d. Flexible Metal Hose Company.
e. International Metal Hose Company.
f. Triangle PWC Inc.
g. LTV Steel Company.
5. Wire way:
a. Hoffman Engineering Company.
b. Wiegmann.
c. Square D.
6. Conduit fittings and accessories:
a. Appleton Electric Co.
b. Carlon.
c. Cantex.
d. Crouse-Hinds.
e. Killark.
f. Osburn Associates.
g. OZ Gedney Company.
h. RACO.
i. Steel City.
j. Thomas & Betts.
7. Support systems:
a. Unistrut Building Systems.
b. Eaton B-Line.
c. Kindorf.
d. Minerallac Fastening Systems.
e. Caddy.
f. Thomas & Betts Superstrut.
8. Outlet, pull and junction boxes:
a. Appleton Electric Co.
b. Eaton Crouse-Hinds.
c. Killark.
d. O-Z/Gedney.
e. Thomas & Betts Steel City.
f. Raco.
g. Bell.
h. Hoffman Engineering Co.
i. Wiegmann.
j. Eaton B-Line.
k. Adalet.
l. Rittal.
m. Stahlin.

2.2 RIGID METALLIC CONDUITS

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A. Rigid Galvanized Steel Conduit (RGS):
1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Threads galvanized after cutting.
4. Internal coating: Baked lacquer, varnish or enamel for a smooth surface.
5. Standards: NEMA/ANSI C80.1, UL 6.
B. PVC-Coated Rigid Steel Conduit (PVC-RGS):
1. Nominal 40 mil Polyvinyl Chloride Exterior Coating:
a. Coating: Bonded to hot-dipped galvanized rigid steel conduit conforming to NEMA/ANSI C80.1.
b. The bond between the PVC coating and the conduit surface: Greater than the tensile strength of the coating.
2. Nominal 2 mil, minimum, urethane interior coating.
3. Urethane coating on threads.
4. Conduit: Epoxy prime coated prior to application of PVC and urethane coatings.
5. Female Ends:
a. Have a plastic sleeve extending a minimum of 1 pipe diameter or 2 IN, whichever is less beyond the opening.
b. The inside diameter of the sleeve shall be the same as the outside diameter of the conduit to be used with it.
6. Standards: NEMA/ANSI C80.1, UL 6, NEMA RN 1.
C. Electrical Metallic Tubing (EMT):
1. Mild steel with continuous welded seam.
2. Metallic zinc applied by hot-dip galvanizing or electro-galvanizing.
3. Internal coating: Baked lacquer, varnish, or enamel for a smooth surface.
4. Standards: NEMA/ANSI C80.3, UL 797.
2.3 RIGID NONMETALLIC CONDUIT
A. Schedules 40 (PVC-40) and 80 (PVC-80):
1. Polyvinyl-chloride (PVC) plastic compound which includes inert modifiers to improve weatherability and heat distribution.
2. Rated for direct sunlight exposure.
3. Fire retardant and low smoke emission.
4. Shall be suitable for use with 90 DegC wire and shall be marked "maximum 90 DegC".
5. Standards: NEMA TC 2, UL 651.
B. Reinforced Thermosetting Resin Conduit (RTRC):
1. Standards: NFPA 130 and 502 for low smoke density and without releasae of toxic gasses.
2. Standard: ASTM E136 for flame resistance.
3. Not field bendable, utilize with factory made fitttings only.
2.4 FLEXIBLE CONDUIT
A. Flexible Galvanized Steel Conduit (FLEX):
1. Formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Standard: UL 1.

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B. PVC-Coated Flexible Galvanized Steel (liquid-tight) Conduit (FLEX-LT):
1. Core formed of continuous, spiral wound, hot-dip galvanized steel strip with successive convolutions securely interlocked.
2. Extruded PVC outer jacket positively locked to the steel core.
3. Liquid and vapor tight.
4. Standard: UL 360.
2.5 WIREWAY
A. General:
1. Suitable for lay-in conductors.
2. Designed for continuous grounding.
3. Covers:
a. Hinged or removable in accessible areas.
b. Non-removable when passing through partitions.
4. Finish: Rust inhibiting primer and manufacturers standard paint inside and out except for stainless steel type.
5. Standards: UL 870, NEMA 250.
B. General Purpose (NEMA 1 rated) Wire way:
1. 14 or 16 gage steel without knockouts.
2. Cover: Solid, non-gasketed and held in place by captive screws.
C. Raintight (NEMA 3R) Wiring Trough:
1. 14 or 16 GA galvanized steel without knockouts.
2. Cover: Non-gasketed and held in place by captive screws.
D. Watertight (NEMA 4X rated) Wire way:
1. 14 GA Type 304 or 316 stainless steel bodies and covers without knockouts and 10 GA stainless steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.
E. Dust tight (NEMA 12 rated) Wire way:
1. 14 GA steel bodies and covers without knockouts and 10 GA steel flanges.
2. Cover: Fully gasketed and held in place with captive clamp type latches.
3. Flanges: Fully gasketed and bolted.
2.6 CONDUIT FITTINGS AND ACCESSORIES
A. Fittings for Use with RGS {and IMC} {and RAC}:
1. General:
a. In hazardous locations listed for use in Class I, Groups C and D locations.
2. Locknuts:
a. Threaded steel or malleable iron.
b. Gasketed or non-gasketed.
c. Grounding or non-grounding type.
3. Bushings:
a. Threaded, insulated metallic.
b. Grounding or non-grounding type.
4. Hubs: Threaded, insulated and gasketed metallic for raintight connection.
5. Couplings:
a. Threaded straight type: Same material and finish as the conduit with which they are used on.

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b. Threadless type: Gland compression or self-threading type, concrete tight.
6. Unions: Threaded galvanized steel or zinc plated malleable iron.
7. Conduit bodies (ells and tees):
a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
b. Standard and mogul size.
c. Cover:
1) Clip-on type with stainless steel screws.
2) Gasketed or non-gasketed galvanized steel, zinc plated cast iron or cast copper free aluminum.
8. Conduit bodies (round):
a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
b. Cover: Threaded screw on type, gasketed, galvanized steel, zinc plated cast iron or cast copper free aluminum.
9. Sealing fittings:
a. Body: Zinc plated cast iron or cast copper free aluminum with threaded hubs.
b. Standard and mogul size.
c. With or without drain and breather.
d. Fiber and sealing compound: UL listed for use with the sealing fitting.
10. Hazardous location flexible coupling (HAZ-FLEX):
a. Liquid tight and arc resistant.
b. Electrically conductive so no bonding jumper is required.
c. Dry and wet areas:
1) Bronze braided covering over flexible brass core.
2) Bronze end fittings.
3) Zinc-plated steel or malleable iron unions and nipples.
d. Corrosive areas:
1) Stainless steel braided covering over flexible stainless steel core.
2) Stainless steel end fittings.
3) Aluminum unions and nipples.
11. Service entrance head:
a. Malleable iron, galvanized steel or copper free aluminum.
b. Insulated knockout cover for use with a variety of sizes and number of conductors.
12. Expansion couplings:
a. 2 IN nominal straight-line conduit movement in either direction.
b. Galvanized steel with insulated bushing.
c. Gasketed for wet locations.
d. Internally or externally grounded.
13. Expansion/deflection couplings:
a. 3/4 IN nominal straight-line conduit movement in either direction.
b. 30-degree nominal deflection from the normal in all directions.
c. Metallic hubs, neoprene outer jacket and stainless steel jacket clamps.
d. Internally or externally grounded.

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e. Watertight, raintight and concrete tight.
14. Standards: UL 467, UL 514B, UL 886.
B. Fittings for Use with PVC-RGS:
1. The same material and construction as those fittings listed under paragraph "Fittings for Use with RGS " and coated as defined under paragraph "PVC Coated Rigid Steel Conduit (PVC-RGS)."
C. Fittings for Use with EMT:
1. Connectors:
a. Straight, angle and offset types furnished with locknuts.
b. Zinc plated steel.
c. Insulated gland compression type.
d. Concrete and raintight.
2. Couplings:
a. Zinc plated steel.
b. Gland compression type.
c. Concrete and raintight.
3. Conduit bodies (ells and tees):
a. Body: Copper free aluminum with threaded hubs.
b. Standard and mogul size.
c. Cover:
1) Screw down type with steel screws.
2) Gasketed or non-gasketed galvanized steel or copper free aluminum.
4. Standard: UL 514B.
D. Fittings for Use with FLEX:
1. Connector:
a. Zinc plated malleable iron.
b. Squeeze or clamp-type.
2. Standard: UL 514B.
E. Fittings for Use with FLEX-LT:
1. Connector:
a. Straight or angle type.
b. Metal construction, insulated and gasketed.
c. Composed of locknut, grounding ferrule and gland compression nut.
d. Liquid tight.
2. Standards: UL 467, UL 514B.
F. Fittings for Use with Rigid Nonmetallic PVC Conduit:
1. Coupling, adapters and conduit bodies:
a. Same material, thickness, and construction as the conduits with which they are used.
b. Homogeneous plastic free from visible cracks, holes or foreign inclusions.
c. Bore smooth and free of blisters, nicks or other imperfections which could damage the conductor.
2. Solvent cement for welding fittings shall be supplied by the same manufacturer as the conduit and fittings.
3. Standards: ASTM D2564, NEMA TC 3, UL 651, UL 514B.
G. Weather and Corrosion Protection Tape:

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1. PVC based tape, 10 mils thick.
2. Protection against moisture, acids, alkalis, salts and sewage and suitable for direct bury.
3. Used with appropriate pipe primer.

2.7 ALL RACEWAY AND FITTINGS

A. Mark Products:
1. Identify the nominal trade size on the product.
2. Stamp with the name or trademark of the manufacturer.

2.8 OUTLET BOXES

A. Metallic Outlet Boxes:
1. Hot-dip galvanized steel.
2. Conduit knockouts and grounding pigtail.
3. Styles:
a. 2 IN x 3 IN rectangle.
b. 4 IN square.
c. 4 IN octagon.
d. Masonry/tile.
4. Accessories:
a. Flat blank cover plates.
b. Barriers.
c. Extension, plaster or tile rings.
d. Box supporting brackets in stud walls.
e. Adjustable bar hangers.
5. Standards: NEMA/ANSI OS 1, UL 514A.

B. Cast Outlet Boxes:
1. Zinc plated cast iron or die-cast copper free aluminum with manufacturer's standard finish.
2. Threaded hubs and grounding screw.
3. Styles:
a. "FS" or "FD".
b. "Bell".
c. Single or multiple gang and tandem.
d. "EDS" or "EFS" for hazardous locations.
4. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
5. Standards: UL 514A, UL 886.

2.9 PULL AND JUNCTION BOXES

A. NEMA 1 Rated:
1. Body and cover: 14 GA minimum, galvanized steel or 14 GA minimum, steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
2. With or without concentric knockouts on four (4) sides.
3. Flat cover fastened with screws.

B. NEMA 4 Rated:
1. Body and cover: 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.

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2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged or non-hinged cover held closed with stainless steel screws and clamps.
6. Cover with oil resistant gasket.
C. NEMA 4X Rated (metallic):
1. Body and cover: 14 GA Type 304 or 316 stainless steel.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Hinged door and stainless steel screws and clamps.
6. Door with oil-resistant gasket.
D. NEMA 4X Rated (Nonmetallic):
1. Body and cover: Ultraviolet light protected fiberglass-reinforced polyester boxes.
2. No knockouts.
3. External mounting flanges.
4. Hinged door with quick release latches and padlocking hasp.
5. Door with oil resistant gasket.
E. NEMA 7 and NEMA 9 Rated:
1. Cast gray iron alloy or copper-free aluminum with manufacturer's standard finish.
2. Drilled and tapped openings or tapered threaded hub.
3. Cover bolted-down with stainless steel bolts or threaded cover with neoprene gasket.
4. External mounting flanges.
5. Grounding lug.
6. Accessories: 40 mil PVC exterior coating and 2 mil urethane interior coating.
F. NEMA 12 Rated:
1. Body and cover:
a. 14 GA steel finished with rust inhibiting primer and manufacturers standard paint inside and out.
b. Type 5052 H-32 aluminum, unpainted.
2. Seams continuously welded and ground smooth.
3. No knockouts.
4. External mounting flanges.
5. Non-hinged cover held closed with captivated cover screws threaded into sealed wells or hinged cover held closed with stainless steel screws and clamps.
6. Flat door with oil resistant gasket.
G. Miscellaneous Accessories:
1. Rigid handles for covers larger than 9 SF or heavier than 25 LBS.
2. Split covers when heavier than 25 LBS.
3. Weldnuts for mounting optional panels and terminal kits.

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4. Terminal blocks: Screw-post barrier-type, rated 600 volt and 20 ampere minimum.

H. Standards: NEMA 250, UL 50.

2.10 SUPPORT SYSTEMS

A. Multi-conduit Surface or Trapeze Type Support and Pull or Junction Box Supports:

1. Material requirements.

a. Galvanized steel: ASTM A123/A123M or ASTM A153/A153M.

b. Stainless steel: AISI Type 316.

c. PVC coat galvanized steel: ASTM A123/A123M or ASTM A153/A153M and 20 mil PVC coating.

B. Single Conduit and Outlet Box Support Fasteners:

1. Material requirements:

a. Zinc plated steel.

b. Stainless steel.

c. Malleable iron.

d. PVC coat malleable iron or steel: 20 mil PVC coating.

e. Steel protected with zinc phosphate and oil finish.

2.11 OPENINGS AND PENETRATIONS IN WALLS AND FLOORS

A. Sleeves, smoke and fire stop fitting through walls and floors:

C Construction

3.1 RACEWAY INSTALLATION - GENERAL

A. Shall be in accordance with the requirements of:

1. NFPA 70.

2. Manufacturer instructions.

B. Size of Raceways:

1. Raceway sizes are shown on the Drawings, if not shown on the Drawings, then size in accordance with NFPA 70.

2. Unless specifically indicated otherwise, the minimum raceway size shall be:

a. Conduit: 3/4 IN.

b. Wire way: 2-1/2 IN x 2-1/2 IN.

C. Field Bending and Cutting of Conduits:

1. Utilize tools and equipment recommended by the manufacturer of the conduit, designed for the purpose and the conduit material to make all field bends and cuts.

2. Do not reduce the internal diameter of the conduit when making conduit bends.

3. Prepare tools and equipment to prevent damage to the PVC coating.

4. Degrease threads after threading and apply a zinc rich paint.

5. Debur interior and exterior after cutting.

D. Male threads of conduit systems shall be coated with an electrically conductive anti-seize compound.

E. The protective coating integrity of conduits, fittings, outlet, pull and junction boxes and accessories shall be maintained.

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1. Repair galvanized components utilizing a zinc rich paint.
2. Repair painted components utilizing touch up paint provided by or approved by the manufacturer.
3. Repair PVC coated components utilizing a patching compound, of the same material as the coating, provided by the manufacturer of the conduit; or a self-adhesive, highly conformable, cross-linked silicone composition strip, followed by a protective coating of vinyl tape.
a. Total nominal thickness: 40 mil.
4. Repair surfaces which will be inaccessible after installation prior to installation.
F. Remove moisture and debris from conduit before wire is pulled into place.
1. Pull mandrel with diameter nominally 1/4 IN smaller than the interior of the conduit, to remove obstructions.
2. Swab conduit by pulling a clean, tight-fitting rag through the conduit.
3. Tightly plug ends of conduit with tapered wood plugs or plastic inserts until wire is pulled.
G. Only nylon or polyethylene rope shall be used to pull wire and cable in conduit systems.
H. Where portions of a raceway are subject to different temperatures and where condensation is known to be a problem, as in cold storage areas of buildings or where passing from the interior to the exterior of a building, the raceway shall be sealed to prevent circulation of warm air to colder section of the raceway.
I. Fill openings in walls, floors, and ceilings and finish flush with surface.
3.2 RACEWAY ROUTING
A. Raceways shall be routed in the field unless otherwise indicated.
1. Conduit and fittings shall be installed, as required, for a complete system that has a neat appearance and is in compliance with all applicable codes.
2. Run in straight lines parallel to or at right angles to building lines.
3. Do not route conduits:
a. Through areas of high ambient temperature or radiant heat.
b. In suspended concrete slabs.
4. Conduit shall not interfere with, or prevent access to, piping, valves, ductwork, or other equipment for operation, maintenance and repair.
5. Provide pull boxes or conduit bodies as needed so that there is a maximum of 360 degrees of bends in the conduit run or in long straight runs to limit pulling tensions.
B. All rigid conduits within a structure shall be installed exposed except as follows:
1. As indicated on the Drawings.
2. Concealed above gypsum wall board or acoustical tile suspended ceilings.
3. Concealed within stud frame, poured concrete, concrete block and brick walls of an architecturally finished area.
4. Embedded in floor slabs or buried under floor serving equipment in non-architecturally finished areas that are not located on or near a wall or column and the ceiling height is greater than 12 FT.

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5. Embedded in floor slabs or buried under floor slabs where shown on the Contract Drawings or with the Engineer's permission.

C. Maintain minimum spacing between parallel conduit and piping runs in accordance with the following when the runs are greater than 30 FT:

1. Between instrumentation and telecommunication: 1 IN.
2. Between instrumentation and 125 V, 48 V and 24 Vdc, 2 IN.
3. Between instrumentation and 600 V and less AC power or control: 6 IN.
4. Between instrumentation and greater than 600 Vac power: 12 IN.
5. Between telecommunication and 125 V, 48 V and 24 Vdc, 2 IN.
6. Between telecommunication and 600 V and less AC power or control: 6 IN.
7. Between telecommunication and greater than 600 Vac power: 12 IN.
8. Between 125 V, 48 V and 24 Vdc and 600 V and less AC power or control: 2 IN.
9. Between 125 V, 48 V and 24 Vdc and greater than 600 Vac power: 2 IN.
10. Between 600 V and less AC and greater than 600 Vac: 2 IN.
11. Between process, gas, air and water pipes: 6 IN.

D. Conduits shall be installed to eliminate moisture pockets.

1. Where water cannot drain to openings, provide drain fittings in the low spots of the conduit run.

E. Conduit shall not be routed on the exterior of structures except as specifically indicated on the Drawings.

F. Where sufficient room exists within the housing of roof-mounted equipment, the conduit shall be stubbed up inside the housing.

G. Provide all required openings in walls, floors, and ceilings for conduit penetration.

3.3 RACEWAY APPLICATIONS

A. Permitted Raceway Types Per Wire or Cable Types:

1. AC and LV DC Power wire or cables: All raceway types.
2. DC Traction Power cables: RTRC only for exposed; PVC encased in concrete or RTRC encased in concrete for DC duct banks.
3. Control wire or cables: All raceway types.
4. Instrumentation cables: Metallic raceway except nonmetallic may be used underground.
5. Motor leads from a VFD: RGS, RAC or shielded VFD cables in all other raceways.
6. Telecommunication cables: All raceway types.

B. Permitted Raceway Types Per Area Designations:

1. Dry areas:
a. RGS.
b. RAC.
2. Wet areas:
a. RGS.
b. RAC.
3. Corrosive areas:
a. PVC-RGS.

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b. RAC.
c. Fiberglass. (RTRC)
4. Highly corrosive areas:
a. PVC-RGS.
b. PVC-80.
c. Fiberglass. (RTRC)
5. NFPA 70 hazardous areas:
a. RGS.
b. RAC when required by other area designations.
C. Permitted Raceway Types Per Routing Locations:
1. In stud framed walls:
a. EMT.
2. In concrete block or brick walls:
a. PVC-40.
3. Above acoustical tile ceilings:
a. EMT.
b. NEMA 1 rated wire way.
4. Embedded in poured concrete walls and floors:
a. PVC-40.
b. Fiberglass.
c. Fiberglass when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
d. PVC-RGS when emerging from concrete into areas designated as wet, corrosive or highly corrosive.
5. Beneath floor slab-on-grade:
a. PVC-40.
b. Fiberglass.
6. Direct buried conduits and duct banks:
a. PVC-80.
b. Fiberglass.
c. 90 degree elbows for transitions to above grade:
1) PVC-RGS.
2) Fiberglass.
d. Long sweeping bends greater than 15 degrees:
1) PVC-RGS.
2) Fiberglass.
7. Concrete encased duct banks:
a. PVC-40.
b. Fiberglass. (RTRC)
c. 90 degree elbows for transitions to above grade:
1) PVC-RGS.
2) Fiberglass.(RTRC)
d. Long sweeping bends greater than 15 degrees:
1) RGS for sizes 2 IN and larger.
2) Fiberglass. (RTRC)

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D. FLEX conduits shall be installed for connections to light fixtures, HVAC equipment and other similar devices above the ceilings.
1. The maximum length shall not exceed:
a. 6 FT to light fixtures.
b. 3 FT to all other equipment.
E. FLEX-LT conduits shall be install as the final conduit connection to light fixtures, dry type transformers, motors, electrically operated valves, instrumentation primary elements, and other electrical equipment that is liable to vibrate.
1. The maximum length shall not exceed:
a. 6 FT to light fixtures.
b. 3 FT to motors.
c. 2 FT to all other equipment.
F. HAZ-FLEX coupling shall be installed as the final conduit to motors, electrically operated valves, instrumentation primary elements and electrical equipment that is liable to vibrate.
1. The maximum length shall not exceed:
a. 3 FT to motors.
b. 2 FT to all other equipment.
G. NEMA 1 Rated Wire way:
1. Surface mounted in electrical rooms.
2. Surface mounted above removable ceilings tiles of an architecturally finished area.
H. NEMA 3R Wiring Trough:
1. Surface mounted in exterior locations.
I. NEMA 4X Rated Wire way:
1. Surface mounted in areas designated as wet and or corrosive.
J. NEMA 12 Rated Wire way:
1. Surface mounted in areas designated as dry in architecturally and non-architecturally finished areas.
K. Underground Conduit: See Specification Section 26 05 43.
3.4 CONDUIT FITTINGS AND ACCESSORIES
A. Conduit Seals:
1. Installed in conduit systems located in hazardous areas as required by the NFPA 70.
2. Filler plug and drain shall be accessible.
3. Pour the conduit seals in a two-step process.
a. Pour the seal and leave cover off.
b. After seal is dry, inspect for proper sealng, install cover and mark (for example, paint or permanent marker) as complete.
B. Rigid nonmetallic conduit and fittings shall be joined utilizing solvent cement.
1. Immediately after installation of conduit and fitting, the fitting or conduit shall be rotated 1/4 turn to provide uniform contact.
C. Install Expansion Fittings:

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1. Where conduits are exposed to the sun and conduit run is greater than 200 FT.
2. Elsewhere as identified on the Drawings.
D. Install Expansion/Deflection Fittings:
1. Where conduits enter a structure.
a. Except electrical manholes and hand holes.
b. Except where the duct bank is tied to the structure with rebar.
2. Where conduits span structural expansions joints.
3. Elsewhere as identified on the Drawings.
E. Threaded connections shall be made wrench-tight.
F. Conduit joints shall be watertight:
1. Where subjected to possible submersion.
2. In areas classified as wet.
3. Underground.
G. Terminate Conduits:
1. In metallic outlet boxes:
a. RGS {and IMC and RAC}:
1) Conduit hub and locknut.
2) Insulated bushing and two (2) locknuts.
3) Use grounding type locknut or bushing when required by NFPA 70.
b. EMT: Compression type connector and locknut.
2. In NEMA 1 rated enclosures:
a. RGS }:
1) Conduit hub and locknut.
2) Insulated bushing and two (2) locknuts.
3) Use grounding type locknut or bushing when required by NFPA 70.
b. EMT: Compression type connector and locknut.
3. In NEMA 12 rated enclosures:
a. Watertight, insulated and gasketed hub and locknut.
b. Use grounding type locknut or bushing when required by NFPA 70.
4. In NEMA 4 and NEMA 4X rated enclosures:
a. Watertight, insulated and gasketed hub and locknut.
5. In NEMA 7 and NEMA 9 rated enclosures:
a. Into an integral threaded hub.
6. When stubbed up through the floor into floor mount equipment:
a. With an insulated grounding bushing on metallic conduits.
b. With end bells on nonmetallic conduits.
H. Threadless couplings shall only be used to join new conduit to existing conduit when the existing conduit end is not threaded and it is not practical or possible to cut threads on the existing conduit with a pipe threader.
3.5 CONDUIT SUPPORT
A. Permitted multi-conduit surface or trapeze type support system per area designations and conduit types:
1. Dry or wet and/or hazardous areas:
a. Galvanized system consisting of: Galvanized steel channels and fittings, nuts and hardware and conduit clamps.

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b. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.

2. Corrosive areas:

a. Aluminum system consisting of: Aluminum channels, fittings and conduit clamps with stainless steel nuts and hardware.

b. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.

3. Highly corrosive areas:

a. PVC coated steel system consisting of: PVC coated galvanized steel channels and fittings and conduit clamps with stainless steel nuts and hardware.

b. Fiberglass system consisting of: Fiberglass channels and fittings, nuts and hardware and conduit clamps.

4. Conduit type shall be compatible with the support system material.

a. Galvanized steel system may be used with RGS .

b. Stainless steel system may be used with RGS and PVC-RGS.

c. PVC coated galvanized steel system may be used with PVC-RGS.

d. Aluminum system may be used with RAC .

e. Fiberglass system may be used with PVC-40 and PVC-80 .

B. Permitted single conduit support fasteners per area designations and conduit types:

1. Architecturally finished areas:

a. Material: Zinc plated steel, or steel protected with zinc phosphate and oil finish.

b. Types of fasteners: Spring type hangers and clips, straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

c. Provide anti-rattle conduit supports when conduits are routed through metal studs.

2. Dry or wet and/or hazardous areas:

a. Material: Zinc plated steel, stainless steel and malleable iron.

b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

3. Corrosive areas:

a. Material: Stainless steel and PVC coat malleable iron or steel.

b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

4. Highly corrosive areas:

a. Material: PVC coat malleable iron or steel.

b. Types of fasteners: Straps, hangers with bolts, clamps with bolts and bolt on beam clamps.

5. Conduit type shall be compatible with the support fastener material.

a. Zinc plated steel, steel protected with zinc phosphate and oil finish and malleable iron fasteners may be used with RGS and EMT.

b. Stainless steel system may be used with RGS .

c. PVC coated fasteners may be used with PVC-RGS and PVC-40and PVC-80.

d. Nonmetallic fasteners may be used with PVC-40, PVC-80 and fiberglass.

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C. Conduit Support General Requirements:
1. Maximum spacing between conduit supports per NFPA 70.
2. Support conduit from the building structure.
3. Do not support conduit from process, gas, air or water piping; or from other conduits.
4. Provide hangers and brackets to limit the maximum uniform load on a single support to 25 LBS or to the maximum uniform load recommended by the manufacturer if the support is rated less than 25 LBS.
a. Do not exceed maximum concentrated load recommended by the manufacturer on any support.
b. Conduit hangers:
1) Continuous threaded rods combined with struts or conduit clamps: Do not use perforated strap hangers and iron bailing wire.
c. Do not use suspended ceiling support systems to support raceways.
d. Hangers in metal roof decks:
1) Utilize fender washers.
2) Not extend above top of ribs.
3) Not interfere with vapor barrier, insulation, or roofing.
5. Conduit support system fasteners:
a. Use sleeve-type expansion anchors as fasteners in masonry wall construction.
b. Do not use concrete nails and powder-driven fasteners.
3.6 OUTLET, PULL AND JUNCTION BOX INSTALLATION
A. General:
1. Install products in accordance with manufacturer's instructions.
2. See Specification Section 26 05 00 and the Drawings for area classifications.
3. Fill unused punched-out, tapped, or threaded hub openings with insert plugs.
4. Size boxes to accommodate quantity of conductors enclosed and quantity of conduits connected to the box.
B. Outlet Boxes:
1. Permitted uses of metallic outlet boxes:
a. Housing of wiring devices:
1) Recessed in all stud framed walls and ceilings.
2) Recessed in poured concrete, concrete block and brick walls of architecturally finished areas and exterior building walls.
b. Pull or junction box:
1) Above gypsum wall board or acoustical tile ceilings.
2) Above 10 FT in an architecturally finished area where there is no ceiling.
2. Permitted uses of cast outlet boxes:
a. Housing of wiring devices surface mounted in non-architecturally finished dry, wet, corrosive, highly corrosive and hazardous areas.
b. Pull and junction box surface mounted in non-architecturally finished dry, wet, corrosive and highly corrosive areas.

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3. Mount device outlet boxes where indicated on the Drawings and at heights as scheduled in Specification Section 26 05 00.
4. Set device outlet boxes plumb and vertical to the floor.
5. Outlet boxes recessed in walls:
a. Install with appropriate stud wall support brackets or adjustable bar hangers so that they are flush with the face of the wall.
b. Locate in ungrouted cell of concrete block with bottom edge of box flush with bottom edge of block and flush with the face of the block.
6. Place barriers between switches in boxes with 277 V switches on opposite phases.
7. Back-to-back are not permitted.
8. When an outlet box is connected to a PVC coated conduit, the box shall also be PVC coated.
C. Pull and Junction Boxes:
1. Install pull or junction boxes in conduit runs where indicated or required to facilitate pulling of wires or making connections.
a. Make covers of boxes accessible.
2. Permitted uses of NEMA 1 enclosure:
a. Pull or junction box surface mounted above removable ceiling tiles of an architecturally finished area.
3. Permitted uses of NEMA 4 enclosure:
a. Pull or junction box surface mounted in areas designated as wet.
4. Permitted uses of NEMA 4X metallic enclosure:
a. Pull or junction box surface mounted in areas designated as wet and/or corrosive.
5. Permitted uses of NEMA 7 enclosure:
a. Pull or junction box surface mounted in areas designated as Class I hazardous.
1) Provide PVC coating in corrosive and highly corrosive areas when PVC coated conduit is used.
6. Permitted uses of NEMA 12 enclosure:
a. Pull or junction box surface mounted in areas designated as dry.

D (Vacant)

E (Vacant)

16.10 Electrical: Exterior Underground

A Description

1.1 SUMMARY
A. Section Includes:
1. Material and installation requirements for:
a. Manholes.
b. Handhole.
c. Underground conduits and ductbanks.

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B. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 26 05 26 - Grounding.
4. Section 26 05 33 - Raceways and Boxes.
1.2 QUALITY ASSURANCE
A. Referenced Standards:
1. American Association of State Highway and Transportation Officials (AASHTO):
a. HB, Standard Specifications for Highway Bridges.
2. ASTM International (ASTM):
a. A536, Standard Specification for Ductile Iron Castings.
3. National Fire Protection Association (NFPA):
a. 70, National Electrical Code (NEC).
4. Society of Cable Telecommunications Engineers (SCTE):
a. 77, Specification for Underground Enclosure Integrity.
1.3 DEFINITIONS
A. Direct-buried conduit(s):
1. Individual (single) underground conduit.
2. Multiple underground conduits, arranged in one or more planes, in a common trench.
B. Concrete encased ductbank: An individual (single) or multiple conduit(s), arranged in one or more planes, encased in a common concrete envelope.
1.4 SUBMITTALS
A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data:
a. Provide submittal data for all products specified in PART 2 of this Specification Section.
3. Fabrication and/or layout drawings:
a. Provide dimensional drawings of each manhole indicating all specified accessories and conduit entry locations.

B Materials

2.1 ACCEPTABLE MANUFACTURERS
A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Prefabricated composite handholes:
a. Quazite Composolite.
b. Armorcast Products Company.
c. Synertech.
2. Precast manholes and handholes:
a. Utility Vault Co.
b. Oldcastle Precast, Inc.

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c. Lister Industries.
3. Manhole and handhole and ductbank accessories:
a. Neenah.
b. Unistrut.
c. Condux International, Inc.
d. Underground Devices, Inc.
2.2 MANHOLES AND HANDHOLES
A. Prefabricated Composite Material Handholes:
1. Handhole body and cover: Fiberglass reinforced polymer concrete conforming to all test provisions of SCTE 77.
2. Minimum load ratings: SCTE 77 Tier 15.
3. Solid bottom.
4. Stackable design as required for specified depth.
5. Cover:
a. Engraved legend of "ELECTRIC" or "COMMUNICATIONS".
b. Non-gasketed bolt down with stainless steel penta head bolts.
c. Lay-in non-bolt down, when cover is over 100 LBS.
d. One or multiple sections so the maximum weight of a section is 125 LBS.
6. Cover lifting hook: 24 IN minimum in length.
B. Precast Manholes and Handholes:
1. Fiberglass reinforced polymer concrete or steel reinforced cement concrete structures:
2. AASHTO live load rating: H-20 for full deliberate vehicle traffic.
3. Mating edges: Tongue and groove type.
4. Solid bottom with an 18 IN DIA, 18 IN deep sump with aluminum grate in the bottom of each manhole.
5. Gasketed removable top slab with lifting eyes and cast in frame for cover.
6. Cover extension rings as required.
7. Cable pulling eyes opposite all conduit entrances.
a. Coordinate exact location with installation contractor.
2.3 CONCRETE MANHOLE AND HANDHOLE ACCESSORIES
A. Cover and Frame:
1. Cast ductile iron: ASTM A536.
2. AASHTO live load rating: H-20.
3. Diameter: 30 IN.
4. Cast the legend "ELECTRICAL" or "COMMUNICATIONS" into manhole and handhole covers.
B. Cable Racks and Hooks:
1. Material: Heavy-duty nonmetallic (glass reinforced nylon).
2. Hook loading capacity: 400 LBS minimum.
3. Rack loading capacity: Four (4) hooks maximum.
4. Hook deflection: 0.25 IN maximum.
5. Hooks: Length, as required, with positive locking device to prevent upward movement.
6. Mounding hardware: Stainless steel.
C. Cable Pulling Irons:

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1. 7/8 IN DIA hot-dipped galvanized steel.
2. 6000 LB minimum pulling load.
D. Ground Rods and Grounding Equipment: See Specification Section 26 05 26.
2.4 UNDERGROUND CONDUIT AND ACCESSORIES
A. Conduit: See Specification Section 26 05 33.
B. Duct Spacers/Supports:
1. High density polyethylene or high impact polystyrene.
2. Interlocking.
3. Provide 2 IN minimum spacing between conduits.
4. Accessories, as required:
a. Hold down bars.
b. Ductbank strapping.

C Construction

3.1 GENERAL
A. Drawings indicate the intended location of manholes and handholes and routing of {precast cable trench,} ductbanks and direct buried conduit.
1. Field conditions may affect actual routing.
B. Manhole and Handhole Locations:
1. Approximately where shown on the Drawings.
2. As required for pulling distances.
3. As required to keep pulling tensions under allowable cable tensions.
4. As required for number of bends in ductbank routing.
5. Shall not be installed in a swale or ditch.
6. Determine the exact locations after careful consideration has been given to the location of other utilities, grading, and paving.
7. Locations are to be approved by the Engineer prior to excavation and placement or construction of manholes and handholes.
C. Install products in accordance with manufacturer's instructions.
D. Install manholes and handholes in conduit runs where indicated or as required to facilitate pulling of wires or making connections.
3.2 MANHOLES AND HANDHOLES
A. Prefabricated Composite Material Handholes:
1. For use in areas subjected to occasional non-deliberate vehicular traffic.
2. Place handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than handholes footprint on all sides.
3. Provide concrete encasement ring around handhole per manufacturers installation instructions (minimum of 10 IN wide x 12 IN deep).
4. Install so that the surrounding grade is 1 IN lower than the top of the handhole.
5. Size: As indicated on the Drawings or as required for the number and size of conduits.
6. Provide cable rails and pulling eyes as needed.
B. Precast Manholes and Handholes:

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1. For use in vehicular and non-vehicular traffic areas.
2. Construction:
a. Grout or seal all joints, per manufacturer's instructions.
b. Support cables on walls by cable racks:
1) Provide a minimum of two (2) racks, install symmetrically on each wall of manholes and handholes.
a) Provide additional cable racks, as required, so that both ends of cable splices will be supported horizontally.
2) Equip cable racks with adjustable hooks: Quantity of cable hooks as required by the number of conductors to be supported.
c. In each manhole and handhole, drive 3/4 IN x 10 FT long copper clad ground rod into the earth with approximately 6 IN exposed above finished floor.
1) Drill opening in floor for ground rod.
2) Connect all metallic components to ground rod by means of #8 AWG minimum copper wire and approved grounding clamps.
3) Utilize a ground bar in the manhole or handhole if the quantity of ground wires exceeds three (3).
a) Connect ground bar to ground rod with a #2/0 AWG minimum copper wire.
3. Place manhole or handhole on a foundation of compacted 1/4 to 1/2 IN crushed rock or gravel a minimum of 8 IN thick and 6 IN larger than manholes or handholes footprint on all sides.
4. Install so that the top of cover is 1 IN above finished grade.
a. Where existing grades are higher than finished grades, install sufficient number of courses of curved segmented concrete block between top of handhole and manhole frame to temporarily elevate manhole cover to existing grade level.
5. After installation is complete, backfill and compact soil around manholes and handholes.
6. Handhole size:
a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
b. Minimum floor dimension of 4 FT x 4 FT and minimum depth of 4 FT.
7. Manhole size:
a. As indicated on the Drawings or as required for the number and size of conduits entering or as indicated on the Drawings.
b. Minimum floor dimension of 6 FT x 6 FT and a minimum depth of 6 FT.

3.3 UNDERGROUND CONDUITS

A. General Installation Requirements:
1. Ductbank types per location:
a. Reinforced concrete ductbank:
1) As indicated in the Ductbank Schedule.
b. Concrete encased ductbank:
1) Under roads.
2) Conduits containing medium voltage cables.
3) As indicated in the Ductbank Schedule.
c. Direct-buried conduit(s):

NOT FOR CONSTRUCTION

1) As indicated in the Ductbank Schedule

2. Do not place concrete or soil until conduits have been observed by the Engineer.

3. Ductbanks shall be sloped a minimum of 4 IN per 100 FT or as detailed on the Drawings.

a. Low points shall be at manholes or handholes.

4. During construction and after conduit installation is complete, plug the ends of all conduits.

5. Provide conduit supports and spacers.

a. Place supports and spacers for rigid nonmetallic conduit on maximum centers as indicated for the following trade sizes:

1) 1 IN and less: 3 FT.

2) 1-1/4 to 3 IN: 5 FT.

3) 3-1/2 to 6 IN: 7 FT.

b. Place supports and spacers for rigid steel conduit on maximum centers as indicated for the following trade sizes:

1) 1 IN and less: 10 FT.

2) 1-1/4 to 2-1/2 IN: 14 FT.

3) 3 IN and larger: 20 FT.

c. Securely anchor conduits to supports and spacers to prevent movement during placement of concrete or soil.

6. Stagger conduit joints at intervals of 6 IN vertically.

7. Make conduit joints watertight and in accordance with manufacturer's recommendations.

8. Accomplish changes in direction of runs exceeding a total of 15 degrees by long sweep bends having a minimum radius of 25 FT.

a. Sweep bends may be made up of one or more curved or straight sections or combinations thereof.

9. Furnish manufactured bends at end of runs.

a. Minimum radius of 18 IN for conduits less than 3 IN trade size and 36 IN for conduits 3 IN trade size and larger.

10. Field cuts requiring tapers shall be made with the proper tools and shall match factory tapers.

11. After the conduit run has been completed:

a. Prove joint integrity and test for out-of-round duct by pulling a test mandrel through each conduit.

1) Test mandrel:

a) Length: Not less than 12 IN

b) Diameter: Approximately 1/4 IN less than the inside diameter of the conduit.

b. Clean the conduit by pulling a heavy duty wire brush mandrel followed by a rubber duct swab through each conduit.

12. Pneumatic rodding may be used to draw in lead wire.

a. Install a heavy nylon cord free of kinks and splices in all unused new ducts.

b. Extend cord 3 FT beyond ends of conduit.

NOT FOR CONSTRUCTION

13. Transition from rigid nonmetallic conduit to rigid metallic conduit, per Specification Section 26 05 33, prior to entering a structure or going above ground.

a. Except rigid nonmetallic conduit may be extended directly to manholes, handholes, pad mounted transformer boxes and other exterior pad mounted electrical equipment where the conduit is concealed within the enclosure.

b. Terminate rigid PVC conduits with end bells.

c. Terminate steel conduits with insulated bushings.

14. Place warning tape in trench directly over ductbanks, direct-buried conduit, and direct-buried wire and cable in accordance with Specification Section 10 14 00.

15. Placement of conduits stubbing into handholes and manholes shall be located to allow for proper bending radiuses of the cables.

B. Concrete Encased Ductbank:

1. Ductbank system consists of conduits completely encased in minimum 2 IN of concrete and with separations between different cabling types as required in Specification Section 26 05 33 or as detailed on the Drawings.

2. Install so that top of concrete encased duct, at any point:

a. Is not less than 30 IN below grade.

b. Is below pavement sub-grading.

3. Where identified and for a distance 10 FT either side of the area, the concrete shall be reinforced.

a. The reinforcement shall consist of #4 bars and #4 ties placed 12 IN on center, in accordance with Division 03 Specification Sections or as detailed on the Drawings.

4. Conduit supports shall provide a uniform minimum clearance of 2 IN between the bottom of the trench and the bottom row of conduit.

5. Conduit separators shall provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.

C. Direct-Buried Conduit(s):

1. Install so that the top of the uppermost conduit, at any point:

a. Is not less than 30 IN below grade.

b. Is below pavement sub-grading.

2. Provide a uniform minimum clearance of 2 IN between conduits or as required in Specification Section 26 05 33 for different cabling types.

a. Maintain the separation of multiple planes of conduits by one of the following methods:

1) Install multilevel conduits with the use of conduit supports and separators to maintain the required separations, and backfill with flowable fill (100 PSI) or concrete.

2) Install the multilevel conduits one level at a time.

a) Each level is backfilled with the appropriate amount of soil and compaction, to maintain the required separations.

D (Vacant)

NOT FOR CONSTRUCTION

E (Vacant)

16.11 Acceptance Testing

A Description

1.1 SUMMARY

A. Section Includes:

1. Basic requirements for acceptance testing.

2. Streetcar operation shall be fully integrated with individual and all Traction Power Substations (TPSS).

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

a. 400, Guide for Field Testing and Evaluation of the Insulation of Shielded Power Cable Systems.

b. 400.3, Guide for Partial Discharge Testing of Power Cable Systems in a Field Environment.

2. International Electrical Testing Association (NETA):

a. ATS, Standard for Acceptance Testing Specifications for Electric Power Equipment and Systems.

3. Nationally Recognized Testing Laboratory (NRTL).

4. Telecommunications Industry Association/Electronic Industries Alliance/American National Standards Institute (TIA/EIA/ANSI):

a. 455-78-B, Optical Fibers - PART 1-40: Measurement Methods and Test Procedures - Attenuation.

B. Qualifications:

1. Testing firm qualifications: See Specification Section 01 61 03.

2. Field personnel:

a. See Specification Section 01 61 03.

b. As an alternative, supervising technician may be certified by the equipment manufacturer.

3. Analysis personnel:

a. See Specification Section 01 61 03 As an alternative, supervising technician may be certified by the equipment manufacturer.

C. Phasing Diagram:

1. Coordinate with Utility Company for phase rotations and Phase A, B and C markings.

a. Create a phasing diagram showing the coordinated phase rotations with generators and motors through the transformers.

1.3 SUBMITTALS

A. Shop Drawings:

NOT FOR CONSTRUCTION

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. See Specification Section 01 61 03 for electrical equipment and connection testing plan submittal requirements.
B. Informational Submittals:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Prior to energizing equipment:
a. Coordinated phasing diagram.
3. Within two (2) weeks after successful completion of Demonstration Period (Commissioning Period):
a. Single report containing information including:
1) Summary of Project.
2) Information from pre-energization testing.
3) See testing and monitoring reporting requirements in Specification Section 01 61 03.

B Materials

2.1 FACTORY QUALITY CONTROL

A. Provide Electrical equipment with all factory tests required by the applicable industry standards or NRTL.

B. Factory testing will not be accepted in lieu of field acceptance testing requirements specified in this Specification Section and Specification Section 01 61 03.

C Construction

3.1 FIELD QUALITY CONTROL
A. General:
1. See Specification Section 01 61 03.
2. Complete electrical testing in three (3) phases:
a. Pre-energization testing phase.
b. Equipment energized with no load.
c. Equipment energized under load.
3. Perform testing in accordance with this Specification Section and NETA ATS.
4. Provide field setting and programming of all adjustable protective devices and meters to settings as determined by the approved coordination study.
B. Equipment Monitoring and Testing Plan: See Specification Section 01 61 03.
C. Instruments Used in Equipment and Connections Quality Control Testing: See Specification Section 01 61 03.
D. Testing and Monitoring Program Documentation: See Specification Section 01 61 03.
E. Electrical Equipment and Connections Testing Program:
1. See Specification Section 01 61 03.

NOT FOR CONSTRUCTION

2. See individual Division 26 Specification Sections for equipment specific testing requirements.
3. Test all electrical equipment.
a. Perform all required NETA testing.
b. Perform all required NETA testing plus the optional testing identified with each specific type of equipment in Article 3.2 of this Specification Section.
3.2 SPECIFIC EQUIPMENT TESTING REQUIREMENTS
A. Switchgear and Switchboards:
1. Perform inspections and tests per NETA ATS 7.1.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
B. Transformers - Small Dry Type:
1. Perform inspections and tests per NETA ATS 7.2.1.1.
2. Perform the following additional tests:
a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after startup.
3. Adjust tap connections as required to provide secondary voltage within 2-1/2 percent of nominal under normal load after approval of Engineer.
4. Record as-left tap connections.
C. Transformers - Large Dry Type:
1. Perform inspections and tests per NETA ATS 7.2.1.2.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following additional tests:
a. Record phase-to-phase, phase-to-neutral, and neutral-to-ground voltages at no load after energizing, and at operating load after start-up.
4. Adjust tap connections as required to provide secondary voltage within 2-1/2 percent of nominal under normal load.
5. Record as-left tap connections.
D. Cable - Low Voltage:
1. Perform inspections and tests per NETA ATS 7.3.2.
E. Cable - Medium Voltage:
1. Perform inspections and tests per NETA ATS 7.3.3.
2. Non-destructive partial discharge test:
a. After energization, perform a partial discharge test for baseline data for future partial discharge maintenance testing.
b. Perform the work while the medium voltage circuits and equipment are energized.
1) The cables shall not be disconnected or de-energized and the testing shall not expose the cables to voltages that exceed normal operating voltage.
c. Use a frequency domain detection process incorporating a spectrum analyzer with radio frequency current transformer (RF CT) sensors.
1) The detection system, including spectrum analyzer, RF CT's and interconnecting cable, shall have a partial discharge detection range that at least covers the frequency range of 10 kHz to 300 MHz.

NOT FOR CONSTRUCTION

2) Testing shall be performed in a manner that complies with the requirements of IEEE 400 and IEEE 400.3.

F. Medium Voltage Circuit Breakers:

1. Perform inspections and tests per NETA ATS 7.6.2.

2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

3. Perform the following optional tests per NETA ATS:

a. Control wiring insulation resistance.

b. Minimum trip and close voltage.

c. Over potential.

4. Perform the following additional tests:

a. High-potential vacuum integrity test per manufacturer's recommendations.

5. Medium voltage DC circuit breakers are to be tested per the manufacturer's standard factory and field test procedure.

G. Low Voltage Molded Case Circuit Breakers:

1. Perform inspections and tests per NETA ATS 7.6.1.1.

2. Components:

a. Test all components per applicable paragraphs of this Specification Section and NETA ATS.

b. Thermal magnetic breakers: Visual and mechanical inspection per NETA ATS only.

c. Solid state trip type: Visual and mechanical inspection and electrical tests per NETA ATS.

3. Record as-left settings.

H. Protective Relays:

1. Perform inspections and tests per NETA ATS 7.9.

a. Tests to be performed using secondary injection of current and potential at final settings.

b. Test at manufacturer's recommended test points and critical timing points identified on relay setting sheet.

2. Perform all tests identified as optional per NETA ATS.

3. Perform the following additional tests:

a. Verification of direct trip of associated lockout relay or circuit breaker(s) by using relay test function or shorting trip contact at relay case.

b. Microprocessor-based relays:

1) Complete commissioning procedure per manufacturer's instructions, followed by tests of each relay element at final settings.

2) Verification of all internally-programmed logic.

c. Verification of all auxiliary input and output signals.

d. Verification of power supply/self-diagnostic alarm contact and remote annunciation.

4. Record as-left settings.

I. Instrument Transformers:

1. Perform inspections and tests per NETA ATS 7.10.

2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.

NOT FOR CONSTRUCTION

3. Perform the following optional tests per NETA ATS:
a. Dielectric withstand test on potential transformers.
J. Grounding:
1. Perform inspections and tests per NETA ATS 7.13.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Each TPSS site ground grid is to be tested for a 3-point fall of potential test prior to connection to the TPSS.
K. DC Power Systems (other than MV traction power):
1. Perform inspections and tests per NETA ATS 7.18.
2. Components: Test all components per applicable paragraphs of this Specification Section and NETA ATS.
3. Perform the following optional tests per NETA ATS:
a. Cell impedance test.
L. Control System Functional Test:
1. Perform test upon completion of equipment acceptance tests.
2. The test is to prove the correct interaction of all sensing, processing and action devices.
3. Develop a test plan and parameters for the purpose of evaluating the performance of the system.
4. Perform the following tests:
a. Verify the correct operation of all interlock safety devices for fail-safe functions in addition to design function.
b. Verify the correct operation of all sensing devices, alarms and indicating devices.
5. Systems to be tested:
a. Fire alarm system.
b. Security system.
3.3 INTEGRATED TRACTION POWER SYSTEM TEST
A. One (1) rolling stock test, operating in a zone leaving the yard and passing both ways over the entire route with three (3) TPSS energized.
B. Six (6) rolling stock tests, operating in a zone leaving the yard and passing both ways over the entire route with three (3) TPSS energized.
C. Six (6) rolling stock tests, operating in a zone leaving the yard and passing both ways over the entire route with one (1) TPSS energized. Repeat for each of three (3) TPSS.
D. Staged short circuit test between OCS and running rails for one (1) TPSS in service, close to TPSS and at end of route.

D (Vacant)

E (Vacant)

16.12 Dry-Type Transformers

A Description

NOT FOR CONSTRUCTION

1.1 SUMMARY

A. Section Includes:

1. Dry-type transformers, 1500 kVA and less.

B. Related Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

3. Section 26 05 00 - Electrical: Basic Requirements.

4. Section 26 05 26 - Grounding.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. Department of Energy (DOE):

a. 10 CFR 431, Energy Conservation Program: Energy Conservation Standards for Distribution Transformers.

2. Institute of Electrical and Electronics Engineers, Inc. (IEEE):

a. C57.96, Guide for Loading Dry-Type Distribution and Power Transformers.

3. National Electrical Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

b. ST 20, Dry-Type Transformers for General Applications.

c. TP 1, Guide for Determining Energy Efficiency for Distribution Transformers.

4. Underwriters Laboratories, Inc. (UL):

a. 506, Standard for Safety Specialty Transformers.

b. 1561, Standard for Safety Dry-Type General Purpose and Power Transformers.

1.3 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.

2. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. See Specification Section 26 05 00 for additional requirements.

3. Fabrication and/or layout drawings.

a. Nameplate drawing.

4. Certifications:

a. Sound level certifications.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

B Materials

2.1 ACCEPTABLE MANUFACTURERS

NOT FOR CONSTRUCTION

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Eaton.
2. General Electric Company.
3. Square D Company.
4. Siemens.
5. Sola/Hevi-Duty.
B. Submit request for substitution in accordance with Specification Section 01 25 13.
2.2 GENERAL PURPOSE DRY-TYPE TRANSFORMERS
A. Ventilated or non-ventilated, air cooled, two (2) winding type.
B. Cores:
1. High grade, non-aging silicon steel with high magnetic permeability, and low hysteresis and eddy current losses.
2. Magnetic flux densities are to be kept well below the saturation point.
C. Coils: Continuous wound with electrical grade aluminum.
D. Ventilated Units:
1. Core and coils assembly impregnated with non-hygroscopic, thermosetting varnish and cured to reduce hot spots and seal out moisture and completely isolated from the enclosure by means of vibration dampening pads.
2. Dripproof, NEMA 1, steel enclosure finished with a weather-resistant enamel and ventilation openings protected from falling dirt.
E. Furnish Taps for Transformers as follows:
1. 3 PH, 15 kVA and above: Two (2) 2.5 percent FCAN and four (4) 2.5 percent FCBN.
F. Sound Levels:
1. Manufacturer shall guarantee not to exceed the following:
a. 151 to 300 kVA: 55 dB.
b. 301 to 1500 kVA: 60 dB.
G. Efficiency (minimum):
1. Ventilated:
a. 3 PH, 15 - 1000 kVA: DOE 2016 Efficiency.
H. Insulating Material (600 V and below):
1. 15 kVA and above units: 220 DegC insulation system with a 150 DegC rise.
I. Ratings: 60 Hz, voltage, KVA and phase, as indicated on the Drawings.
J. Finish: Rust inhibited primer and manufacturers standard paint inside and out.
K. Standards: IEEE C57.96, NEMA ST 20, UL 506, UL 1561.

C Construction

3.1 INSTALLATION
A. Install products in accordance with manufacturer's instructions.
B. Indoor Locations:
1. Provide ventilated type for 15 kVA units and above.
2. Provide rubber vibrations isolation pads.

NOT FOR CONSTRUCTION

C. Enclosures: Painted steel in all areas except stainless steel in highly corrosive areas.
D. Ground in accordance with Section 26 05 26.

D (Vacant)

E (Vacant)

16.13 TPSS Substations

A Description

1.1 SUMMARY

A. This section includes the technical requirements of detail design, supply, installation, testing, and commissioning of the several traction power substations and associated equipment. The work includes, but is not limited to, the following:

1. Traction power substation (TPSS) for supplying dc power to the street cars via an overhead contact system (OCS).
2. AC and DC auxiliary power supply systems; including battery eliminator and emergency lighting inverter.
3. Positive and negative power cables.
4. Control cables.
5. Safety interlocks between traction power supply, access gates and fall gates.
6. Visual and audible alarms for dc trolley wires and auxiliary power station circuits.
7. Emergency trip stations at designated locations.
8. Testing and commissioning of traction power and associated installations.
9. Coordination of the work included in other sections of the contract.

B. Special Features of the Work

1. Requests for deviation must be submitted with full justification, cost and schedule impact.
2. TPSS equipment will be shipped by the substation manufacturer after factory acceptance tests.
3. TPSS equipment manufacturers and type are to be the same and interchangeable between the multiple TPSS manufactured. See Section 26 05 00 Part 2.1.
4. Installation, testing and commissioning of the traction substation shall be performed under direct supervision of the substation supplier. The Contractor shall ensure their presence at all times during the installation, testing and commissioning activities.
5. Remote control and SCADA is not proposed. City of Milwaukee Design Criteria does not require connection to SCADA. However, a consolidated alarm status and availability of dc power shall be annunciated at a location to be determined by the Owner.

NOT FOR CONSTRUCTION

6. In case of any conflict between the specifications and referenced or otherwise applicable federal, state, local or industry standards, most stringent requirements shall prevail.
7. Obtain requirements for installation of substation equipment on concrete foundation from substation supplier and coordinate with the engineer for compliance.
8. Contractor shall coordinate between all trades and disciplines for installation, testing and commissioning of substation and related equipment, including testing of the safety interlocks.
9. Contractor shall ensure that the maintenance facility tracks are isolated from the yard tracks by insulated rail joints per the contract documents.
10. Contractor shall:
a. Provide conduits, raceways, duct banks, junction boxes, manholes, hand holes and other accessories for the power and control cables per the contract documents.
b. Provide grounding for the substation equipment and other equipment per the contract documents.
c. Provide safety interlocks between traction power supply and other shop equipment, including but not limited to, OCS, access gates and fall gates.
C. The Contractor is responsible for the testing, commissioning and system integration tests of all traction power and related equipment. The Contractor shall develop and submit all construction acceptance test procedures for review and approval according to the project schedule, but no less than three weeks prior to performing the tests.
D. Deviations from the contract documents, if any, proposed by the Contractor, shall be submitted to the Engineer for review and approval.
E. Related Specification Sections include but are not necessarily limited to:
1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 01 11 00 – Summary of Work
4. Section 10 14 00 - Identification Devices.
5. Section 10 43 33 – Fire Extinguisher
6. Section 26 05 19 - Wire and Cable - 600 Volt and Below.
7. Section 26 05 33 - Raceways and Boxes.
8. Section 26 22 13 – Dry Type Transformers
9. Section 26 24 16 – Panelboards
10. Section 26 52 13 – Central Emergency Lighting Inverter

1.2 REFERENCED STANDARDS

A.	AASHTO	American Association of State Highway Transportation Officials
B.	City of Milwaukee	Street Car Design Criteria Manual
C.	NFPA	National Fire Protection Association
D.	NEC	National Electrical Code
E.	NESC	National Electrical Safety Code

NOT FOR CONSTRUCTION

F. NEMA National Electrical Manufacturers Association
G. WisDOT Roadway, Traffic, Geotechnical. And Bridge Design Requirements
H. WisDOT Construction and Materials Specification (2010)
I. ANSI C34.2 Semiconductor Power Rectifiers
J. ANSI C37.14 Low-Voltage DC Power Circuit Breakers Used in Enclosures
K. ANSI C37.16 Preferred Ratings, Related Requirements and Applications
Recommendations for low Voltage Power Circuit Breakers
L. ANSI C37.20.1 Standard for Metal-Enclosed Low-Voltage Power Circuit Breaker
Switchgear
M. ANSI C37.20.3 Standard for Metal-Enclosed Interrupter Switchgear
N. ANSI C37.46 Specifications for Power Fuses and fuse Disconnecting Switches
O. ANSI C37.90 Relays and Relay Systems Associated with Electric Power
Apparatus
P. ANSI C39.1 Requirements for Electrical Analog Indicating Instruments
Q. ANSI C57.12.01 General Requirements for Dry Type Distribution and Power
Transformers
R. ANSI C57.12.50 Requirements for Ventilated Dry-Type Power Transformers, 15 to
500 A, Three-Phase, with High-Voltage 601-34.5kV,
Low-Voltage 208Y/120 to 4160 volts
S. ANSI C57.12.91 Test Code for Dry Type Distribution and Power Transformers
T. ANSI C57.13 Standard Requirements for Instrument Transformers
U. ANSI C62.11 Standard for Metal Oxide Surge Arresters for AC Power Circuits
V. ASTM B8 Concentric Lay Stranded Copper Conductors, Hard, Medium-Hard,
Or Soft
W. NEMA AB1 Molded Case Circuit Breakers
X. NEMA PB1 Panel Boards
Y. NEMA PE5 Constant Potential Type Electric Utility Battery Chargers
Z. NEMA SK60 Silicon Rectifier Diodes and Stacks
AA. UL 83 Thermoplastic-Insulated Wires and Cables

1.3 SUBMITTALS

NOT FOR CONSTRUCTION

A. Submit the following reports and data. Allow four weeks for review by the Engineer for each submittal. Additional time will be required by the Contractor/Engineer to review and respond to comments of the submittal review with no impact to the project schedule.

1. Relay Coordination and Protection Study.
2. Shop drawings and manufacturer's product data.
3. Testing and Commissioning Procedure. Coordinate with Section 26 08 13.
4. Arc Flash Hazard Study and TPSS signage to meet OSHA and NFPA 70E for electrical safety within the TPSS.

B. Substation Compliance Report

1. Submit a Substation Compliance Report to certify that the substation complies with NEC and other applicable federal, state and local requirements. The Substation Compliance Report shall be identified in the Contractor's Submittal Schedule.

C. Protective Device Coordination Study Report

1. Submit relay coordination and setting study for coordination of the protective relays of the AC and DC breakers of the traction power substation with fuse characteristics of the rectifier. Include coordination of the protection of the AC panel with the AC breaker of the traction power substation. The Protective Device Coordination Study Report shall be identified in the Contractor's Submittal Schedule.

D. Testing and Commissioning Procedure

1. Submit testing and commissioning procedures for all equipment. Tests within this specification include, but are not limited to factory tests, field tests, step-by-step energization, and post-energization tests. Testing and commissioning procedures shall be identified in the Contractor's Submittal Schedule.

E. Shop Drawings and Product Data

1. Submit shop drawings and technical product data sheets for review and approval for all items of the system. Make use of standard equipment product data and specifications where practical. Describe functional, design and performance requirements as well as identify the materials, fabrication procedures, factory and field tests and installation procedures. Include information on the past service experience. At a minimum include data on the following equipment:

a. AC switchgear
b. Protective equipment
c. Power measuring devices of AC switchgear
d. Rectifier transformer
e. Rectifier and its main components including diodes, fuses, surge arresters, bleeder resistors and door switches
f. DC switchgear
g. DC contactors
h. Molded-case AC circuit breakers
i. Fuses and fuse holders
j. Protective devices and auxiliary relays

NOT FOR CONSTRUCTION

k. Instruments and indicating devices
l. Transducers and converters
m. Batteries and battery charger
n. Auxiliary power panel boards
o. Power and control cables and wires
p. Alarm and interlocking devices

F. Documentation

1. The Contractor shall submit one complete, comprehensive, coordinated package of documentation that identifies the characteristics of the TPSS as described above. The Contractor shall not submit multiple, broken-up packages of documentation that identifies the TPSS as described above.

G. As-built Drawings

1. The Contractor shall submit as-built drawings within 5 weeks of final commissioning and acceptance. The drawings should include all field changes and must be signed and sealed by a professional engineer registered in the State of Wisconsin.

B Materials

2.1 SUBSTATION RATING

A. The traction power substation shall be rated for 1000 kW (minimum) output, continuous. The overload rating of the substation shall be Extra Heavy Duty Traction per ANSI C.34.2, i.e. 150% load for two hours after reaching stabilized temperature at 100% load.

B. Milwaukee Streetcar Design Criteria states that the City of Milwaukee will provide substation locations with a minimum dimension of 14 feet by 44 feet.

2.2 TPSS EQUIPMENT

A. TPSS equipment shall consist of the following cells at minimum in a lineup:

1. AC switchgear
2. Rectifier transformer
3. Rectifier
4. DC switchgear (including positive disconnect switch and negative link)
5. OCS control panel consisting of six 1000 V dc contactors

B. Provide conduits for power cables (AC and DC), control cables from safety interlocks and emergency trip stations, and from 120 V distribution panel board for 120 V auxiliary power supply. Provide fixed inspection lights in all cubicles.

C. Buried conduits shall be Schedule 40 PVC or FRE. Exposed conduits shall be rigid galvanized steel (RGS). Provide red warning tape 12 inches above buried conduits. Couplings for transitions from PVC to RGS conduit shall be installed prior to exiting floor slabs.

D. Provide thermostat controlled anti-condensation heaters in all cells.

2.3 SUBSTATION ENCLOSURE

A. The TPSS shall be a modular prefabricated transformer/rectifier unit within a weatherproof enclosure completely assembled and tested at the factory.

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The TPSS enclosure shall have minimum dimensions of 14 feet wide and 44 feet long. The enclosure shall have two means of egress. The doors shall be equipped with heavy duty lockable vandal resistant door latches and an intrusion device on each door.

B. The TPSS shall be equipped with an exterior blue light that will illuminate to indicate that the substation is off-line. The TPSS shall be equipped with an external lock box to provide access for the Fire Department and an Emergency Trip Station to de-energize the entire substation in an emergency. Exterior lighting shall be photo electric controlled and designed to meet a minimum illumination level of two (2) foot candles at ground level.

C. The interior of the TPSS shall be illuminated with fluorescent light fixtures to provide a minimum lighting level of thirty (30) foot candles average. Fixtures shall be located so as not to cause a glare on the faces of instruments and devices. Light switches shall be located by each access door. The TPSS shall be equipped with an emergency lighting system powered by the substation battery and controlled by manual switches by each access door. The emergency lighting system shall provide a minimum of two (2) foot candles illumination at floor level for 1.5 hours. The TPSS shall be equipped with several 20 Amp GFCI receptacles per NEC requirements.

D. The TPSS shall contain auxiliary equipment including a 125 VDC battery, battery rack, 125 VDC power panel, battery charger and eliminator, central emergency lighting inverter and storage cabinet for battery maintenance PPE equipment. The safety storage cabinet shall be located near the batteries. The cabinet shall be lockable, provide at least four cubic feet of storage space, and capable of storing all of the specified battery safety equipment and supplies. The Contractor shall provide one personal protection kit for battery maintenance. All items shall be electrolyte resistant. Each kit shall contain maintenance gloves, apron, sleeves, over shoes, face shield and safety goggles. The Contractor shall furnish and install one portable eyewash kit mounted near the battery installation. The Contractor shall furnish and install signs near the battery installation including “Danger, Hazardous Area”, “No Smoking, No Open Flames”, Hydrogen Gas and “Eye Protection Required”.

E. The TPSS shall be equipped with a fire extinguisher, fire protection panel, intruder alarm panel and communication equipment panel.

F. The TPSS shall be equipped with heating/air conditioning equipment to maintain the substation interior temperature and permit the transformer/rectifier unit to operate at the designed load cycle.

2.4 SUBSTATION LOCATION

A. The substation shall be located as shown on the contract drawings. Provide working clearance around equipment per NEC and other applicable codes to ensure movement of the draw-out switchgear. Modifications to the layout shall be coordinated with and subject to approval of the Engineer.

B. Equipment dimensions shown on the layout plan represent the approximate size of the equipment. The Contractor shall endeavor to procure equipment of smaller size or coordinate space requirements with the Engineer.

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C. Traction substation equipment shall be installed under the supervision of the substation manufacturer. Include cost of supervision in the bid price.

D. Power and control connections between switchgear cells shall be provided by the substation manufacturer. Power connections (13.2 kV AC and 750 V DC) shall be by rigid copper bus. Cabling of power connections is not allowed. Buses shall be constructed of 98% minimum conductivity copper conforming to ASTM B187 with maximum current density of 800 Amps per square inch in accordance with the City of Milwaukee Street Car Design Criteria Manual.

E. The Contractor shall complete installation of anchor channels and bolts per manufacturer's recommendations for equipment prior to installation. Obtain required details and instructions for installing on the foundation from the manufacturer prior to construction.

2.5 PRIMARY POWER SUPPLY

A. Power for the TPSS shall be obtained from WE Energies 13.2 kV distribution system. The Utility will provide cable for two feeder circuits in buried duct bank or buried conduit to the incoming AC circuit breakers in the substation. Cable entrance to the AC switchgear is from the bottom. The Utility will furnish and install the cable terminations and connect to the switchgear.

2.6 AC SWITCHGEAR

A. The AC incoming cubicle shall be standard 15 kV metered switchgear with protective relays as shown on the contract drawings.

B. The AC switchgear shall be draw-out type with the capability of tripping automatically in the event of loss of either primary 13.2 kV supply or 125 V dc control voltage.

C. Protection shall be coordinated with WE Energies.

2.7 AUXILIARY POWER SUPPLY TRANSFORMER

A. Obtain auxiliary power at 208/120 V AC from the distribution panel supplied by auxiliary power transformer.

B. Provide conduit from nearest distribution panel.

2.8 TRANSFORMER – RECTIFIER UNIT

A. The transformer-rectifier unit shall consist of a rectifier transformer and rectifier that have been designed and tested to function as a unit. The transformer-rectifier shall be complete with equipment, auxiliaries, controls, internal wiring, wire ways, terminals and provisions for interconnecting, power wiring, cable supports and necessary hardware and devices.

B. Rating:

The transformer-rectifier unit shall be rated at a minimum of 1000 kW at the output terminals at 750 V DC full load. The transformer-rectifier shall be rated based upon an extra heavy traction duty cycle, which is defined as follows: the unit will be energized and loaded to 100% of its rated load and allowed to remain with this loading until the temperature rise has stabilized and remained constant for 30 minutes. At this time, the unit will be loaded to 150% of rated load for two hours. During this two hour period, five evenly spaced loads of 300% of rated load of one minute duration each will be placed on the rectifier. During the last 15 seconds of the two hour cycle, a load of 450% of rated load will be placed on the rectifier. After this duty cycle, the transformer-rectifier unit and all of its

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components shall not exhibit any damage due to the duty cycle imposed nor initiate a thermal shutdown. Components of the transformer-rectifier shall be suitable for operation at the specified ratings under the specified ambient conditions.

C. Efficiency:

Overall efficiency of the transformer-rectifier unit, from the high-tension terminals of the rectifier transformer to the dc terminals of the rectifier shall be 98.5% minimum, at full rated load. No-load losses of the transformer shall be 1.00 kW maximum.

D. Power Factor:

Displacement power factor of the transformer-rectifier unit shall be 0.96 lagging or greater from 25% of continuous rated load to continuous rated load at the rated AC voltage.

E. Regulation:

The transformer-rectifier unit shall provide the following output voltage at rated 13.2 kV AC input:

	Maximum Voltage	Rated Voltage	Minimum Voltage
1% Load	795 V		
100% Load	825 V	750 V	525 V
150% Load	825 V	750 V	525 V

Regulation shall be measured with sustained primary sinusoidal voltage on the rectifier-transformer and the tap setting at rated voltage. The measurement shall be based on 750 V at full load current. The Contractor shall take into account the combined inherent characteristics of the transformer, regulating devices and any part of the equipment affecting the dc voltage characteristics of the transformer-rectifier unit. Since voltage drop on the OCS is minimal, 750 V is selected to provide realistic on-line voltage for testing.

F. Audible Sound Levels

Transformer noise shall not exceed limits set forth in IEEE Std. C57.12.01 when tested per IEEE Std. C57.12.91.

G. Short Circuits

Supply individual parts of the transformer-rectifier unit and its terminal connections and buswork to withstand the resultant mechanical and electrical stresses caused by a bolted fault at its DC output after overloads described herein, for the period required by the protection equipment to clear the fault, without mechanical or electrical damage to the equipment or measurable deterioration of the insulation. Design transformer to withstand a full short circuit for the duration of one second on its low voltage terminals with rated voltage on the primary terminals in accordance with ANSI C57.12.01.

H. Traction Power Transformer

1. The traction power transformer (TPT) shall be designed, manufactured and tested in accordance with ANSI C57.12.01, C57.12.51 and C57.12.91 except as modified herein.

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2. Type and Rating – The TPT shall be air cooled ventilated dry type, self-cooled transformer class AA. The TPT shall furnish AC power at the rated voltage and phase for successful operation of the associated 1000 kW silicon rectifier for traction duty.

3. Transformer insulation shall be 220 degrees Celsius class as defined in IEEE Standards. The TPT temperature rise shall not exceed the following at a 40□ C average ambient temperature at the following ratings and conditions:

	Winding Temp Rise	Hot Spot Temp Rise
100% Load for 6 hours	65□C	95□C
150% Load for 2 hours	120□C	150□C

4. Number of Taps: Seven 2.5% taps, three above and three below normal.

5. BIL: Primary 45kV
Secondary 10kV

6. Accessories

a. Qualitrol transformer temperature indicator for winding hot spot temperature.

b. Winding temperature alarm and trip functions, 49T1, 49T2.

2.9 RECTIFIER

A. The transformer-rectifier shall be connected in accordance with ANSI circuit 31 to provide 12-pulse rectification. Output voltage shall be 750 VDC at rated load and rated input AC voltage. Output voltage shall not exceed 795 VDC at 1% load and rated input voltage.

B. An interphase transformer shall be provided between the direct outputs of the two six-pulse sections to absorb the instantaneous direct voltage differences. The supplier shall coordinate the design of the interphase transformer with the rectifier and rectifier transformer to ensure that the interphase transformer will function acceptably under the expected levels of unbalance for the specified service conditions. To achieve the lowest practical noise level, the core of the interphase transformers shall be designed to minimize the magnetostriction. Magnetostriction is the phenomenon of elastic deformation of ferromagnetic materials during the process of magnetization. Noise damping treatment may be required in reducing the noise level by canceling some of the noise frequencies of the interphase transformer.

C. Silicone Diodes

1. Silicone diodes shall be hermetically sealed and mounted on adequate heat sinks and shall be rated and tested in accordance with the latest NEMA publication SK-60.

2. The rectifier shall be built with a sufficient number of diodes to be capable of carrying the specified rated load, specified overloads and short-circuit current at 40□C ambient temperature with one parallel diode removed from each phase arm. The safe junction temperature, as recommended by the supplier, on the active diodes shall not be exceeded. The duration of the overloads shall be as specified above and the duration of the short circuit shall correspond to the time required by the AC breaker to clear the fault.

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3. During blocking periods, each diode at its maximum operating temperature shall be capable of withstanding repetitive voltage having a value of 2.5 times the diode working peak reverse voltage without a permanent change in diode characteristics. Each individual diode shall have a voltage rating equal to at least 266% of the applied peak inverse voltage at no load.

4. The rectifier shall not be externally balanced to maintain current balance between parallel-connected diodes in each phase. Also, the current balancing shall not be achieved by use of selectively matched diodes. Diodes shall have uniform voltage division within plus or minus ten percent across each diode. The diode type shall be selected so that individual diode currents are within their capabilities under all load and fault conditions.

5. Provide light for viewing the rectifiers when in operation. Provide a 120 V receptacle for instruments.

D. Cooling

1. The rectifier shall be natural convection air cooled.

E. Terminations

1. The rectifier shall be connected to its associated rectifier transformer through copper bus bar

2. The rectifier DC output shall be connected through copper bus bar to its associated DC switchgear

3. The throat connections between equipment and bus ways shall be designed for close coupling and for installation and removal without the necessity of moving the transformer, rectifier, or DC switchgear.

2.10 DC SWITCHGEAR

A. Provide a DC breaker as part of the lineup to be installed in the substation room with limited vertical clearance. The DC switchgear shall be dead-front, ventilated, metal enclosed, free standing, sheet steel enclosure suitable for indoor service. Access to components of the switchgear shall be from the front. Equipment access panels located on the side or rear of the enclosure are prohibited. Equipment access panels located on the top of the enclosure are permitted within the overall height limitation of 86 inches. Connection to the rectifier on one side and control panel on the other side will be by rigid copper bus bar.

B. The switchgear assembly shall consist of draw out DC feeder breakers and a draw out DC rectifier output breaker in the positive circuit. A Negative DC disconnect switch is required.

C. The rectifier output main DC breaker shall be designed to trip automatically in the event of loss of 750 V DC on the bus or loss of 125 V DC control power. The DC feeder breakers shall be designed for automatic reclose.

D. The switchgear shall be equipped with individually-enclosed, high-speed power circuit breaker with rating as specified herein. The breaker and interrupting device of the DC breakers shall be of the removable type arranged for moving physically between connected, test and disconnected positions. The switchgear assembly shall also include DC buses and connections, negative feeder

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cable terminal connections, indicating lights, indicating voltmeter, indicating ammeter, terminal blocks, protective relays, auxiliary relays, control circuitry, wiring and other devices necessary to make a complete and operable assembly. A key interlock on the main DC breaker shall not allow the main to close when the negative bus disconnect switch is open.

E. The DC switchgear enclosure, including negative bus, shall be electrically insulated from the rectifier transformer and the AC switchgear. The enclosure shall have all principal members if its structure electrically bonded together.

F. Ratings: The DC switchgear assembly and circuit breaker shall have the following minimum ratings. Although rectifier output is rated at 750 V, 750 V has been retained for the breaker as the nominal voltage.

Full –Load voltage	750 VDC
Maximum Voltage	825 VDC
Continuous Current	2000 Amps
Insulation Level	2 kV

G. Switchgear Enclosure: The switchgear steel structure shall be rigid, self-supporting, self-contained conforming to ANSI C37.20.1 and to the requirements indicated. Fabricated assemblies of electrically welded or bolted 14 gauge minimum thickness steel. The enclosures shall be sufficiently rigid to support equipment under normal loads, short circuit conditions and seismic conditions. The switchgear enclosure shall be suitable for accommodation of draw out circuit breakers and shall include stationary disconnecting device contacts and supporting rails for the circuit breakers. The design shall allow the circuit breakers to be easily drawn in or out of their housing and connected or disconnected from the buses and auxiliary circuits by means of self-aligning, self-coupling, primary and secondary disconnecting devices. The devices shall be suitably shrouded or provided with automatic safety shutters to prevent accidental contact with live parts. Provide guide rails or cradles for positioning the removable elements as an integral part of the equipment. Connection of control wiring to the DC breaker by a plug-style disconnect will be acceptable, provided the breaker cannot be mechanically racked into the connected position with the plug disconnected. Furnish each compartment with a hinged door or full width panel fro front access to the circuit breakers; disconnect switches, instruments and terminal blocks. Form doors from 14 gauge minimum sheet steel and properly reinforce against distortion by suitable flanges and stiffening members. The hinges shall be heavy duty stainless steel. Doors shall be securely fastened in the closed position with a minimum of three latches easily opened without the use of tools. Two latches will be allowed if the front panel consists of more than one full-length door. Provide each door with a handle and with stops to hold it securely in the open position. Access doors on all enclosures shall have a sign stating “DANGER: LIVE PARTS” and “DANGER: HIGH VOLTAGE”.

H. Provide each enclosure with protective shutters which cover the live high-voltage terminals when the access door is opened or a DC feeder breaker is racked out of the cubicle. Construct enclosures to allow adequate clearance to ground and for the dissipation of ionized gas from the circuit breaker arc chutes when interrupting maximum short-circuit energy at rated maximum voltage. These

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ionized gases shall not be a hazard to personnel or establish a conducting path to ground. Make adequate provisions for release of gas to the outside by means of suitable stacks, louvered vent opening or vent openings covered with grilles. These shall be arranged in such a way that hot gas or other materials cannot create a hazard for personnel. Enclosure surfaces exposed to arcs or ionized gases shall be lined with flame resistant, high dielectric insulating materials.

I. Auxiliary heating shall be by thermostatically-controlled space heater mounted inside the DC switchgear enclosure. The heater shall be rated 250 watts and shall be powered from the 120 VAC supply. Provide a manual switch to switch off the heater. The heater shall be completely isolated from the DC distribution and control systems.

J. Disconnect Switches: The negative disconnect switch shall be single-pole, bolted pressure type, solid copper blade with silver-plated contacts. The disconnect switch shall be operated manually. Provide a green and a red indicating light on the front panel of the enclosure. The green light shall be illuminated when the disconnect switch is open, and the red light shall be illuminated when the switch is closed. Wire the indicator to a secondary contact on each switch which is isolated from the 750 VDC bus.

1. Full-Load Voltage 750 VDC
2. Maximum Voltage 1000 VDC
3. Continuous Current 2000 Amps
4. Insulation Level 4.6 kV, 60 Hz RMS

K. Circuit Breaker: The DC main and feeder circuit breakers shall be a single-pole, air-break, high-speed, draw out type, circuit breaker conforming to ANSI C37.14. Breakers shall be provided with short time and long time overcurrent protective relays, rate of rise relay and adjustable direct acting instantaneous overcurrent protection. The breakers shall be electrically and mechanically trip free. Breakers shall be draw out type and shall have three distinct positions – Connected, Test and Disconnected. Fixed contacts shall be protected by automatically operated shutters when the breaker is not in the connected position. The breaker shall have electrical On/Off switches on the front panel. The breaker shall be wired to trip automatically in the event of:

1. Loss of 750 VDC voltage
2. Loss of DC control power

2.11 OCS CONTROL PANEL

A. Provide an OCS control panel for supply of 750 VDC power to the overhead contact system.

B. The enclosure shall be rated NEMA 1, completely metal enclosed with all welded construction, ventilated, and self-supporting with adequate lifting means, and adequate structural members and stiffeners. The enclosure shall meet or exceed the requirements of ANSI C.37.20.1, Appendix A. The enclosure shall be fabricated from minimum 12 gauge steel except that doors shall be fabricated from minimum 14 gauge. Doors shall be provided with 3 point latches and full height stainless steel hinges. The doors shall be insulated with 1/8 inch glastic, full height. The removable High Voltage panel shall be fabricated from ¼ inch glastic. The removable Low Voltage panel shall be fabricated from 14 gauge or

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thicker steel with rolled edges for stiffness. The High Voltage panel and the Low Voltage panel shall be fastened in place using a minimum of ¾ inch studs welded to structural support members and stainless steel hardware. The steel enclosure shall be finished the same as the DC switchgear enclosure. Provide cable entry space for DC conduits and cables. Provide enclosure with door switch and warning signs. The busbar shall be rated for 1000 Amps and insulated for 2 kV.

C. The control panel shall have six DC contactors, each with a fuse and lockable disconnect switch or a lockable trip disconnect switch to provide isolation. All circuits shall have a door disconnect switch so that no circuit can be energized unless the panel door is closed. The control panel shall also be interlocked with the voltage on the bus so that all contactors will drop if bus voltage is lost. Additionally, each circuit will have other safety interlocks with associated access gates and fall gates as required. The contactors shall be rated for use on a 1000 VDC system and full load continuous current of 400 Amps. Make and break rating of the contactors shall be 1000 Amps minimum. Contactors contacts shall not be wired in series or parallel to obtain the required duty. Main contacts shall be silver plated. The contactors shall have adequate auxiliary contacts for the interlocks and a minimum of two NO and two NC spares. Control voltage supply to the holding coils of the contactors shall be interrupted if the DC breaker opens. Fuses shall be rated as shown on the contract drawings. The fuses shall be rate for 1000 VDC minimum.

D. Contactors for OCS circuits shall be provided with time delay relays, adjustable 0 to 30 seconds, as shown on the contract drawings. The time delay relays shall delay energization of the overhead wires. The operator will have to push and hold the ON button until the contactor is closed.

E. The contactors shall be Microelettrica Model LTHS 400 contactors or approved equal.

F. The contactors shall be capable of operation from a 120 V, 60 Hz single phase AC power supply for control as shown on the contract drawings. Rectifiers to convert the AC to DC shall be provided by the contactor supplier.

G. Provide a lockable trip switch for each contactor for isolation of the circuit be maintenance personnel.

2.12 POWER CABLES

A. Provide all power and control cables for traction power system, associated safety interlocks and emergency trip stations. Also provide required conduits, junction boxes, pull boxes, man holes, risers, bends and elbows and other related hardware.

B. DC positive and negative traction cables shall have 2000 V rated insulation minimum with ethylene-propylene rubber (EPR). The cable insulation shall be rated 90□C continuous operating temperature, 130□C emergency rating and 250□C short circuit rating.

C. The cables shall be furnished with low smoke, non-toxic insulation and comply with ICEA/NEMA Std. S-68-516/ WC8-1976 type II and ASTM Specification D-3802-78. In addition, the sheath compound shall be listed by Underwriters Laboratories for use with cable of the specified ratings.

2.13 PROTECTIVE DEVICES

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A. Provide emergency trip stations (ETS) at locations shown on contract drawings. Operation of any ETS shall trip and lock the DC feeder breaker. Coordinate the size and routing of the conduits with others.

B. Provide interlock from fire alarm system such that activation of the fire alarm shall trip the AC and DC breakers of the TPSS.

2.14 ANNUNCIATOR

A. Annunciator Panel: Provide a substation alarm panel to monitor all alarms listed on the single line drawings. The annunciator panel shall be powered from the 125 VDC battery eliminator and have 512 MB of memory and 512 MB of non-volatile memory at a minimum. The screen size shall be a touch screen 1024 x 768 LCD display capable of displaying the substation alarms in the following manner:

1. Red – An alarm shall be "flashing red" until the acknowledge button for the annunciator panel has been pushed.

2. Yellow – An alarm shall be yellow when the acknowledge button for the annunciator has been pushed, but the alarm has not been returned to the normal state.

3. Green – An alarm shall be green when it is in the normal state.

B. Provide status of DC voltage and a combined alarm at remote location to be determined by O&M.

2.15 RELAY, METERING, AND INDICATING DEVICES

A. Temperature-measuring Devices shall be installed to detect an abnormal rise in diode heat sink temperatures. Each device shall have at least two stages. First stage contact shall be for annunciation and the second stage for breaker tripping. The pickup point of each stage shall be adjustable and factory-set so that upon the heat sink temperature reaching the preset level the corresponding contact shall initiate an alarm or trip the station circuit breakers through the lockout relay as indicated.

B. Monitoring Devices shall be furnished to detect the loss of one or more diodes:

1. Failure of any diode in any string shall initiate an alarm.

2. Failure of a second diode in a rectifier bridge shall initiate the tripping of the substation circuit breakers via a lockout relay.

3. Rectifier doors to normally energized buses or components and to the negative disconnect switch shall be electrically interlocked to trip the ac and dc main circuit breakers through the lockout relay when a door is opened.

2.16 NEGATIVE BUS CONNECTIONS

A. Connect the negative bus of the rectifier to the ground and rails via two 500 kCmil copper cables. Provide a minimum of two connections to the rails of each track.

B. Bond all rail joints on the electrified tracks with 4/0 copper cables.

2.17 DC AUXILIARY POWER

A. Provide a 125 VDC battery eliminator for control power. Battery eliminator shall be supplied from the AC distribution power panel.

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B. Battery eliminator shall be capable of closing, holding and opening the breakers, contactors, and powering other protective relays, indicating and annunciator.

2.18 CABLE RACEWAYS

A. Cable raceways external to the substation shall be designed with the raceways for other equipment. The raceways shall be non-metallic. Raceway supports shall be NEC compliant. Do not mix the 750 VDC cables in any conduit with any other cable.

B. Positive and negative cables shall be provided in separate conduits.

2.19 ELECTRICAL INSULATION

A. DC equipment cubicles shall be insulated from the substation floor as shown on the contract drawings. Insulating covering shall be ¼ inch thick, applied using an approved epoxy, in a manner recommended by the supplier.

B. Epoxy flooring shall be abrasion resistant. Compressive strength, per ASTM D695 shall be 8500 psi, minimum.

C. Insulation shall be capable of withstanding 2000V DC for one minute. Submit test procedure for review and approval.

D. Basis of design is Hallemite Dielectric Grey Amazite by RBC Industries. Approved equal is acceptable.

2.20 SPARES

A. Submit a list of the spare parts recommended by the Contractor for three years normal use. The list should include the description of the part, manufacturer's name, manufacturers catalog number, quantity installed on the job, quantity recommended for spares, unit price and total price. Include the total price of recommended spares in the Contract bid.

B. As a minimum, the following spares shall be included:

1. One DC breaker, unless a similar spare is included as spare for the other substations
2. One AC breaker
3. Ten spare diodes with fuses and current balancing resistors
4. Two complete sets of indicating lamps
5. One set of interlocking switches, limit switches and emergency push buttons
6. Two 60 foot lengths of composite cable
7. 200 feet each of all other types of cables

2.21 MANUALS

A. Provide City of Milwaukee with a comprehensive operation and maintenance manual of all equipment and systems furnished.

B. Show all subsystems in sufficient detail with labeled photographs to present a complete and clear picture of the system. Confirm nomenclature, functional description of the components on the As-Built Drawings.

C. Include the names, addresses and telephone numbers of the vendors and suppliers.

D. Include the following as a minimum:

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1. Preventative maintenance schedule and procedure to enable maintenance personnel to perform periodic inspections and preventative maintenance. Include periodical testing schedule (such as relays, etc.) if any, to be performed.
2. Corrective Maintenance Manual to enable maintenance personnel to troubleshoot and correct any malfunction.
3. Heavy Repair Manual to enable maintenance personnel to replace, rebuild and overhaul the system.

E. Submit three (3) hard copies of the draft manual for approval by City of Milwaukee.

F. Supply ten (10) hard copies and a CD-ROM of the approved manual.

2.22 TRAINING

A. Provide training to the City of Milwaukee staff and O&M Contractor relevant to the operation and maintenance of the system and equipment furnished.

B. Include a classroom session (not less than 8 hours) and on-site training for a total on not less than 16 hours.

C. Use As-Built drawings and the O&M manual for training.

D. As a minimum, include the following:

1. Complete overview of the substation from the AC switchgear, DC switchgear, Contactors and all auxiliaries inside the substation
2. Replacement of diodes
3. Working of safety interlocks
4. Periodic testing of the safety interlocks
5. Testing of the protective relays
6. Testing and maintenance of the AC breakers
7. Testing and maintenance of the DC breakers
8. Testing and maintenance of the negative disconnect switch
9. Testing and troubleshooting of all annunciator alarms
10. Procedure for de-energizing traction power circuits for maintenance

C Construction

3.1 GROUNDING

A. Connect substation AC equipment to the ground grid, providing two connections for each item.

B. Ground all exposed metallic objects such as hand rails, stairways, columns, switch boxes, etc. by redundant connections.

C. All outdoor or buried ground connections shall be thermionic welds.

3.2 SUBSTATION MANUFACTURE

A. Perform all phases of substation equipment manufacture by qualified and experienced personnel using proper tools and equipment under competent supervision.

B. Use only new components for substation manufacture.

C. Use only products and material free of asbestos, lead and other potentially harmful substances.

3.3 SUBSTATION INSTALLATION

A. The installation shall be done under the direct supervision of the supplier. Coordinate with the supplier and include the cost in the bid.

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B. The equipment may need to be partly re-assembled at site. Obtain re-assembly instructions from the supplier in advance.

C. Upon receipt at site, the contractor shall open and inspect the equipment. Damage, if any, shall be reported to the carrier and supplier. The contractor is responsible for inspecting and protecting all equipment until such time it is turned over to the Owner. In the event that the contractor requests to repair damaged equipment, the Owner reserves the right to reject damaged equipment that is not repaired to their satisfaction. Delays associated with any repairs or replacement of equipment shall be considered inexcusable if the damage is attributed to the Contractor and/or his subcontractors, suppliers, installers, etc.

D. Deliver substation equipment to the designated location and place onto the foundations. Align each item of equipment and attach to the foundation. Interconnect all items of equipment.

E. Install power and control cables ensuring that AC and DC power cables are not mixed in any conduit or terminal board.

F. Connect equipment to be grounded to the ground grid.

G. Install all ETS at the designated locations.

H. Install control cables and complete interlocking.

3.4 PROTECTIVE DEVICE SETTINGS

A. Set all protective devices in accordance with the results of the Protective Device Coordination Study.

3.5 TESTING

A. Perform all tests under direct supervision of supplier.

B. Perform tests in accordance with the approved testing and commissioning procedure which must be submitted for review and approval in accordance with the project schedule.

C. The following tests shall be performed per IEEE Std. 57.18.10 on the transformer at the manufacturer's factory. Transformer shall be shipped only after approval of the test results by the engineer.

1. Resistance and impedance measurements
2. Ratio test
3. Winding resistance
4. Polarity and phase relation
5. Excitation current and no-load loss at rated voltage
6. Impedance and load loss measurement
7. Temperature rise test
8. Dielectric tests – impulse tests
9. Partial discharge test
10. Noise level test
11. Short circuit test at an approved laboratory
12. Applied potential test
13. Induced voltage test
14. Determination of no-load losses, full-load losses and regulation

D. As a minimum, perform the following tests and checks on completely assembled substation. Follow NETA standards for testing. Submit testing procedure for review and approval in accordance with the project schedule.

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Supplier and testing agency shall be made aware that the testing procedure submittals may have multiple reviews. The Contractor shall allocate sufficient time for these reviews with no impact to the project schedule.

1. Verification of the insulation and dielectric strength of all power and control cables. Perform insulation resistance test of control cables by 1000V megger. Insulation resistance of control wires shall not be less than 5 meg-ohms. Insulation resistance of power cables shall be measured by 2500 V megger and shall not be less than 10 meg-ohms. Hipot test shall be performed on control cables at 1800 VAC for one minute. Hipot test on 2 kV insulation power cables shall be performed at 85% of supplier recommended voltage or 3500 V, whichever is lower, for one minute. Field testing of power circuit shall be performed by NETA approved independent company. Test voltage shall be per NETA standards.
2. Verify power and control circuits with reference to drawings. Markup variations for as-built drawings. Include AC and DC switchgear, DC disconnect switch, annunciator, indicating lights and safety interlocks.
3. Verify transformer winding resistance and ratio at all taps.
4. Verify epoxy floor insulation at 2000 VDC. Floor shall be divided into 1 foot x 1foot grids for test.
5. Verification of protective relay settings of the AC and DC by primary injection tests.
6. Verify operation of AC breaker, DC breaker, contactors, disconnect switches electrically and manually. Rack-in and rack-out breakers. Verify operation of all protective devices, alarms, measuring instruments, lockout relays and annunciator.
7. Verification of correct operation of all emergency trip stations, interlocks, indicating lights and trip circuits.
8. Verify proper operation of thermostats and anti-condensation heaters.
9. Step-by-step energization of the TPSS, verification of output voltage and protective relay functionality.
10. Energization of all 750 VDC circuits, verification of working alarms and safety devices, verification of voltage at remote end of line and operation of cars from OCS.

D (Vacant)

E (Vacant)

16.14 Panelboards

A Description

1.1 SUMMARY

A. Section Includes:

1. Lighting and appliance panelboards.
2. Power distribution panelboards.

B. Related Specification Sections include but are not necessarily limited to:

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1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.
2. Division 01 - General Requirements.
3. Section 26 05 00 - Electrical: Basic Requirements.

1.2 QUALITY ASSURANCE

A. Referenced Standards:
1. National Electrical Manufacturers Association (NEMA):
a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).
b. PB 1, Panelboards.
2. National Fire Protection Association (NFPA):
a. 70, National Electrical Code (NEC).
3. Underwriters Laboratories, Inc. (UL):
a. 50, Enclosures for Electrical Equipment, Non-Environmental Considerations.
b. 67, Standard for Panelboards.

1.3 SUBMITTALS

A. Shop Drawings:
1. See Specification Section 01 33 00 for requirements for the mechanics and administration of the submittal process.
2. Product technical data.
a. Provide submittal data for all products specified in PART 2 of this Specification Section.
b. See Specification Section 26 05 00 for additional requirements.
3. Fabrication and/or layout drawings:
a. Panelboard layout with alphanumeric designation, branch circuit breakers size and type, as indicated in the panelboard schedules.

B. Contract Closeout Information:
1. Operation and Maintenance Data:
a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.
2. Panelboard schedules with as-built conditions.

B Materials

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:
1. Eaton.
2. General Electric Company.
3. Square D Company.
4. Siemens.

2.2 MANUFACTURED UNITS

A. Standards: NEMA PB 1, NFPA 70, UL 50, UL 67.
B. Ratings:
1. Current, voltage, number of phases, number of wires as indicated on the Drawings.

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2. Panelboards rated 240 Vac or less: 10,000 amp minimum short circuit rating or as indicated in the schedule.
3. Panelboards rated 480 Vac: 14,000 amp minimum short circuit rating or as indicated in the schedule.
C. Construction:
1. Interiors factory assembled and designed such that switching and protective devices can be replaced without disturbing adjacent units and without removing the main bus connectors.
2. Multi-section panelboards: Feed-through or sub-feed lugs.
3. Main lugs: Solderless type approved for copper and aluminum wire.
D. Bus Bars:
1. Main bus bars:
a. Plated aluminum or copper sized to limit temperature rise to a maximum of 65 DegC above an ambient of 40 DegC.
b. Drilled and tapped and arranged for sequence phasing of the branch circuit devices.
2. Ground bus and isolated ground bus, when indicated on the Drawings: Solderless mechanical type connectors.
3. Neutral bus bars: Insulated 100 percent rated or 200 percent rated, when indicated on the Drawings and with solderless mechanical type connectors.
E. Enclosure:
1. Boxes: Code gage galvanized steel, furnish without knockouts.
2. Trim assembly: Code gage steel finished with rust inhibited primer and manufacturers standard paint inside and out.
3. Lighting and appliance panelboard:
a. Trims supplied with hinged door over all circuit breaker handles.
b. Trims for surface mounted panelboards, same size as box.
c. Trims for flush mounted panelboards, overlap the box by 3/4 IN on all sides.
d. Doors lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.
e. Nominal 20 IN wide and 5-3/4 IN deep with gutter space in accordance with NFPA 70.
f. Clear plastic cover for directory card mounted on the inside of each door.
g. If NEMA 3R or NEMA 12 rated: Door gasketed.
4. Power distribution panelboard:
a. Trims cover all live parts with switching device handles accessible.
b. Less than or equal to 12 IN deep with gutter space in accordance with NFPA 70.
c. Clear plastic cover for directory card mounted front of enclosure.
d. If NEMA 3R or NEMA 12 rated: Doors gasketed and lockable with corrosion resistant chrome-plated combination lock and catch, all locks keyed alike.
F. Overcurrent and Short Circuit Protective Devices:
1. Main overcurrent protective device:
a. Molded case circuit breaker.

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2. Branch overcurrent protective devices:
a. Mounted molded case circuit breaker.
3. Factory installed.

C Construction

3.1 INSTALLATION

A. Install as indicated on the Drawings, in accordance with the NFPA 70, and in accordance with manufacturer's instructions.

B. Support panelboard enclosures from wall studs or modular channels support structure, per Specification Section 26 05 00.

C. Provide NEMA 1, NEMA 3R or NEMA 12 rated enclosure as indicated on the Drawings.

D. Provide each panelboard with a typed directory:

1. Identify all circuit locations in each panelboard with the load type and location served.

2. Mechanical equipment shall be identified by Owner-furnished designation if different than designation indicated on the Drawings.

3. Room names and numbers shall be final building room names and numbers as identified by the Owner if different than designation indicated on the Drawings

D (Vacant)

E (Vacant)

16.15 Central Emergency Lighting Inverter

A Description

1.1 SUMMARY

A. Section Includes:

1. Material and installation requirements for:

a. Central emergency lighting inverter.

B. Related Specification Sections include but are not necessarily limited to:

1. Division 00 - Bidding Requirements, Contract Forms, and Conditions of the Contract.

2. Division 01 - General Requirements.

3. Section 26 05 00 - Electrical: Basic Requirements.

4. Section 26 08 13 - Acceptance Testing.

1.2 QUALITY ASSURANCE

A. Referenced Standards:

1. National Electric Manufacturers Association (NEMA):

a. 250, Enclosures for Electrical Equipment (1000 Volts Maximum).

2. National Fire Protection Association (NFPA):

a. 70, National Electrical Code (NEC).

b. 101, Life Safety Code.

3. Underwriters Laboratories, Inc. (UL):

NOT FOR CONSTRUCTION

a. 924, Standard for Emergency Lighting and Power Equipment.

1.3 SYSTEM DESCRIPTION

A. An on-line uninterruptible power supply for the emergency operation of incandescent and fluorescent emergency lighting loads and other emergency loads (e.g., security and fire alarm systems).

1. The system shall provide full light output for a minimum of 1.5 HRS.

1.4 SUBMITTALS

A. Shop Drawings:

1. See Specification Section 01 33 04 for requirements for the mechanics and administration of the submittal process.

2. Product technical data:

a. Provide submittal data for all products specified in PART 2 of this Specification Section.

b. Descriptive bulletins.

c. Installation instructions.

d. See Specification Section 26 05 00 for additional requirements.

3. Fabrication and/or layout drawings:

a. Cabinet outline drawings indicating dimensions, weights, heat loss, input/output connection locations and required clearances.

b. Wiring diagrams.

B. Contract Closeout Information:

1. Operation and Maintenance Data:

a. See Specification Section 01 33 04 for requirements for the mechanics, administration, and the content of Operation and Maintenance Manual submittals.

B Materials

2.1 ACCEPTABLE MANUFACTURERS

A. Subject to compliance with the Contract Documents, the following manufacturers are acceptable:

1. Controlled Power Company.

2. LightGuard.

3. Lithonia Lighting.

4. Myers Power Products.

5. PowerClone.

2.2 COMPONENTS

A. Standards: UL 924.

B. Electrical Characteristics:

1. System configuration:

a. Off-line (Standby): 50 ms transfer time for non-HID lighting loads.

b. Off -line (Line Interactive): 2 ms transfer time for HID and non-HID lighting loads.

c. On-line (Double conversion): 0 ms transfer time for HID and non-HID lighting loads.

2. System capacity:

a. As indicated on the Drawings.

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b. When normally off system is utilized, the unit shall have the capacity for the required amount of inrush current expected from luminaire ballasts.
3. Input and output:
a. Voltage: As indicated on the Drawings.
b. Number of phases: As indicated on the Drawings.
c. Frequency: 60 Hz.
4. Total Harmonic Distortion:
a. Less than 3 percent with linear load.
b. Less than 5 percent with non-linear load.
5. System efficiency:
a. Off-line: 95 percent.
b. On-line: Over-all efficiency, input to output, at least 85 percent with the battery fully charged and the inverter supplying full-rated load.
C. Rectifier and/or Battery Charger:
1. Solid-state equipment.
2. Controls necessary to convert incoming AC power to regulated DC power for input to the inverter and for battery charging.
3. Battery charger voltage: 2 percent RMS maximum.
D. Inverter:
1. Solid-state equipment.
2. Controls to convert DC power from the rectifier or battery to regulated AC power for supporting critical load.
E. Maintenance Bypass Switch:
1. An external or internal, wrap around, make-before-break switch for complete isolation of the inverter output terminals.
F. Battery:
1. Maintenance free, sealed lead calcium.
2. 90 minutes of run time at full load.
3. Battery charger to recharge fully discharged batteries within 24 HRS.
G. Input Protection:
1. Input circuit breaker.
2. Overload capacity:
a. 100 percent continuous.
b. Minimum of 115 percent for 5 minutes.
H. Output Distribution:
1. Normally ON 20A circuit breakers with neutral and ground buses.
I. Display, Alarm and Testing Functions:
1. Supervision and display panel:
a. Microprocessor controlled.
b. Alphanumeric display and optional indicator lights.
c. Touch pad.
d. Control, programming and data logging functions.
2. Alphanumeric display or in combination with indicating lights shall display, at a minimum:
a. Input voltage.
b. Output voltage.

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c. Battery voltage.
d. Battery current.
e. Output current.
f. Output VA.
g. On AC power.
h. On battery power.
i. Battery charging.
j. System temperature.
k. System fault.
3. Audible alarm for alarm conditions.
a. High and low battery charger voltage.
b. High and low AC input voltage.
c. Near low and low battery voltage.
d. Load reduction fault.
e. High ambient temperature.
f. Inverter fault
g. Output fault and overload.
h. Output circuit breaker trip.
4. Common output contact for remote monitoring of alarm conditions.
5. Programmable self-diagnostics test with user selectable battery test intervals.
J. Enclosure:
1. Minimum of 14 GA steel.
2. Free standing.
3. NEMA 1.
4. Forced air cooling as required by manufacturer.
5. Factory-applied paint coating system.
2.3 PERFORMANCE
A. Normal Operation:
1. On-line system shall supply power to the load from the AC source through the rectifier and/or inverter.
2. Battery charger to maintain a ripple free float charge on the batteries.
B. Emergency Operation:
1. Upon the failure or unacceptable AC power, supply power to the load to be derived from the batteries through the inverter.
2. An on-line system shall have no break or interruption of power to the load on failure or restoration of AC power.

C. Automatic Restart:
1. If the power outage exceeds 90 minutes and the batteries are fully discharged, the unit may shut down, but automatically restart once the AC power returns to power the load and recharge the batteries.
D. Automatic Battery Testing:
1. The unit shall automatically test the batteries at the programmed intervals.
2. The test data shall be logged into the data logger.

NOT FOR CONSTRUCTION

C Construction

3.1 INSTALLATION

A. Install in accordance with manufacturer's instructions, NFPA 70 and NFPA 101.

B. Arrange as shown on the Drawings.

3.2 FIELD QUALITY CONTROL

A. Acceptance Testing: See Specification Section 26 08 13.

B. A qualified factory-trained manufacturer's representative shall certify in writing that the equipment has been installed, adjusted and tested in accordance with the manufacturer's recommendations.

3.3 TRAINING

A. Provide 4 HRS of on-site training in the operation and maintenance of the central emergency lighting inverter and its components.

D (Vacant)

E (Vacant)

17. Communications.

Communications specifications are under development and will be provided at a later time.

18. Fare Collection.

Fare Collection specifications are under development and will be provided at a later time.

19. Signing and Marking.

19.1 Signs and Supports

Complete work in accordance to section 638 of the standard specifications and as herein provided.

Revise subsection 638.1 of the standard specifications as follows:

This section describes moving, removing, revising, or erecting City of Milwaukee owned signs and supports.

19.2 Left Turn Queue Box, Item SPV.0060.2500.

A Description

This item includes composition of a left turn queue box pavement marking.

B Materials

NOT FOR CONSTRUCTION

Furnish and apply preformed thermoplastic marking material from the city's approved products list. Consideration should be given to selecting pavement marking materials that will minimize loss of traction for cyclists.

B.1 Composition

Material must conform to AASHTO M249-79.

B.1.1 Glass Beads

B.1.1.1 Intermixed

Material must contain at least thirty percent intermixed graded glass beads by weight. Beads shall be clear and transparent. Not more than twenty percent of beads shall consist of irregular fused spheroids, or silica. The index of refraction shall not be less than 1.50.

B.1.1.2 Surface

Material must have factory applied coated surface beads in addition to intermixed beads at a rate of ½ lb. (±20%) per 11 sq. ft. Surface beads must meet the following specifications:

- Minimum 80% rounds
- Minimum refractive index of 1.5
- Minimum SiO_2 content of 70%
- Maximum iron content of 0.1%

B.2 Thickness

Material shall be 90 mils thick.

B.3 Slip Resistance

Material shall test at greater than 60 BPN slip resistance when tested according to ASTM E 303.

B.4 Retroreflectivity

White preformed reflective marking materials shall have a minimum of 275 $mcd \cdot m^{-2} \cdot lx^{-1}$ as measured using a Delta LTL 2000 or LTL-X Retroreflectometer.

B.5 Refraction

Material must have an index of refraction of greater than 1.50.

C Construction

C.1 General

For quality assurance, provide the project engineer evidence of manufacturer training in the proper placement and installation of epoxy pavement marking.

C.2 Installation

Materials shall be applied using propane torch method. Pavement shall be clean, dry and free of debris. For application on Portland concrete, a compatible primer may be applied prior to application to ensure proper adhesion.

D Measurement

The City will measure Left Turn Queue Boxes by the unit, acceptably placed and meeting post-application retroreflectivity and slip resistance parameters.

E Payment

The City will pay for measured quantities at the contract unit price under the following bid item:

NOT FOR CONSTRUCTION

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.2500	Left Turn Queue Box	Each

Payment is full compensation for cleaning and preparing the pavement surface, furnishing and installing the material; and for furnishing all labor, tools, equipment and incidentals necessary to complete the contract work.

19.3 Extra Visible Preferential Bike Lane Marking, Item SPV.0090.2505.

A Description

This item includes pavement marking utilized to provide extra visibility to preferential bike lane.

B Materials

Furnish and apply preformed thermoplastic marking material from the city's approved products list. Consideration should be given to selecting pavement marking materials that will minimize loss of traction for cyclists.

B.1 Composition

Material must conform to AASHTO M249-79.

B.1.1 Glass Beads

B.1.1.1 Intermixed

Material must contain at least thirty percent intermixed graded glass beads by weight. Beads shall be clear and transparent. Not more than twenty percent of beads shall consist of irregular fused spheroids, or silica. The index of refraction shall not be less than 1.50.

B.1.1.2 Surface

Material must have factory applied coated surface beads in addition to intermixed beads at a rate of ½ lb. (±20%) per 11 sq. ft. Surface beads must meet the following specifications:

- Minimum 80% rounds
- Minimum refractive index of 1.5
- Minimum SiO_2 content of 70%
- Maximum iron content of 0.1%

B.2 Thickness

Material shall be 90 mils thick.

B.3 Slip Resistance

Material shall test at greater than 60 BPN slip resistance when tested according to ASTM E 303.

B.4 Retroreflectivity

White preformed reflective marking materials shall have a minimum of 275 $mcd \cdot m^{-2} \cdot lx^{-1}$ as measured using a Delta LTL 2000 or LTL-X Retroreflectometer.

B.5 Refraction

Material must have an index of refraction of greater than 1.50.

C Construction

NOT FOR CONSTRUCTION

C.1 General
For quality assurance, provide the project engineer evidence of manufacturer training in the proper placement and installation of epoxy pavement marking.
C.2 Installation
Materials shall be applied using propane torch method. Pavement shall be clean, dry and free of debris. For application on Portland concrete, a compatible primer may be applied prior to application to ensure proper adhesion.

D Measurement
The City will measure Extra Visible Preferential Bike Lane Marking by the linear foot, acceptably placed and meeting post-application retroreflectivity and slip resistance parameters.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0090.2505	Extra Visible Preferential Bike Lane Marking	LF

Payment is full compensation for cleaning and preparing the pavement surface, furnishing and installing the material; and for furnishing all labor, tools, equipment and incidentals necessary to complete the contract work.

20. Architectural/Miscellaneous/Incidental Construction.

20.1 Survey Project, Item SPV.0105.9005.

A Description
Perform work conforming to standard spec 105.6 and 650. This special provision describes modifying standard specs 105.6 and 650 and as follows to define the requirements for construction staking for this contract.

Replace standard spec 105.6.2 with the following:

The City will not perform any construction staking for this contract. Obtain engineer's approval prior to performing all survey required to lay out and construct the work under this contract.

The survey includes establishing horizontal and vertical position for all aspects of construction including but not limited to storm sewer, subgrade, base, curb, gutter, curb and gutter, drainage structures, pavement, pavement markings (temporary and permanent), overhead signs, local street lighting, electrical installations, supplemental control, traffic signals, utilities, conduit, landscaping elements, irrigation system layout, , traffic control items, etc.

NOT FOR CONSTRUCTION

The City may choose to perform quality assurance surveys during the project. These quality assurance surveys do not relieve the responsibility for performing all survey work required to lay out and construct the work under this contract.

Delete standard spec 650.1.

B (Vacant)

C Construction
Replace standard specs 650.3.1 (5) and 650.3.1 (6) with the following:

Perform survey work using global positioning or conventional methods. Establish additional benchmarks and control points as necessary to support the method of operation, or as the engineer directs. Do not use global positioning methods to establish the following:

1. Concrete pavement vertical locations.
2. Curb, gutter, and curb and gutter vertical locations.
3. Storm Sewer layout horizontal or vertical locations, including but not limited to structure centers, offsets, access openings, rim and invert elevations.

Make the survey notes and computations available to the engineer within 24 hours as the work progresses unless a longer period is approved by the engineer.

Replace standard spec 650.3.3.1 with the following:

Under the Survey Project bid item, global positioning system (GPS) machine guidance for conventional subgrade staking on all or part of the work may be substituted. The engineer may require reverting to conventional subgrade staking methods for all or part of the work at any point during construction if, in the engineer's opinion, the GPS machine guidance is producing unacceptable results.

D Measurement
Replace standard spec 650.4 with the following:

The City will measure Survey Project as a single lump sum unit of work, acceptably completed.

E Payment
Replace standard spec 650.5 with the following:

The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.9005	Survey Project	LS

NOT FOR CONSTRUCTION

Payment is full compensation for performing all survey work required to lay out and construct all work under this contract. The City will not make final payment for any staking item until the contractor submits all survey notes and computations used to establish the required lines and grades to the engineer within 24 hours of completing this work. The City will deduct from payments due the contractor for the additional costs specified in 105.6. No additional payments will be made for restaking due to construction disturbance and knock-outs.

20.2 Salvage and Reinstall Drink Rails, Item SPV.0060.9010.

A Description
This special provision describes removing, salvaging, and reinstalling existing drink rails / bike racks at the Colectivo Coffee on E. St. Paul Ave. in accordance with section 204 of the standard specifications and as hereinafter provided.

B (Vacant)

C Construction
The existing drink rails shall be removed and salvaged where shown on the plans. The contractor shall include the cost of any and all methods that may be needed for the expected removal of the materials under this bid item.

The contractor shall be responsible for storing the drink rails from the time they are removed until the time they are reinstalled.

Reinstall the existing drink rails where shown on the plans. The final location of the drink rails shall be coordinated with Colectivo and approved by the engineer.

D Measurement
The City will measure Salvage and Reinstall Drink Rails by each unit acceptably removed, salvaged, and reinstalled.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0060.9010	Salvage and Reinstall Drink Rails	Each

Payment is full compensation for removing, storing, and reinstalling existing drink rails; and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the contract work.

20.3 Salvage and Reinstall Pavers, Item SPV.0165.9015.

A Description
This special provision describes removing, salvaging, and reinstalling existing pavers as described in section 204 of the standard specifications and as hereinafter.

NOT FOR CONSTRUCTION

Salvage granite pavers from intersection of N. Milwaukee St and E. Mason St.

B Materials
Bedding and Leveling Material: ASTM C33 or AASHTO M43, #10 graded clean course concrete sand, 1" depth.

C Construction
Spread leveling sand evenly over the entire area to be paved, screed to a level 5 ½" below paver finished grade. Protect screeded leveling course from damage until covered with paver units.

The pavers shall be laid matching existing patterns as approved by the engineer.

The pavers shall be laid "hand tight" in such a manner that the desired pattern is maintained and the joints between the stones do not exceed 1/16". The gaps at the edges of the paved surface shall be filled with stones cut to fit tightly. Pavers shall be cut to a straight, even surface without cracks or chips to fit closely around existing surface features.

Any pavers damaged will be replaced incidental to this item.

Cut pavers with power saw equipment designed to cut masonry with clean, sharp unchipped edges. Cut units as required to match existing pattern as directed by the engineer and to fit adjoining work neatly.

Any cut pieces smaller than 15% of a whole unit paver shall be set with an engineer-approved industrial epoxy on one vertical side to adhere to an adjacent paver.

Use full units without cutting wherever possible. Where cutting is required, use the largest size units possible. Avoid use of small pieces of pavers or large joint spaces.

Pavers shall be vibrated to their final level by 2 or 3 passes of vibrating plate compactor.

After first vibration, sand shall be brushed over the surface and vibrated into the joints with additional passes of the plate vibrator so as to completely fill joints. Wash sand into joints with water spray after first vibration, let pavers dry, place additional sand on pavers and vibrate a second time. Surplus sand shall be swept from the surface and the entire site left clean.

Restrict traffic from concrete paver surfaces during setting of units and until completion of installation.

Protect pavers from damage until final acceptance.

D Measurement

NOT FOR CONSTRUCTION

The City will measure Salvage and Reinstall Pavers by each square foot acceptably completed.

E Payment
The City will pay for measured quantities at the contract unit price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0165.9015	Salvage and Reinstall Pavers	SF

Payment is full compensation for removing, storing, furnishing, vibrating, compacting, setting bed sand, cutting, and reinstalling existing pavers; and for furnishing all labor, tools, equipment, materials, and incidentals necessary to complete the contract work.

20.4 Station Stop Equipment, Item SPV.0105.9020.

A Description

Furnish all labor, material and tools required for the satisfactory completion of the equipment for the Milwaukee Streetcar stops in accordance with the drawings and as set forth in these specifications.

Included are the following:

1. Streetcar stop shelters.
2. Leaning rails and handrails.
3. Bike racks.
4. Trash receptacles.
5. Benches.
6. Porcelain-enamel signs

B Materials

B.1 Coordination
Coordinate installation of streetcar stop equipment that is anchored to or that receives other work. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

B.2 Submittals
Product Data: For each type of manufactured product.

Shop Drawings: For each type of fabricated product. Include plans, elevations, sections, and details of fabrications and their connections. Show anchorage and accessory items.

Samples for Initial Selection: For each type of exposed finish requiring color selection.

Samples for Verification

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Each painted finish.

Tactile warning surface, in manufacturer's standard sizes unless otherwise indicated, showing edge condition, truncated-dome pattern, texture, color, and cross section; with fasteners and anchors.

Delegated-Design Submittals:

For steel shelter frames indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

For glass indicated to comply with performance requirements and design criteria, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

For railings, including analysis data signed and sealed by the qualified professional engineer responsible for their preparation

Certificates.

Mill Certificates: Signed by stainless-steel manufacturers, certifying that products furnished comply with requirements.

Welding certificates.

Maintenance data.

B.3 Quality Assurance

Welding Qualifications: Qualify procedures and personnel according to the following:

AWS D1.1/D1.1M, "Structural Welding Code - Steel."
AWS D1.6/D1.6M, "Structural Welding Code - Stainless Steel."

B.4 Field Conditions

Field Measurements: Verify actual locations of construction contiguous with streetcar stop equipment by field measurements before fabrication.

B.5 Performance Requirements

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

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detrimental effects.

Temperature Change: 130 deg F, ambient; 200 deg F, material surfaces.

Delegated Design: Engage a qualified professional engineer to design steel shelter frames, glazing and railings.

Glazing Structural Performance: Glazing shall withstand the following design loads within limits and under conditions indicated determined according to the IBC and ASTM E 1300.

Design Wind Pressures: Determine design wind pressures applicable to Project according to ASCE/SEI 7, based on heights above grade indicated on Drawings.

Basic Wind Speed: 90 mph.
Importance Factor: 1.0
Exposure Category: B

Design Snow Loads: 30 lbf/sq. ft.

Probability of Breakage for Sloped Glazing: For glass surfaces sloped more than 15 degrees from vertical, design glass for a probability of breakage not greater than 0.001.

Differential Shading: Design glass to resist thermal stresses induced by differential shading within individual glass lites.

Railing Structural Performance: Railings, including attachment to platform construction, shall withstand the effects of gravity loads and the following loads and stresses within limits and under conditions indicated:

Handrails and Leaning Rails:

Uniform load of 50 lbf/ ft. applied in any direction.
Concentrated load of 200 lbf applied in any direction.

Uniform and concentrated loads need not be assumed to act concurrent

B.6 Metals

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

Steel Plates, Shapes, and Bars: ASTM A 36/A 36M.

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Steel Tubing: ASTM A 500/A 500M, cold-formed, or ASTM A 513.

Steel Pipe: ASTM A 53/A 53M, Standard Weight (Schedule 40) unless otherwise indicated.

Steel Sheet: Cold-rolled steel sheet, ASTM A 1008/A 1008M, or hot-rolled steel sheet, ASTM A 1011/A 1011M, commercial steel Type B.

Cast Iron: Either gray iron, ASTM A 48/A 48M, or malleable iron, ASTM A 47/A 47M, unless otherwise indicated.

Stainless Steel Sheet, Strip, and Plate: ASTM A 240/A 240M or ASTM A 666, Type 316L.
Stainless Steel Tubing: ASTM A 554, Grade MT 316L.

Stainless Steel Cable Assemblies:

Wire Rope: 1-by-19 wire rope made from wire complying with ASTM A 492, Type 316.

Wire-Rope Fittings: Type 316 stainless steel terminals, turnbuckles, adjusters, and fixed ends and other hardware as recommended by manufacturer for installation conditions, and with capability to sustain, without failure, a load equal to minimum breaking strength of wire rope with which they are used.

Aluminum Plate and Sheet: ASTM B 209, Alloy 6061-T6.

B.7 Glass

Tempered Safety Glass: Clear laminated glass with two plies of fully tempered float glass.

Minimum Thickness of Each Glass Ply: 6 mm.

Interlayer Thickness: 0.060 inch.

Safety glazing labeling required.

Glazing Publications: Comply with published recommendations of glass product manufacturers and organizations below unless more stringent requirements are indicated. See these publications for glazing terms not otherwise defined in this Section or in referenced standards.

GANA Publications: "Laminated Glazing Reference Manual" and "Glazing Manual."

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AAMA Publications: AAMA GDSG-1, "Glass Design for Sloped Glazing," and AAMA TIR A7, "Sloped Glazing Guidelines."

IGMA Publication for Sloped Glazing: IGMA TB-3001, "Guidelines for Sloped Glazing."

Safety Glazing Labeling: Where safety glazing is indicated, permanently mark glazing with certification label of the SGCC or another certification agency acceptable to authorities having jurisdiction. Label shall indicate manufacturer's name, type of glass, thickness, and safety glazing standard with which glass complies.

Thickness: Where glass thickness is indicated, it is a minimum. Provide glass that complies with performance requirements and is not less than the thickness indicated.

Fully Tempered Float Glass: ASTM C 1048, Kind FT (fully tempered), Condition A (uncoated) unless otherwise indicated, Type I, Class 1 (clear), Quality-Q3.

Laminated Glass: ASTM C 1172. Use materials that have a proven record of no tendency to bubble, discolor, or lose physical and mechanical properties after fabrication and installation.

Construction: Laminate glass with polyvinyl butyral interlayer to comply with interlayer manufacturer's written instructions.

Interlayer Thickness: Provide thickness not less than that indicated and as needed to comply with requirements.

Interlayer Color: Clear for wall panels, translucent for roof panels, (architect to approve color).

B.8 Wood

Ironwood: Ipe (Tabebuia serratifolia) meeting 'Architectural Woodwork Standards' grading rules for Honduras Mahogany, Premium Grade, plain sawn.

B.9 Fasteners

General: Unless otherwise indicated, provide Type 316 stainless-steel fasteners.

Anchors: Anchors capable of sustaining, without failure, a load equal to six times the load imposed when installed in unit masonry and four times the load imposed when installed in concrete, as determined by testing according to ASTM E 488/E 488M, conducted by a qualified independent testing agency.

Post-Installed Anchors: Torque-controlled expansion anchors or chemical anchors.

NOT FOR CONSTRUCTION

Material: Alloy Group 2 stainless-steel bolts, ASTM F 593, and nuts, ASTM F 594.

Stainless Steel Glass Standoff Fittings:

Manufacturers: Subject to compliance with requirements, available manufacturers offering products that may be incorporated into the Work include, but are not limited to, the following:

Custom Hardware Manufacturing, Inc. (CHMI)
C. R. Lawrence
KL Megla Architectural Systems
R & B Wagner, Inc.

B.10 Miscellaneous Materials

Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

For stainless-steel, provide type and alloy as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

Etching Cleaner for Galvanized Metal: Complying with MPI#25.

Galvanizing Repair Paint: High-zinc-dust-content paint complying with SSPC-Paint 20 and compatible with paints specified to be used over it.
Shop Primer for Galvanized Steel: Primer formulated for exterior use over zinc-coated metal and compatible with finish paint system indicated.

Epoxy Intermediate Coat: Complying with MPI #77 and compatible with primer and topcoat.

Topcoat: Complying with MPI #72 and compatible with undercoat.

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

B.11 Fabrication, General

Shop Assembly: Preassemble items in the shop to greatest extent possible. Disassemble units only as necessary for shipping and handling limitations. Use connections that maintain structural value of joined pieces. Clearly mark units for reassembly and coordinated installation.

NOT FOR CONSTRUCTION

Cut, drill, and punch metals cleanly and accurately. Remove burrs and ease edges to a radius of approximately 1/32 inch unless otherwise indicated. Remove sharp or rough areas on exposed surfaces.

Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

Form exposed work with accurate angles and surfaces and straight edges.

Weld metal corners and seams continuously to comply with the following:

> Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
>
> Obtain fusion without undercut or overlap.
>
> Remove welding flux immediately.
>
> At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

Form exposed connections with hairline joints, flush and smooth, using concealed fasteners or welds where possible. Where exposed fasteners are required, use Phillips flat-head (countersunk) fasteners unless otherwise indicated. Locate joints where least conspicuous.

Fabricate seams and other connections that are exposed to weather in a manner to exclude water. Provide weep holes where water may accumulate.

Close exposed ends of metal members with flat plate except as otherwise indicated.

Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

Provide for anchorage of type indicated; coordinate with supporting structure. Space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

B.12 Streetcar Stop Equipment
B.12.1 Streetcar Stop Shelters

Fabricate steel structure from steel shapes tubes, plates, angles and bars of welded construction unless otherwise indicated. Fabricate to sizes, shapes, and profiles indicated and as necessary to receive adjacent construction.

NOT FOR CONSTRUCTION

Provide cutouts, fittings, and anchorages as needed to coordinate assembly and installation with other work.

Stainless Steel Tension Rods: Stainless steel units, 1/2 inch diameter high strength threaded rod with architectural fork end, pin and lock covers. Fabricate units in lengths necessary to accurately fit openings and conditions.

Basis of Design: Subject to compliance with requirements, provide Macalloy S460 or comparable product.

Fabricate glazing units in sizes required to fit openings indicated for Project, with edge and face clearances, edge and surface conditions, and bite complying with written instructions of product manufacturer and referenced glazing publications, to comply with system performance requirements.

Grind smooth and polish exposed glass edges and corners.

Fabricate woodwork to dimensions, profiles, and details indicated. Ease edges to 1/8 inch radius.

B.12.2 Leaning Rails and Handrails

Fabricate rails to comply with requirements indicated for design, dimensions, member sizes and spacing, details, finish, and anchorage, but not less than that required to support structural loads.

Form changes in direction by bending. Use jigs to produce uniform curvature for each repetitive configuration required. Maintain cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of components.

Make up stainless-steel cable assemblies in the shop to field-measured dimensions with fittings machine swaged. Minimize amount of turnbuckle take-up used for dimensional adjustment so maximum amount is available for tensioning wire ropes. Tag wire-rope assemblies and fittings to identify installation locations and orientations for coordinated installation.

Basis of Design: Subject to compliance with requirements, provide Feeney Wire Rope & Rigging: Cable Rail or comparable product by one of the following:

Carl Stahl DecorCable, Inc.
Esmet, Inc.

Wire Rope Diameter: 3/16 inch.

NOT FOR CONSTRUCTION

For posts set in concrete, provide steel sleeves not less than 6 inches long with inside dimensions not less than 1/2 inch greater than outside dimensions of post, with metal plate forming bottom closure.

B.12.3 Bike Racks

Serpentine type bicycle racks.

Basis of Design: Subject to compliance with requirements, provide DuMor Site Furnishings: Bike Rack 130-50 or comparable product by one of the following:

Bike Rack Company: Wave Style
Columbia Cascade, Cycloops 2170-11

Capacity: 5 bicycles, except as otherwise indicated.

Height: 35 inches

Material: 2-inch diameter (2-3/8-inch O.D.) schedule 40 steel pipe

Finish: Powder-coated in color selected by architect from manufacturer's standard range.

Installation Type: In-ground.

B.12.4 Trash Receptacles

Perforated steel sheet cylindrical waste container with aluminum top and vandal proof cables that attach top to container. Provide plastic liner and precast concrete base for stability.

Basis-of-Design: Subject to compliance with requirements, provide DuMor Site Furnishings: Receptacle 170 -32-FTO, or one of the following:

Ulta Site: Diamond pattern, 32 with flat top FTR-32-8 spun metal lid
Timber Form: Boulevard 2618-FT

Finish: Powder-coated in color selected by architect from manufacturer's standard range.

Liner: 32 gallon heavy duty black plastic liner.

B.12 5 Benches

Product: Powder coated steel frame with Ipe wood seat.

Basis of Design: Subject to compliance with requirements, provide DuMor Site Furnishings: Wood Bench 105 or one of the following:

NOT FOR CONSTRUCTION

Site-craft T Series: T-300
Thomas Steele: Fairway Flat Bench
Timber Form: Diller

•

Color: As selected by Architect from manufacturer's full line.

Mounting: In ground.

B.12.6 Porcelain-Enamel Signs

Steel sheet signs with silk screened graphics and porcelain-enamel finish, in compliance with PEI-1002.

Basis-of-Design: Subject to compliance with requirements, provide porcelain-enamel signs by Standard Signs, Inc, or comparable products by one of the following:

Cherokee Porcelain Enamel Corporation
KVO Industries,Inc.

Steel Sheet: Special purposed “enameling iron or steel” of low metalloid and copper content, especially manufactured and processed for the production of porcelain enamel units for architectural purposes per PEI-201, Manual for Selection of Porcelain Enameling Steels.

Porcelain-Enamel Finish: A substantially vitreous, or glassy, inorganic coating bonded to metal by fusion at a temperature above 1000 degrees F.

Graphics and Colors: As selected by Architect.

B.13 Steel Finishes

Hot-dip galvanize steel streetcar stop equipment, including hardware, after fabrication, except as otherwise indicated.

Comply with ASTM A 123/A 123M for hot-dip galvanized railings.

Comply with ASTM A 153/A 153M for hot-dip galvanized hardware.

Do not quench or apply post galvanizing treatments that might interfere with paint adhesion.

Fill vent and drain holes that are exposed in the finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

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After galvanizing, thoroughly clean components of grease, dirt, oil, flux, and other foreign matter, and treat with etching cleaner.

Apply shop primer to prepared surfaces of components unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Primer need not be applied to surfaces to be embedded in concrete or masonry.

High-Performance Coating: Apply epoxy intermediate and polyurethane topcoats to prime-coated surfaces. Comply with coating manufacturer's written instructions and with requirements in SSPC-PA 1, "Shop, Field, and Maintenance Painting of Steel," for shop painting. Apply at spreading rates recommended by coating manufacturer.

Color and Gloss: As selected by Architect.

B.14 STAINLESS-STEEL FINISH

Remove tool and die marks and stretch lines, or blend into finish.

Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

Directional Satin Finish: No. 4.

When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

C. Construction

C.1 Examination

Before proceeding with each component of the work, examine substrates, areas, and conditions for compliance with requirements for installation tolerances and other conditions affecting performance.

Examine roughing-in for electrical systems to verify actual locations of connections before equipment and fixture installation.

Examine walls, floors, and roofs for suitable conditions where products and systems are to be installed.

Proceed with installation only after unsatisfactory conditions have been corrected. Proceeding with the Work indicates acceptance of surfaces and conditions.

C.2 Preparation

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Field Measurements: Take field measurements as required to fit the Work properly. Recheck measurements before installing each product. Where portions of the Work are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication. Coordinate fabrication schedule with construction progress to avoid delaying the Work.

C.3 Installation

Locate the Work and components of the Work accurately, in correct alignment and elevation, as indicated.

Make vertical work plumb and make horizontal work level.

Comply with manufacturer's written instructions and recommendations for installing products in applications indicated.

Install products at the time and under conditions that will ensure the best possible results. Maintain conditions required for product performance until Substantial Completion.

Conduct construction operations so no part of the Work is subjected to damaging operations or loading in excess of that expected during normal conditions of occupancy.

Sequence the Work and allow adequate clearances to accommodate movement of construction items on site and placement in permanent locations.

Attachment: Provide anchors and fasteners of adequate size and number to securely anchor each component in place, accurately located and aligned with other portions of the Work. Where size and type of attachments are not indicated, verify size and type required for load conditions.

Coordinate installation of anchorages. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete. Deliver such items to Project site in time for installation.

Allow for building movement, including thermal expansion and contraction.

Joints: Make joints of uniform width. Where joint locations in exposed work are not indicated, arrange joints for the best visual effect. Fit exposed connections together to form hairline joints.

In-Ground Posts: One of the following:

Use metal sleeves preset and anchored into concrete for installing posts. After posts are inserted into sleeves, fill annular space between post and sleeve with nonshrink, nonmetallic grout mixed and placed to comply with anchoring material

NOT FOR CONSTRUCTION

manufacturer's written instructions.

Leave anchorage joint exposed with 1/8-inch buildup, sloped away from post.

Surface-Mounted Posts: Anchor to existing construction with expansion anchors. Provide four 3/4 inch bolts at each shelter post unless otherwise indicated.

Embed anchor bolts at least 4 inches in concrete.

C.4 Adjusting and Cleaning

Clean stainless steel by washing thoroughly with clean water and soap and rinsing with clean water.

Touchup Painting: Immediately after erection, clean field welds, bolted connections, and abraded areas of shop paint, and paint exposed areas with the same material as used for shop painting to comply with SSPC-PA 1 requirements for touching up shop-painted surfaces.

Apply by brush or spray to provide a minimum 2.0-mil dry film thickness.

C.5 Protection

Provide final protection and maintain conditions that ensure installed Work is without damage or deterioration at time of Substantial Completion.

Protect finishes of streetcar stop equipment from damage during construction period with temporary protective coverings approved by manufacturers. Remove protective coverings at time of Substantial Completion.

D. Method of Measurement

The City will measure Streetcar stop Equipment, completed in accordance to the contract and accepted, as a single complete unit of work.

E. Basis of Payment

The City will pay for the measured quantity at the contract price under the following bid item:

ITEM NUMBER	DESCRIPTION	UNIT
SPV.0105.9020	Streetcar Stop Equipment	LS

Payment is full compensation for all materials, labor and incidentals for Streetcar Stop Equipment, including streetcar stop shelters, leaning rails and handrails, bike racks, trash receptacles, benches and porcelain-enamel signs, in accordance with the drawings and as set forth in these specifications.

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