SECTION 05091

RAIL WELDING

NOTE:

Section 1 (Parts 1 - 4) of this specification includes rail welding by Electric Flash-Butt Welding method.

Section 2 (Parts 5 - 8) of this specification includes rail welding by the Thermite Rail Welding method.

SECTION 1 - ELECTRIC FLASH-BUTT WELDING

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The work specified in this section shall include the fabrication of continuous welded rail (CWR) strings by electric flash-butt welding, including testing, inspection, and qualification of welding and welders.

B. The work specified in this section shall also include movement of rail from the manufacturer to the Contractor's welding plant, from the welding plant to the welded string storage location and from the storage location to the final placement in track location.

1.02 RELATED SECTIONS

A. Section 05651- General Track Construction

B. Section 05652 - Ballasted Track Construction

C. Section 05653 - Direct Fixation Track Construction

D. Section 05656 - Running Rail

1.03 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering, Vol. I, Chapter 4, Specification for Fabrication of Continuous Welded Rail (latest addition).

B. ASTM E18

C. ASTM E709 (replaced E109)

D. ASTM E94 (replaced E142)

E. ASTM E164

~~F. ASTM E709~~ (duplicate)

G. AWS D1.1

H. USNRC Rules and Regulations, Title 10, Atomic Energy, Part 20.

I. ASNT SNT-TC-1A Recommended Guidelines for Qualification and Certification of Non-Destructive Testing Personnel.

1.04 SUBMITTALS

A. The Contractor shall submit procedures and documentation in accordance with the Section 01300 and as follows.

B. Approval of the following items shall be obtained prior to production welding:
1. Identification of welding plant with internal shear and major items of equipment to be used.
2. Standards of welding machine performance as recommended by the manufacturer.
3. Oscillograph record of each qualification weld showing number and duration of preheat impulses, flashing time, upset current time, platen travel during flashing, and platen travel distance for upset cycle.
4. Report of test results of each qualification weld.
5. Schedule showing string number, length, proposed stockpile location and installation location.

C. Production weld approval shall be based on these items:
1. Oscillograph records of production welds.
2. Production welding record.

D. Deliver five each taper gauges graduated in hundredths of an inch, with cases, to the Engineer. Taper gauges shall become Authority property.

E. Deliver four (4) each 36 inch steel straight edges, as manufactured by L. S. Starrett Company of Athol, Massachusetts, or approved equal, to the Engineer. Straight edges shall become Authority property.

1.05 QUALITY ASSURANCE

A. The Contractor shall inspect rail for straightness at the manufacturer's plant.

B. Plant Qualification

C. General
1. Using the welding plant, personnel and procedures proposed for production welding, make six qualification welds, three for each type of rail.
2. The qualification welds shall be made in the presence of the Engineer. Pieces of the Authority furnished short rails shall be used for making the qualification welds.
3. Weld tests shall provide sufficient detail to establish capability of the welding apparatus to meet specified welding requirements.

D. Qualification Weld Testing: The six qualification welds shall be tested by radiography, hardness testing, metallurgical testing and ultrasonic testing in the following manner:
1. Radiography:
a. Radiography shall be conducted in accordance with ASTM E94 using short wave length radiation. The use of nuclear by products for radiography shall be in accordance with USNRC Rules and Regulations, Title 10, Atomic Energy, Part 20. The transportation, handling and storage of hazardous materials used in the examination of welds shall be performed only by or

under the supervision of a person of proven experience and ability, operating under a proper license.

b. Film shall be capable of producing sharp images, and be free of processing and mechanical defects. High speed, coarse-grained film is prohibited. Fine films shall be used covering head, web and each side of base as shown on **Exhibit 05091-A.** Identify each film by contract number, rail identification, date of test, name of testing agency and the view.

c. Acceptance of the weld shall be based on the weld having full penetration, complete fusion and being free of flaws. A letter shall accompany each film plate bearing information given on the film, certifying compliance with ASTM E94 and stating whether or nor the weld satisfies specified requirements.

d. Radiograph plates shall be compared to ultrasonic scans to determine the ability of ultrasonic equipment to identify inclusions or other weld defects. If necessary, compare radiograph plates with ultrasonic scans using the ultrasonic reference blocks. Results of this comparison shall be made in a separate report and include recommended ultrasonic equipment to be used and sensitivity requirements.

2. Hardness testing:

a. Hardness testing shall be in accordance with current AREMA "Specification for Fabrication of Continuous Welded Rail" (latest edition) and "Specification for the Quality Assurance of Electric Flash-butt Welding of Rail."

b. The hardness test shall be performed in accordance with ASTM E18, using a 150kgf diamond sphere conical penetrator. Hardness and location shall be recorded.

3. Metallurgical Tests:

a. A one foot specimen of each weld shall be sectioned longitudinally through the centerline of the rail. Each specimen shall be etched to enable observation of the hardness pattern, metallurgical properties and the heat affected zone.

b. An acceptable weld as determined by the metallurgical test shall meet the following criteria:

1) Steel shall consist of fine-grained pearlite structure with small interlamellar spacing.

2) The hardness pattern in the etched section shall have a uniform distribution.

3) The heat affected zone shall be parallel and fully extended on both sides of the weld.

4) The weld joint shall be planar.

5) Uniform zone of plastic deformation resulting from upset operation shall extend equally on both sides of the weld point.

c. An 8x10 black and white photograph and a description of the metallurgical properties including grain structure and distribution shall be submitted.

4. Ultrasonic test, slow bend test and magnetic particle test in accordance with the AREMA Manual (latest edition).

5. All test samples are to be permanently marked for identification and returned to the Engineer at the completion of testing.

1.06 DELIVERY, STORAGE AND HANDLING

A. It shall be the Contractor's responsibility to make all arrangements for shipment and handling of the rail. The Contractor shall:

1. Coordinate unwelded rail stick movement from the manufacturer's plant to the welding site by rail and truck as necessary.
2. Obtain any required permits from state, regional or local jurisdictions.
3. Make arrangements for loading, unloading and stacking rail sticks.

B. Handle and store rail so that it is not damaged either before or after welding.
   1. Stacking of sticks shall be as approved by the Engineer and layers shall be separated by wood lathing.
   2. Rail shall be handled in a manner that prevents damage to fasteners, rail and structures.
   3. Rail shall not be dropped or dragged on the trackbed. The use of rollers is required.

PART 2 - PRODUCTS

2.01 RAIL FOR CONTINUOUS WELDED RAIL

A. Rail for the Work shall be furnished by the Contractor in accordance with WMATA Standard Specification Section 05656, Running Rail.

PART 3 - EXECUTION

3.01 PREPARATION FOR WELDING

A. The welding plant shall be set up on Authority property as approved by the Engineer.

B. Rail welding shall be in accordance with the current AREMA Manual "Specification for Fabrication of Continuous Welded Rail" (latest edition), "Specification for the Quality Assurance of Electric Flash-butt Welding of Rail" and as specified herein.

C. Rail for installation in this Contract shall be welded in accordance with a string schedule approved by the Engineer. Strings should be not less than 720 feet in length in order to minimize field connections, unless shorter strings are required to satisfy conditions of rail type or installation. Each string shall be of only one rail type; standard or head hardened rail.

D. Rails shall be welded using an electric flash butt welding plant equivalent to the Chessie System plant at Russell, KY or Amtrak Plant at New Haven, CT. An equivalent portable plant may be set up within the contract area.

E. Rail Inspection Prior to Welding
   1. Inspect each rail end prior to welding for deviations from lateral line in either direction and for upsweep, downsweep or droop.
   2. Rail with upsweep, downsweep or droop and rail failing to comply with the tolerances shown on **Exhibit 05091-B** shall be cut back a sufficient distance to achieve the required alignment. Rails shall be cut clean and within 1/32 inch of square by means of rail saws or abrasive cutting discs.
   3. Torch cutting of rail is prohibited. Cutting shall be done at no additional cost to the Authority.

F. Rail End Preparation for Welding: Immediately prior to welding, all rail ends shall be wire brushed to remove mill scale or other dirt which might hinder the flow of electric current.

G. Alignment in Weld Machine:
   1. Alignment of the rail in the welding machine shall be done on the head of the rail.
   2. Vertical alignment shall provide for a flat running surface within 0.01 inch between the abutting rail ends.
   3. Horizontal alignment shall distribute head width differences evenly between each side of the head. No horizontal offset shall exceed 0.03 inch on either side of the head. No horizontal offset shall exceed 0.10 inch on either side of the base of the rail.

3.02 WELDING OF RAILS

A. All welding procedures shall be approved prior to use and as a minimum shall be in accordance with the following:
   1. Forge welds to point of no further plastic deformation with upset of 5/8 inch minimum.
   2. Each weld to achieve full penetration, complete fusion, and be free of flaws and inclusions.

B. Record welding machine performance with an oscillograph recorder or computer printout.
   1. Record platen movement and current impulses.
   2. The oscillograph record shall be compared with the approved procedure record from the qualification welds. If the record indicates performance which is not in conformance with the approved procedure, the weld will be rejected.
   3. The recorder shall be calibrated each day.

C. If flashing is interrupted with less than ½ inch of flashing distance remaining before upsetting, the rails shall be reclamped and flashing initiated again.

D. Grinding shall be done immediately following welding at an elevated temperature.

E. Welds shall be ground to meet the following finishing tolerances:
   1. A finished deviation of not more than plus or minus 0.005 inch of the parent section of the rail head shall be allowed.
   2. The weld at the top and sides of the rail head shall be finished to plus or minus 0.010 inch of the parent section.
   3. The bottom and sides of rail base shall be finished to within plus or minus 0.010 inch of the parent section.
   4. The web zone, underside of head, web, top of base, both fillet each side, shall be finished to within 1/8 inch of parent contour or closer but shall not be deeper than parent section.
   5. Finishing shall eliminate all cracks visible to the unaided eye.
   6. All notches created by offset conditions or twisted rails shall be eliminated by grinding to blend the variations on both sides of the head and base for a distance of 18 inches.
   7. All fins on the weld due to grinding and/or shear drag shall be removed prior to final inspection.

F. All rails used for electric-flash-butt welds shall have scale removed down to bring metal in those areas of the rail where welding current-carrying electrodes contact the rail. The weld and adjacent rail for a distance clearing the electrodes shall be rejected if the areas of the electrodes contact there is not more than 95% of the mill scales removed. Rails showing evidence of electrode burns shall be rejected. An electrode burn is considered to exist where the metal has been displaced.

3.03 WELD QUALITY AND TESTING

A. Inspection and Testing of Welds: Each weld shall be tested and examined by the magnetic particles method, ultrasonic examination method and by the visual method as follows:
   1. Magnetic Particle Examination:
      a. Magnetic particle inspection shall be performed using the dry powder method in accordance with ASTM E709, with the rail at a temperature of less than 800 deg. F.

b. To be acceptable the particles shall form a regular longitudinal pattern indicating homogeneity of the weld and freedom from defects, surface irregularities and internal discontinuities.

2. Ultrasonic Examination:
   a. Ultrasonic examination shall be performed by an independent testing agency under contract to the Authority who will perform ultrasonic examination to the following standards:
   b. Subsequent to the magnetic particle inspection, all welds will be ultrasonically inspected in accordance with ASTM E164.
   c. Ultrasonic test equipment will be capable of detecting a 3/64 inch discontinuity, 6-1/2 inches below the top rail. The sensitivity and resolutions of the proposed equipment shall use appropriate area amplitude and distance amplitude reference blocks made of material similar to the rail steels being tested.
   d. All equipment will be equipped with a distance amplitude correction feature. The equipment will be calibrated daily using an 11W calibration block made of rail steel.
   e. All welds giving fault indication in ultrasonic testing shall be cut out and the rails rewelded according to these specifications.
   f. The Contractor shall provide a weather resistant enclosure with adequate ventilation and light for ultrasonic inspection.
3. Visual Inspection for Final Alignment of Finished Welds:
   a. The combined vertical offset and crown camber at ambient temperature shall not exceed 0.060 inches as shown on **Exhibit 05091-C, Fig. 1**.
   b. No dip camber shall be allowed as shown on **Exhibit 05091-C, Fig. 2**.
   c. Combined horizontal offer and horizontal kink camber at ambient temperature shall not exceed 0.060 inches as shown on **Exhibit 05091-C, Fig. 3**.
   d. Welds shall be free of cracks, fins, and sharp edges.

B. Correction of Defective Welds: Each production weld failing to meet all acceptance criteria will be considered defective. This shall include welds considered defective by the Authority contracted Ultrasonic Inspector.
1. Defective welds shall be cut out by means of rail saw or abrasive disc.
2. Use extra initial flash to burn off cut surface, reclamp, and reweld.
3. Rewelds shall be inspected as specified for initial welds.

C. Submit Production Welding Records to the Engineer at the end of each days production.
1. Oscillograph record of each weld and reweld.
2. Production welding record in accordance with **Exhibit 05091-D and 05091-E**.

D. Marking of Rail Strings:
1. Mark each end and every 100 feet of each rail string with a paint suitable for application to steel and which is weather resistant for a period of two years. High strength rail strings shall be marked with orange paint. Standard rail strings shall be marked with white paint.
2. Each string shall be sequentially numbered and the beginning of welding end marked to permit correlation of each weld with the Production Welding Record.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement and payment for work specified in this Section shall be made in the following manner:
1. No separate measurement.

4.02 PAYMENT

A. Compensation for work specified in this Section will be made in the following manner:
1. Included in the price of the work of which it is a part.

SECTION 2 - THERMITE RAIL WELDING

PART 5 - GENERAL

5.01 SECTION INCLUDES

A. The work specified in this section shall include the fabrication of continuous welded rail (CWR) strings by thermite rail welding, including testing, inspection, and qualification of welding and welders.

B. The work specified in this section shall also include movement of rail from the manufacturer to the Contractor's welding plant, from the welding plant to the welded string storage location and from the storage location to the final placement in track location.

5.02 RELATED SECTIONS

A. Section 05651- General Track Construction

B. Section 05652 - Ballasted Track Construction

C. Section 05653 - Direct Fixation Track Construction

D. Section 05656 - Running Rail

5.03 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA) Manual for Railway Engineering, Vol. I, Chapter 4, Specification for Fabrication of Continuous Welded Rail (latest addition).

B. ASTM E18

C. ASTM E709 (replaced E109)

D. ASTM E94 (replaced E142)

E. ASTM E164

~~F. ASTM E709~~ (duplicate)

F. AWS D1.1

G. USNRC Rules and Regulations, Title 10, Atomic Energy, Part 20.

H. ASNT SNT-TC-1A Recommended Guidelines for Qualification and Certification of Non-Destructive Testing Personnel.

5.04 SUBMITTALS

A. The Contractor shall submit procedures and documentation in accordance with the Section 01300 and as follows.

B. Approval of the following items shall be obtained prior to production welding:
1. Identification of welding kit and major items of equipment to be used.
2. Record of welding kit performance as recommended by the manufacturer.
3. Record of each qualification weld, including manufacturer's kit shelf life/expiration date, rail temperature before and after weld installation, and straightness test acceptance.
4. Report of test results of each qualification weld.
5. Schedule showing string number, length, proposed stockpile location and installation location.

C. Production weld approval shall be based on these items:
1. Ultrasonic test results .
2. Production welding record.

D. Deliver two each rail thermometers and taper gauges graduated in hundredths of an inch, with cases, to the Authority Representative. Taper gauges shall become Authority property.

E. Deliver two each 36 inch steel straight edges, as manufactured by L. S. Starrett Company of Athol, Massachusetts, or approved equal, to the Authority Representative. Straight edges shall become Authority property.

5.05 QUALITY ASSURANCE

Quality Assurance/Quality Control shall be in accordance with the Design-Builder's Construction Quality Management Plan.

A. The Contractor shall inspect rail for straightness in the initial qualification weld.

B. Qualification
1. Initial welds shall be inspected and tested in the presence of qualified Authority personnel to assure quality of procedures and workmanship.

C. General
1. Using the welding kit, personnel and procedures proposed for production welding, make four qualification welds, two for each type of rail. These welds may be retained for the project if acceptable.
2. The qualification welds shall be made in the presence of the Authority Representative.
3. Weld tests shall provide sufficient detail to establish capability of the welding apparatus and procedures to meet specified welding requirements with the rail supplied.

D. Qualification Weld Testing - The six qualification welds shall be tested by ultrasonic testing in the following manner:
1. Ultrasonic test, in accordance with AREMA Manual requirements (latest edition).
2. All test samples are to be permanently marked for identification and returned to the Authority Representative at the completion of testing.

5.06 DELIVERY, STORAGE AND HANDLING

A. It shall be the Contractor's responsibility to make all arrangements for shipment and handling of the rail. The Contractor shall:
   1. Coordinate unwelded rail stick movement from the manufacturer's plant to the welding site by rail and truck as necessary.
   2. Obtain any required permits from state, regional or local jurisdictions.
   3. Make arrangements for loading, unloading and stacking rail sticks.

B. Handle and store rail so that it is not damaged either before or after welding.
   1. Stacking of sticks shall be as approved by the Authority Representative and layers shall be separated by wood lathing.
   2. Rail shall be handled in a manner that prevents damage to fasteners, rail and structures.
   3. Rail shall not be dropped or dragged on the trackbed. The use of rollers is required.

PART 6 - PRODUCTS

6.01 RAIL FOR CONTINUOUS WELDED RAIL

Rail for the Work shall be furnished by the Design-Builder in accordance with the Standard Specification Section 05656, Running Rail.

PART 7 - EXECUTION

7.01 PREPARATION FOR WELDING

A. The welding location may be set up on Authority property as approved by the Authority Representative.

B. Rail welding shall be in accordance with the current AREMA Manual "Specification for Fabrication of Continuous Welded Rail", and as specified herein.

C. Rail for installation in this Contract shall be welded in accordance with a string schedule approved by the Authority Representative. Strings shall be designed in order to minimize field connections and to the maximum length practical for fabrication and handling. The schedule shall show the following for each string.
   1. The string designation.
   2. The track name where the string will be placed.
   3. The begin and end track station where the string will be located.
   4. Whether the string will be in the left or right rail when facing up station.
   5. The rail type in the string or for each portion of a string.
   6. Where there is more than one rail type in a string, the track station where rail types join in a string.
   7. The end of the string where welding will begin.

   The track names and stationing systems shown on the Track Alignment Plan and Profile drawings shall be used in the string schedule.

D. The string designation shall be a unique code identification for each string that indicates
   1. The track
   2. Left or right rail
   3. A consecutive sequential number or letter system that increases with increasing track station.

E. (Not used).

F. Rails shall be stacked and welded so that when the resulting rail string is stored and subsequently placed in track, rail brands for both rails will face to the right when looking up stationing.

G. Rail Inspection Prior to Welding
1. Inspect each rail end prior to welding for deviations from lateral line in either direction and for upsweep, downsweep or droop.
2. Rail with upsweep, downsweep or droop and rail failing to comply with the tolerances shown on **Exhibit 05091-B** shall be cut back a sufficient distance to achieve the required alignment. Rails shall be cut clean and within 1/32 inch of square by means of rail saws or abrasive cutting discs.
3. Torch cutting of rail is prohibited. Cutting shall be done at no additional cost to the Authority.

H. Rail End Preparation for Welding: Immediately prior to welding, all rail ends shall be wire brushed to remove mill scale or other dirt.

I. Alignment of Rail for Weld:
1. Alignment of the rail in the welding machine shall be done on the head of the rail.
2. Vertical alignment shall provide for a flat running surface within 0.01 inch between the abutting rail ends.
3. Horizontal alignment shall distribute head width differences evenly between each side of the head. No horizontal offset shall exceed 0.03 inch on either side of the head. No horizontal offset shall exceed 0.10 inch on either side of the base of the rail.

7.02 WELDING OF RAILS

A. All welding procedures shall be approved prior to use and as a minimum shall be in accordance with the following:
1. Produce welds with upset of 5/8 inch minimum before shearing.
2. Each weld to achieve complete fusion, and be free of flaws and inclusions.

B. (Not used).

C. (Not used).

D. Grinding shall be done immediately following welding at an elevated temperature.

E. Welds shall be ground to meet the following finishing tolerances:
1. A finished deviation of not more than plus or minus 0.005 inch of the parent section of the rail head shall be allowed.
2. The weld at the top and sides of the rail head shall be finished to plus or minus 0.010 inch of the parent section.
3. (Not used).
4. The bottom and sides of rail base, the web zone, underside of head, web, top of base, both fillet each side, shall be finished to within 1/4 inch of parent contour or closer but shall not be deeper than parent section.
5. Finishing shall eliminate all cracks visible to the unaided eye.
6. All notches created by offset conditions or twisted rails shall be eliminated by grinding to blend the variations on both sides of the head and base for a distance of 18 inches.

7. All fins on the weld due to grinding and/or shear drag shall be removed prior to final inspection.

F. Welds at pedestal tracks shall not be suspended; i.e., the rail weld shall be located at the pedestal support plate. The rail base of these welds shall be ground to the same tolerances as the rail head.

7.03 WELD QUALITY

A. Inspection of Welds: Each weld shall be examined by ultrasonic examination method and by the visual method as follows:
   1. Ultrasonic Examination:
      a. Ultrasonic examination shall be performed by an independent testing agency under contract to the Authority who will perform ultrasonic examination to the following standards:
      b. Subsequent to the magnetic particle inspection, all welds will be ultrasonically inspected in accordance with ASTM E164.
      c. Ultrasonic test equipment will be capable of detecting a 3/64 inch discontinuity, 6-1/2 inches below the top rail. The sensitivity and resolutions of the proposed equipment shall use appropriate area amplitude and distance amplitude reference blocks made of material similar to the rail steels being tested.
      d. All equipment will be equipped with a distance amplitude correction feature. The equipment will be calibrated daily using an 11W calibration block made of rail steel.
      e. All welds giving fault indication in ultrasonic testing shall be cut out and the rails rewelded according to these specifications.
      f. The Contractor shall provide a weather resistant enclosure with adequate ventilation and light for ultrasonic inspection.
   2. Visual Inspection for Final Alignment of Finished Welds:
      a. The combined vertical offset and crown camber at ambient temperature shall not exceed 0.060 inches as shown on **Exhibit 05091-C, Fig. 1**.
      b. No dip camber shall be allowed as shown on **Exhibit 05091-C, Fig. 2**.
      c. Combined horizontal offer and horizontal kink camber at ambient temperature shall not exceed 0.060 inches as shown on **Exhibit 05091-C, Fig. 3**.
      d. Welds shall be free of cracks, fins, and sharp edges.

B. Correction of Defective Welds: Each production weld failing to meet all acceptance criteria will be considered defective. This shall include welds considered defective by the Authority contracted Ultrasonic Inspector.
   1. Defective welds shall be cut out by means of rail saw or abrasive disc.
   2. Use extra initial flash to burn off cut surface, reclamp, and reweld.
   3. Rewelds shall be inspected as specified for initial welds.

C. Submit Production Welding Records to the Authority Representative at the end of each days production.
   1. Production welding record in accordance with **Exhibit 05091-D and 05091-E**.

D. Marking of Rail Strings:
   1. Mark each end and on both sides of the rail web every 100 feet of each rail string with a paint suitable for application to steel and which is weather resistant for a period of two years.
   2. High strength rail shall be marked with orange paint.
   3. Standard rail shall be marked with white paint.

4. Each string shall be marked on both ends with its string designation code and the respective beginning and ending station shown on the string schedule.
   a. When two or more strings are welded into one longer string, then, where the ends of two strings join, the strings shall be marked with their string designation codes and the respective beginning and ending station shown on the string schedule.
5. The end of the string where welding began shall be marked to show that is the end where welding began. The welding shall begin on the end shown on the string schedule. The string designation code and the beginning of welding mark shall be coordinated to permit correlation of each weld with the Production Welding Record.

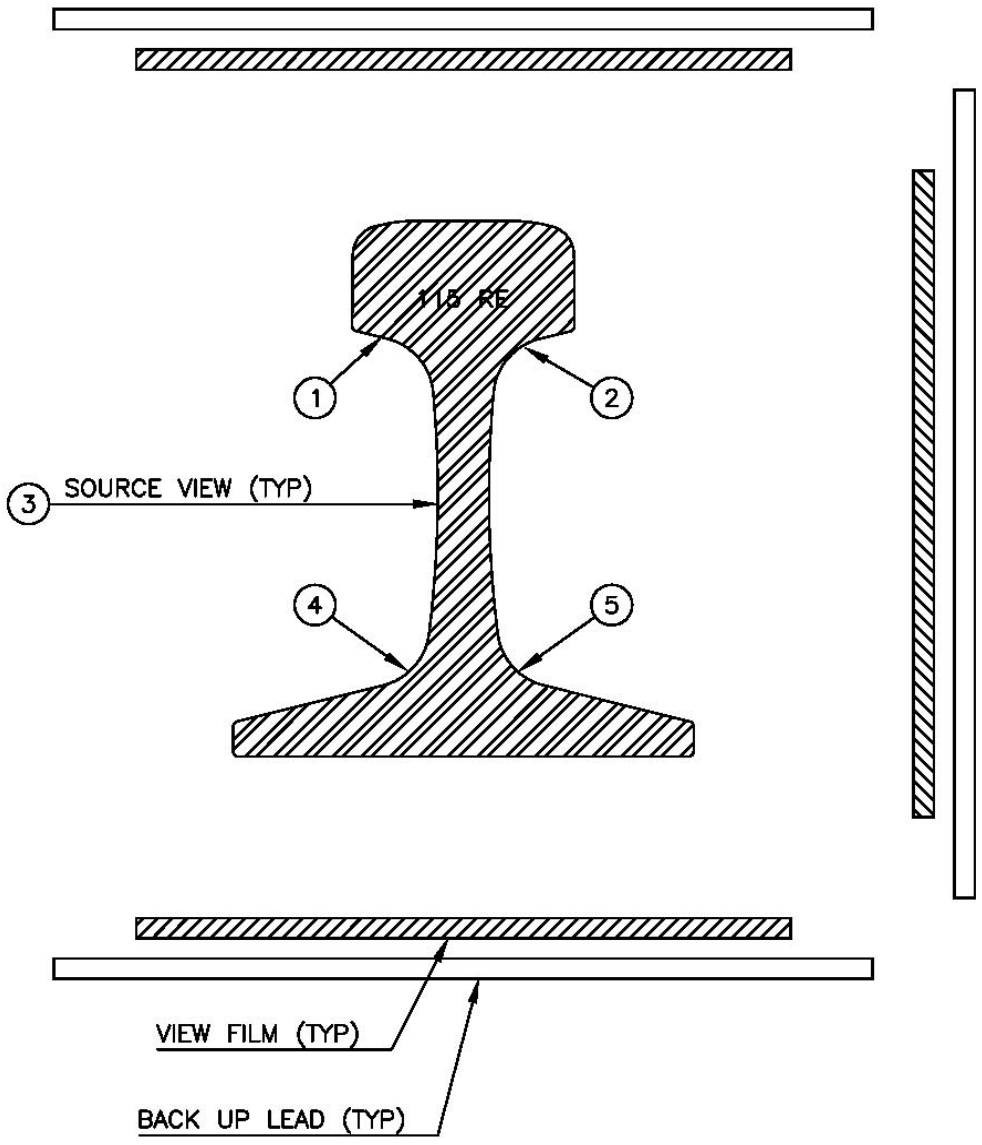
PART 8 - MEASUREMENT AND PAYMENT

8.01 MEASUREMENT

No separate measurement of work specified in this Section will be made.

8.02 PAYMENT

Compensation for work specified in this Section will be included in the price of the work of which it is a part.



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	RADIOGRAPHY SHOOTING SKETCH EXHIBIT 05091–A

NOTE: Not used for Thermite Rail Welding (only applicable for Electric Flash-Butt Welding)

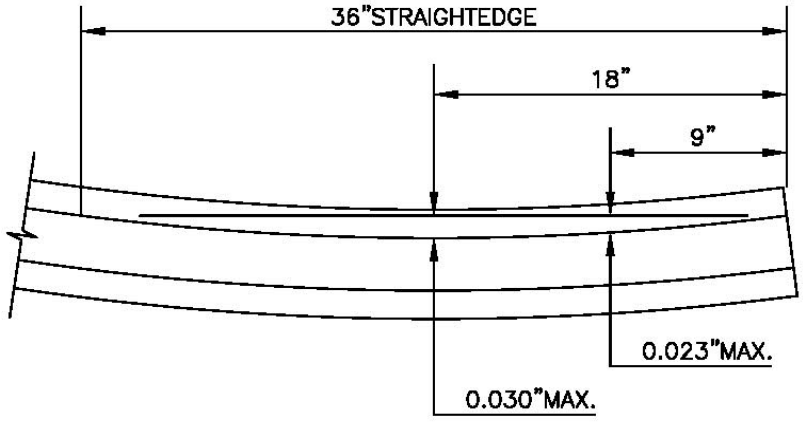


FIGURE 1

TOP VIEW OF RAIL
LATERAL (HORIZONTAL) LINE
TOLERANCE AT RAIL ENDS

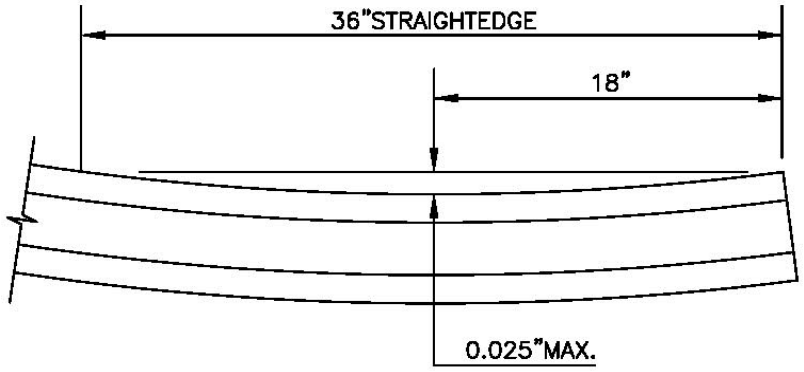


FIGURE 2

SIDE ELEVATION OF RAIL
UNIFORM UPSWEEP
TOLERANCE AT RAIL ENDS

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY	
DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	TOLERANCES FOR INSPECTION OF RAIL EXHIBIT 05091–B

NOTE: Applicable for both Electric Flash-Butt and Thermite Rail Welding.

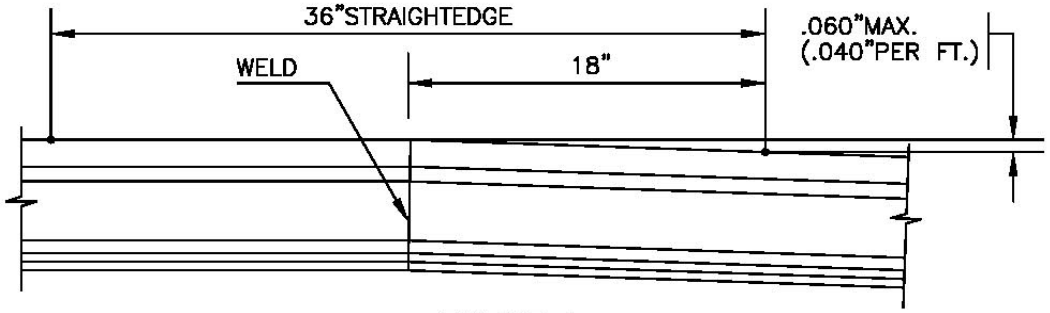


FIGURE 1
ELEVATION OF RAIL SHOWING WELD MISALIGNMENT
TOLERANCE IN VERTICAL ALIGNMENT

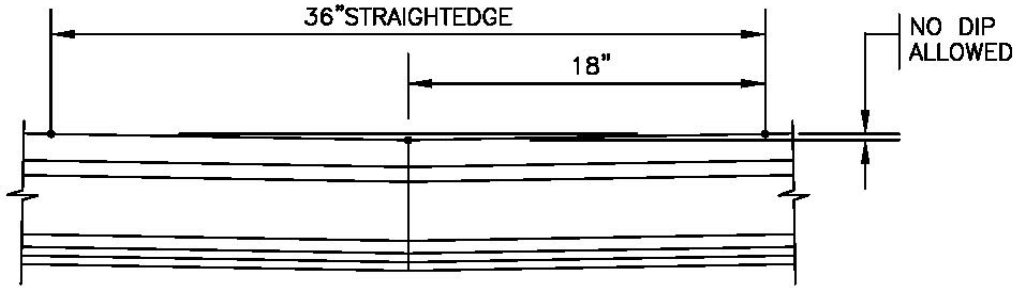


FIGURE 2
ELEVATION OF RAIL SHOWING WELD MISALIGNMENT
TOLERANCE IN VERTICAL ALIGNMENT

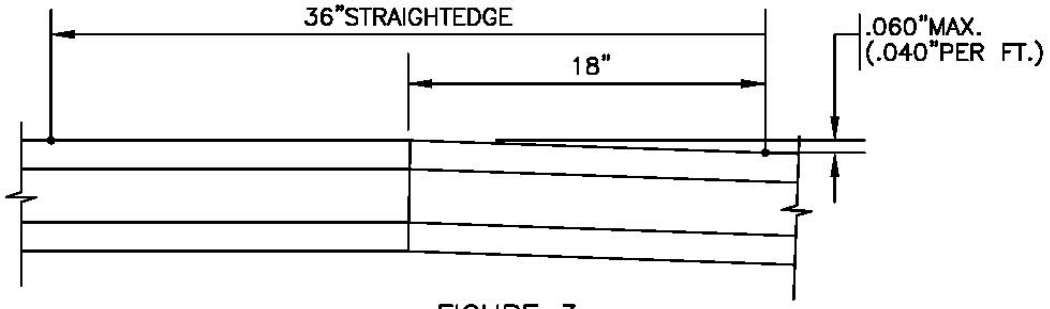


FIGURE 3
PLAN VIEW OF RAIL SHOWING WELD MISALIGNMENT
TOLERANCE IN HORIZONTAL ALIGNMENT

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	TOLERANCES FOR INSPECTION OF WELDED RAIL EXHIBIT 05091 –C

NOTE: Applicable for both Electric Flash-Butt and Rail Thermite Welding.

RAIL STRING NUMBER _____

RAIL TYPE: STANDARD _____ HIGH STRENGTH _____ (CHECK ONE)

FINISH STRING LENGTH (NEAREST FOOT) _____

STAMPING ON FIRST AND LAST RAIL IN STRING:

FIRST _____

LAST _____

WELD NO.	WELD MACHINE RECORD IDENTIFIER	MAGNETIC PARTICLE TEST RESULT	VISUAL INSPECTION RESULTS MAXIMUM DIMENSION RECORDED	
			VERTICAL ALIGNMENT	HORIZONTAL ALIGNMENT
1.				
2.				
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REWELDS

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF
TRANSIT SYSTEM DEVELOPMENT
OFFICE OF
ENGINEERING & ARCHITECTURE

PRODUCTION WELDING RECORD
EXHIBIT 05091 –D

NOTE: Applicable for both Electric Flash-Butt and Thermite Rail Welding.

DATE _____ OPERATORS OPERATORS Straight–time Over–time

MACHINE _____ _____ _____ _____

SHIFT _____ _____ _____ _____

WELD NO.	TIME	REMARKS	WELD NO.	TIME	REMARKS

HO – Horizontal Offset VO – Vertical Offset EB – Electrode Burn MI – Mag. Ind.
MB800 & MB1200 Circuit Breaker RL – Read Light – Explain. Other remarks on reverse side.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF
TRANSIT SYSTEM DEVELOPMENT
OFFICE OF
ENGINEERING & ARCHITECTURE

WELDER'S TIME SHEET
EXHIBIT 05091–E

NOTE: Applicable for both Electric Flash-Butt and Thermite Rail Welding.

END OF SECTION

SECTION 05120

STRUCTURAL STEEL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies structural steel work.

B. Options:
1. Substitution of rolled shapes for welded sections and vice versa is permitted, provided that shapes and sections to be substituted are approved and comply with the following:
   a. Keep depth, width, average or mean thickness, web shear area, moments of inertia, torsional constant and warping constant to be at least equal to those for shape or section shown. Maintain clearances and other dimensions shown as critical.
   b. Have steel shapes, plates and bars conform to same ASTM designation as material for which substitution is made.

C. Related Work Specified Elsewhere:
1. Finish painting for structural steel: Section 09920.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. AWS: D1.1.
3. AASHTO: Interim 1981 Fracture Control Plan; Standard Specifications for Highway Bridges, including supplements. Where conflict occurs between AWS and AASHTO, AASHTO governs.
4. AISC:
   a. Specification for Structural Steel Buildings-Allowable Stress Design and Plastic Design.
   b. Manual of Steel Construction-Allowable Stress Design.
   c. Code of Standard Practice for Steel Buildings and Bridges.
   d. Allowable Stress Design Specification for Structural Joints using ASTM A325 or A490 Bolts.
   e. Specifications for Architecturally Exposed Structural Steel.
5. ASNT: Recommended Practice SNT-TC-1A.
6. SSPC: SP-6, SP-10.
7. ANSI: B27.2.
8. MS: MIL-P-21035.
9. FS: TT-P-645
10. ASTM: A6, A27, A36, A108, A109, A123, A148, A153, A242, A307, A325, A370, A449, A490, A500, A501, A514, A517, A572/572M, A588, A668, A673, A709, A780, B663, B766.

B. Source Quality Control:
1. Testing and inspection:
   a. Nondestructive-test requirements for welded members:
      1) Perform the following:

2) Tension butt welds in fracture-critical nonredundant members and member components of structures subject to repetitive dynamic loading: 100 percent of welds inspected by radiographic and ultrasonic examination.
3) Butt welds of flange material for compression and tension splices: 100 percent of welds inspected by ultrasonic examination.
4) Butt welds for web splices beginning at point of maximum stress: 40 percent of welds inspected by ultrasonic examination.
5) Fillet welds connecting web plates to flange plates: 25 percent of welds inspected by magnetic particle inspection.
6) For all other fillet-weld connections: 10 percent of welds inspected by magnetic particle inspection.
7) The Engineer may designate additional items to be inspected by radiography.

b. Mill testing:
1) For identified stock materials provide three specimens from each heat number, one for tension test, one for bend test and one for Charpy V-notch impact test.
2) Cut, machine and test specimens in accordance with ASTM A370.
3) Perform Charpy V-notch impact test for tension flanges and other tension components of aerial structures in accordance with Table 05120-1.

c. Bolts:
1) The Engineer will randomly select at least five bolts for test purposes from each bin of bolts furnished.

C. Qualification of Welding Personnel and Procedures:
1. Prior to qualifying welding personnel and welding procedures, confirm an agreement with the Engineer as to procedural details, sequence of welding, handling of materials to be inspected, and approval of electrodes, wire, flux and other welding materials and equipment.
2. Employ welding personnel whose qualification is certified in accordance with AWS D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.
3. Do not start fabrication until qualification has been successfully completed.

D. Qualification of Nondestructive-Testing Personnel:
1. Nondestructive testing of fracture-critical members to be conducted by personnel qualified as NDT Level II or Level III in accordance with ASNT SNT-TC-1A.
2. Level-II technicians to be supervised by Level III-personnel.

E. Stock Material:
1. For qualification of welding personnel and procedures and for quality-assurance testing, use only stock materials which can be identified as having been rolled from a given heat and for which certified mill tests can be produced.
2. When stock material is proposed, inform the Engineer of such intention at least 10 days in advance of commencing fabrication to permit sampling and testing. Select identified material from as few heats as possible.

F. Welder's Identification Mark (for Fabrication Shops):
1. Assign each welder and welding operator an identification mark to stamp on pieces he has welded.
2. Have welder or welding operator place his identification mark by metal-die stamp in letters 3/8-inch high in position that identification of welder or operator will appear

adjacent to each of his welds in finally assembled members for ready reference to radiographic films and for identification by the Engineer.

G. Elevator Hoistways:
1. Fabricate framing not to exceed 1/8-inch deviation from dimensions shown throughout. Perform straightening where necessary.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Shop Drawings:
1. Structural details: Include the following:
a. Bills of materials giving complete information for fabrication and erection of component parts of structures including material and finish information.
b. Details of location, type, sizes of bolts and welds and for welded structures details of welding as specified.
c. Structural computations for Contractor-designed work certified by a professional engineer registered in the jurisdiction where the work is to be performed.
2. Match marks:
a. Provide diagram showing match marks for connecting structural parts assembled in shop for purpose of drilling or reaming holes in field connections.
3. Welding:
a. Complete shop details of qualification test specimens.
b. Include information on specimen identification, number of pieces and welding procedure specification, type of material, sizes of pieces and welds and other variables affecting detail or tests.
4. Erection Plan:
a. Details of methods of erection proposed to be used, including calculated stresses for proposed erection certified by a professional engineer registered in the jurisdiction where the work will be performed. Do not proceed until approval has been received.
5. Manufacturer's test procedures for bolts.

B. Certification:
1. Certified mill test reports of structural steel at least 10 days prior to start of fabrication.
2. Certified quality-assurance testing and inspection reports.
3. Certification verifying that welding personnel have been qualified in accordance with AWS D1.1 and as specified above under Qualifications of Welding Personnel and Procedures.
4. Manufacturer's certification that bolts meet approved testing.
5. Certification of nondestructive-testing personnel.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. General:
1. Load, transport, unload and store structural materials so as to keep them clean and free from damage.
2. Store material on platforms, skids or other supports above the ground and ensure proper drainage and protection from corrosion.

B. Steelwork:
   1. When handling and shipping steelwork, prevent bending, scraping or over stressing members.
   2. Block projecting parts likely to be bent or damaged during handling with wood or other approved material
   3. Replace pieces bent or damaged unless repair is approved.
   4. Indicate weight on members weighing more than three tons by means of paint contrasting with shop coat.

C. Bolts and Nuts:
   1. Ship small parts such as bolts, nuts, washers, pins, fillers and small connecting plates or angles in boxes, crates or barrels.
   2. Pack separately bolts of each length and diameter and loose nuts or washers of each size.

D. Paint:
   1. Have paint materials delivered in manufacturer's original sealed containers, bearing manufacturer's label and name, specification identification number where applicable as well as month and year of manufacture.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
   1. Welding:
      a. When welding during cold weather, avoid chilling weld metal within zone of welding influence and avoid restraining manual functions of welder or welding operator.
      b. When temperature where steel is stored is more than 20F below that of welding shop, move steel to be welded into shop sufficiently in advance of welding to allow it to attain shop temperature prior to welding.
      c. Steel to be free of moisture. Dry as necessary by application of heat not exceeding 100F.
      d. Do not weld when shop temperature is below 40F.
   2. Painting:
      a. Apply paint when temperature of steel and paint is above 40F and temperature is forecast to remain above 40F until paint has dried.
      b. Painting steel at a temperature which can cause blistering, porosity or conditions otherwise detrimental to life of paint is prohibited. When paint is applied in hot weather or thinned in cold weather, ensure that specified thickness of paint coating is obtained.
      c. Application of paint in rain, wind, snow, fog or mist or when steel surface temperature is below dew point is prohibited, unless otherwise approved. If painting in damp or cold weather is unavoidable, provide protective covering and heat steel and surrounding air to 40F minimum. Maintain this temperature until weather conditions permit discontinuance.

PART 2- PRODUCTS

2.01 MATERIALS:

A. General Requirements for Rolled-Steel Plates, Shapes and Bars: ASTM A6.

B. Carbon-Steel Plates, Shapes and Bars: ASTM A36, ASTM A709, Grade 36.

C. High-Strength, Low-Alloy, Structural-Steel Plates, Shapes and Bars: ASTM A242.

D. High-Strength, Low-Alloy, Structural, Columbium-Vanadium Structural Steel: ASTM A572/A572M.

E. Corrosion-Resistant Structural Steel: ASTM A242., A588

F. High-Strength, Low-Alloy, Corrosion-Resistant Structural-Steel Shapes, Plates, and Bars: ASTM A588.

G. Low-Carbon Steel Bolts and Nuts: ASTM A307, Grade A or B.

H. High-Strength Carbon-Steel Bolts, Nuts and Washers for Structural Joints: ASTM A325; for bolts over one-inch diameter, ASTM A449.

I. High-Strength Alloy-Steel Bolts, Nuts and Washers for Structural Joints: ASTM A490.

J. Round Washers Other Than Those In Contact With High-Strength Bolt Heads And Nuts: ANSI B27.2, Type B.

K. Beveled Washers:
   1. Square, smooth and sloped to make contact surfaces of bolt head and nut parallel.
   2. Diameter of hole in square beveled washers as follows:
      a. For bolts less than one-inch diameter: 1/16-inch larger than bolt size.
      b. For bolts larger than one-inch diameter: 1/8-inch larger than bolt size.

L. Carbon-Steel Forgings: ASTM A668, Class C.

M. Alloy-Steel Forgings: ASTM A668, Class G.

N. Structural-Steel Tubing:
   1. Structural framing for elevator hoistways: ASTM A500, Grade B.
   2. Other structural tubing: ASTM A501.

O. High-Strength Steel Casting: ASTM A148, metal type as shown.

P. Mild-To-Medium-Strength Carbon-Steel Castings: ASTM A27, grade as shown.

Q. Shear Connectors:
   1. Cold-rolled carbon-steel strip.
   2. Stud-welding fasteners with upset head developing tensile strength of 65,000 psi-minimum and yield strength of 52,000-psi minimum.
   3. Complying otherwise to the following:
      a. Cold-finished bars, Grade 1015, Grade 1018 or Grade 1020, semi-killed or fully killed: ASTM A108.
      b. Low-carbon steel suitable for welding: ASTM A109.
   4. Stud welding conforming to AWS D1.1.
   5. Sizes and shapes: As shown.
   6. Lengths to be after-weld lengths.
   7. Studs arc-welded to parent metal as shown.
   8. Before welding, parent-metal surface to be free from rust, oil, paint, plating and other foreign matter.
   9. Heat treat parent metal where needed to develop full weld strength.

R. Galvanizing:

1. Steel products specified as galvanized to be hot-dip galvanized after fabrication in accordance with the following:
    a. Zinc coatings on products fabricated from rolled, dressed and forged steel shapes, plates and strips: ASTM A123.
    b. Zinc coating on iron and steel hardware: ASTM A153.
    c. Zinc coating on assembled steel products: ASTM A123.
    d. Zinc-coating weight: Two ounces per square foot minimum.
    e. Zinc-dust zinc-oxide primer conforming to MS MIL-P-21035 applied in accordance with ASTM A780 in two coats for repairs to damaged surfaces after removal of loose or cracked zinc coating.

S. Electroplated Zinc Coating: ASTM B663 for type specified.

T. Cadmium Plating: ASTM B766 for type specified.

U. Paint for Shop Prime Coating: FS TT-P-645.

V. Cleaning Solution: Muriatic acid solution, specific gravity 1.18, prepared in a solution of one-part muriatic acid and five parts water.

PART 3 - EXECUTION

3.O1 FABRICATION:

A. Workmanship and finish to best commercial practice accomplished in structural or bridge shops.

B. Straightening Material:
1. Use rolled material that, before being laid off or worked, is straight within tolerances specified in ASTM A6.
2. Perform straightening where necessary by approved methods which will not overstress material.
3. Do not heat-shrink low-alloy structural steel.
4. Achieve fabrication tolerances which will result in full bearing.
5. Perform straightening, planing and connecting of portions of members in bearing assemblies and in direct bearing after fabrication as necessary to provide full bearing assemblies and bearing areas.

C. Cutting:
1. Flame-cut edges of members subject to dynamic loading by mechanically guided torch or by hand. Remove nicks by grinding to depth not exceeding 1/4 inch.
2. Shape re-entrant corners notch-free to radius of 1/2-inch minimum.
3. Perform flame cutting so that metal does not carry stress during cutting operation.
4. Direct flame so that remaining material is not damaged.

D. Planing and Facing:
1. Plane to depth of 1/4 inch sheared edges of plates more than 5/8-inch thick which will carry calculated stress.
2. Face and bring abutting joints to even bearing where shown.
3. Fabricate floor beams, stringers and girders having end connection angles to exact length back-to-back of connection angles.
4. For compression joints depending on contact, prepare bearing surfaces to a common plane by milling, sawing or other approved means.

5. Where end connections are faced, ensure that finished thickness of angle is not less than that shown.

E. Bolt Holes:
1. Punch or drill holes for bolts.
2. Subpunch or subdrill and ream assemblies using steel template for alignment of connections as necessary. Flame cutting is prohibited.
3. Subdrill or subpunch holes 3/16-inch less than nominal diameter of bolt; drill or ream holes 1/16-inch greater than nominal diameter of bolt.

F. Connections:
1. Except where welded or ASTM A307 bolted connections are shown, use ASTM A325 or ASTM A490 bolts for shop connections.
2. Unless otherwise shown, bolt field connections using ASTM A325 or ASTM A490 bolts in accordance with AISC Specifications for Structural Joints.
3. Use of ASTM A490 bolts for dynamic or fluctuating loadings is prohibited.

G. Plates:
1. Bent plates: For load carrying cold-bent plates, use identified stock and arrange direction of bending at right angles to direction of rolling. Ensure radius of bend, measured on concave face of metal, is not less and preferably more than the following:

Angle of Plate Bend in Degrees	Minimum Radius
61 - 90	1.0T*
91 - 120	1.5T*
121 - 150	2.0T*

*T = Plate thickness.

2. Sheared plates: For gusset plates or connection plates, use sheared plates designed to resist applied loads in more than one direction in plane of plate.

3.02 WELDING:

A. Perform welding in accordance with AWS D1.1.

B. Perform procedure and sequence of welding so as to avoid needless distortion and to minimize stresses. Straighten transverse warpage of flanges, if necessary, by controlled heating along outside face.

C. Make allowance in shop for expected weld shrinkage in laying out and assembling members. Trim members to size when most or all of welding has been completed.

D. Complete butt welds in flange joints before flanges are assembled on web. Use extension blocks on such joints when making ends of butt welds, removing extension blocks only upon completion and cooling of weld. Ensure ends of welds are finished smooth and flush with edges of abutting parts. Use double-V-flange butt welds, unless otherwise shown. Back puddle all end craters.

E. Make welds in web plates where shown.

F. Prior to ultrasonic or radiographic testing of butt welds of flanges and webs, grind or machine weld reinforcement of joint to remove irregularities of weld surface so that it merges smoothly with base surface; one side for ultrasonic testing and both sides for radiographic testing.

G. Ensure that welded joints which are to be radiographed are free of paint, scale and grease. Grind off welded ripples and surface irregularities on both sides of joint. Grind perpendicular to length of weld and to such a degree that resulting radiographic contrast due to remaining irregularities cannot mask or be confused with that of objectionable defect and so that weld surface will merge smoothly into adjoining surface.

H. Repair defective welds by chipping or melting out such defects from one or both sides of joint removing no more weld metal than necessary to correct defect. Reweld and have weld retested radiographically.

I. Welded Structures Subjected to Dynamic Loads:
   1. Do not use backup bars for fracture-critical nonredundant members or member components, as defined by AASHTO on Interim 1981 Fracture Control Plan.
   2. Avoid use of backup bars elsewhere, unless explicitly permitted by original design.
   3. When use of backup bars is unavoidable because of practicality but not explicitly permitted by original design, remove backup bar after welding is completed and affected surfaces of weld metal and base metal is ground flush. Roughness of ground surfaces to be similar to that of surrounding unaffected plate surface.

3.03 BOLTING:

A. Connections using high-strength steel bolts in accordance with AISC Specifications for Structural Joints using ASTM A325 or ASTM A490 bolts.

B. Assemble high-strength bolted parts so that they fit solidly together when assembled. Do not use gaskets or other compressible materials.

C. Remove scale, dirt, burrs and other defects likely to prevent proper seating when assembling joint surfaces, including those adjacent to washers.

D. Remove oil, paint, lacquer and galvanizing from contact surfaces of friction joints.

E. Use two nuts on unfinished bolts and turned bolts in tension.

F. Tightening Bolts:

   1. Tighten ASTM A325 or A490 bolts to bolt tension not less than proof load given in AISC Specifications for Bolts.
   2. If approved, tighten by means of properly calibrated wrenches or turn-of-nut method.
   3. When tightening, place hardened washer under nut or bolt head, depending on which element is turned in tightening operation.
   4. Calibrate torque wrenches daily by tightening bolt assembly in device capable of indicating actual bolt tension.
   5. Install three bolts minimum from each lot.
   6. Nuts or bolts to be in tightening motion when torque is measured.
   7. Adjust power wrenches to cut-out or stall at required tension.

G. Arrange bolts so that heads show in areas exposed to public view.

3.04 SHOP ASSEMBLY:

A. Undertake complete or progressive shop assembly of continuous plate and box girders, rigid frames, bents and towers when shown. Obtain approval of progressive shop-assembly procedure.

B. Clean surfaces of metals in contact with each other with high speed wire brushes before assembling.

C. Assemble parts to line and fit; drill or ream bolt holes while assembled. Hand reaming is prohibited unless approved.

3.05 SHOP PRIME PAINTING:

A. Clean steel surfaces in accordance with SSPC SP-6 or SP-10.

B. Shop Painting:
   1. Shop paint structural-steel work which will be left bare in finished structures.
   2. Do not shop paint the following:
      a. Surfaces within three inches of joints to be field welded.
      b. Galvanized surfaces and surfaces to be galvanized.
      c. Contact surfaces: Apply rust-inhibitive treatment to such surfaces; remove by means of appropriate solvent prior to assembly.
      d. Surfaces to be encased in concrete or in fire-protection material.
      e. Weathering steel.
   3. Use paint-spraying equipment, if approved, with type of spray gun recommended by paint manufacturer for paint being applied.
   4. Use brushes of good quality bristle. Nylon brushes and roller coaters are prohibited.
   5. Neutralize areas of welding which are to be painted by applying specified cleaning solution. Wash neutralized area thoroughly with clean water and allow to dry before painting.
   6. Apply shop prime coat at minimum wet-film thickness of three mils. Give surfaces which will be inaccessible after assembly or erection three coats of paint before assembly.
   7. Caulk small cracks, cavities and open seams around stiffeners and connections with pasty mixture of red lead and linseed oil or approved caulking putty and allow to dry before applying full shop coat.
   8. Apply stripe coat of paint to edges, corners, bolts, welds and other sharp edges before giving steel full shop coat of paint. Apply stripe coat at least one-inch beyond area to be striped and allow to dry before applying full shop coat.
   9. Paint erection marks and weight on each member after shop coat has dried.
   10. Complete shop painting and ensure paint has completely dried prior to shipment of steel.

3.06 ERECTION:

A. Install anchor bolts accurately in positions shown.

B. If anchor bolts are cast in substructure masonry during its construction, ensure that each bolt is firmly held in its correct position and elevation by suitable templates.

C. If approval is given for installing anchor bolts in preformed holes or in drilled holes in concrete or masonry, use approved nonshrink, nonstaining grout to secure them in place.

D. Set bearing assemblies to lines and grades shown and adjust to horizontal position shown.

E. Erect steel structures true and plumb following match marks.

F. Use temporary bracing to support loads to which structures may be subjected including erection equipment and their operations. Leave bracing in place as long as safety requires.

G. Report immediately to the Engineer errors in shop fabrication or deformation resulting from handling or transportation which prevent proper erection and fitting of parts.

H. As erection progresses perform sufficient bolting of work to support dead load, wind load and erection load. Perform permanent bolting when enough alignment has been accomplished to ensure that as much of structure as possible will be supported by such fastening work.

I. Ensure that holes are not enlarged and that metal in vicinity of holes is not disturbed by drifting during assembly.

J. Enlargement of holes to accept bolts for connections is prohibited unless approved. Make enlargement by reaming not by burning. Avoid hand reaming.

K. Do not field weld main stress members.

L. Bond premolded elastic filler with adhesive to structural framing at elevator hoistways.

3.07 NONDESTRUCTIVE TESTING OF FIELD WELDS:

A. Perform pertinent testing specified for source quality control.

3.08 FIELD TOUCH-UP PAINTING:

A. Retouch surfaces where shop coat has been damaged using paint and paint-film thickness identical to original shop coat.

B. After erection, clean field bolts, nuts and adjacent areas and apply coat of paint identical to original shop coat.

C. Finish painting for structural steel in accordance with Section 09920.

TABLE 05120-1				
BASE METAL CHARPY V-NOTCH REQUIREMENTS[*a] FOR FRACTURE-CRITICAL MEMBERS				
ASTM	Thickness, Inches (mm)	Zone 1[*b]	Zone 2[*c]	Zone 3[*d]
A36	Up to 4 inches (101.6)	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
A572[*e]	Up to 4 inches (101.6) mechanically fastened	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
	Up to 2 inches (50.8) welded	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
A588[*e]	Up to 4 inches (101.6) mechanically fastened	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
	Up to 2 inches (50.8) welded	25 at 70F (33.9 Nm at 21.1C)	25 at 40F (33.9 Nm at 4.4C)	25 at 10F (33.9 Nm at minus 12.2C)
	Over 2 inches to 4 inches (50.8 to 101.6) welded	30 at 70F (40.7 Nm at 21.1C)	30 at 40F (40.7 Nm at 4.4C)	30 at 10F (40.7 Nm at minus 12.2C)
A514[*f]	Up to 4 inches (101.6) mechanically fastened	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at minus 30F (47.5 Nm at minus 34.4C)
	Up to 2-1/2 inches (63.5) welded	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at zero degree F (47.5 Nm at minus 17.8C)	35 at minus 30F (47.5 Nm at minus 34.4C)
	Over 2-1/2 inches to 4 inches (63.5) welded	45 at zero degree F (61.0 Nm at minus 17.8C)	45 at zero degree F (61.0 Nm at minus 17.8C)	Not permitted

[*a] CVN impact testing to be P-plate frequency testing in accordance with ASTM A673. Code Charpy test pieces with respect to heat/plate number and record such code on mill-test report of steel supplier with test result. If directed, package broken pieces from each test (three specimens, six halves) and forward to the quality-assurance organization of the jurisdictional authority. Use average of three tests. If energy value for more than one of three specimens is below minimum average requirements or if energy value for one of three specimens is less than 2/3 of specified minimum requirements, retest and obtain energy value from each of three retest specimens equal to or exceeding specified minimum average requirement.

[*b] Zone 1: Minimum service temperature zero degree F (minus 17.8C) and above.

*c Zone 2: Minimum service temperature from minus 1F to minus 30F (minus 28.3C to minus 34.4C).

*d Zone 3: Minimum service temperature from minus 31F to minus 60F (minus 35C to minus 51.1C).

*e If the yield strength of the material exceeds 65 ksi (448.159MPa), reduce temperature for CVN value for acceptability by 15F (8.3C) for each increment of 10 ksi (68.947MPa) above 65 ksi (448.159MPa). Yield strength is value given in certified mill-test report.

*f ASTM A517 Charpy requirements are the same as for ASTM A514.

END OF SECTION

SECTION 05210

STEEL JOISTS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing steel joists.

B. Related Work Specified Elsewhere:
   1. Bearing plates and miscellaneous steel framing: Section 05120.
   2. Field painting: Section 09920.

1.02 QUALITY ASSURANCE:

A. Reference Codes and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. AWS: D1.1.
   3. SJI (Steel Joint Institute): Standard Specifications and Load Tables for Series-K Open-Web Steel Joist, Series-LH Longspan Steel Joists and Joist Girders.
   4. SSPC: Steel Structures Painting Manual.
   5. FS: TT-P-645.

B. Qualification of Welding Personnel:
   1. Employ welding personnel whose qualification is certified in accordance with AWS D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Shop Drawings:
   1. Detailed joist and erection drawings showing erection marks, SJI-designation numbers, locations and spacing; bearing-plate and anchor-bolt layouts; bridging details and connections; shop coating; and details necessary for installation. Drawings to be signed and sealed by a professional engineer registered in the jurisdiction where the work will be performed.

B. Certification:
   1. Certificate verifying compliance with SJI specifications.
   2. Certification that welding personnel are currently qualified in accordance with AWS D1.1, and as specified above under Qualification of Welding Personnel.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Load, transport, unload and store steel joists by means which will prevent damage.

B. Use waterproof coverings during transit and storage to protect shop coats and prevent corrosion.

C. Store off the ground preferably supported by their end bearings.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Steel Joists: Designations shown, fabricated in accordance with SJI requirements. Extended ends and ceiling extensions designed to support loads shown.

B. Shop Coating: In accordance with FS TT-P-645 and SSPC recommendations of the Steel Structures Painting Manual, except that asphalt coating is prohibited for joists specified to be field-painted.

C. Bridging: Member sizes, end anchorages and accessories in accordance with SJI requirements.

D. Bearing plates and miscellaneous steel framing: Section 05500.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Install steel joists and bridging in accordance with SJI recommendations.

B. Ensure that bearing plates are set in accordance with approved working drawings. Install joists of proper designations at locations shown.

C. Perform welding in accordance with AWS D1.1. Burning of holes, undercutting or other operations which reduce strength of joists are prohibited.

D. Permanently secure bridging and decking before applying construction or design loads to steel-joist installation.

E. Ensure that construction loads, such as stacked materials, do not exceed designed capacity of the installation.

F. Repair or replace damaged joists as directed.

3.02 FIELD PAINTING:

A. Repair shop coating where damaged. Remove welding flux, rust and other foreign matter. Coat welded and damaged areas with coating to match shop-applied coating.

B. Use joists with asphalt coating only in areas which have ceilings.

C. Paint joists exposed to view in completed project in accordance with Section 09920.

3.03 FIELD QUALITY CONTROL:

A. Inspect steel joists for broken welds, bent chords or web members and other damage harmful to structural integrity of joists.

B. Verify size, spacing, top-chord alignment and level, and tightness of fasteners.

C. Monitor field welding for compliance with AWS D1.1 requirements.

END OF SECTION

SECTION 05310

METAL DECKING

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing metal roof decking.

B. Related Work Specified Elsewhere:
   1. Touch up and field painting of metal deck: Section 09920.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. AISI Specifications for the Design of Light-Gauge Cold-Formed Steel Structural Members.
   3. AWS: D1.1.
   4. SDI (Steel Deck Institute): Design Manual for Floor Decks and Roof Decks.
   5. ASTM: A653/A653M.

B. Qualification of Welding Personnel:
   1. Employ welding personnel whose qualification is certified in accordance with AWS D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Shop Drawings:
   1. nclude details of fabrication and erection including materials, dimensions, methods of joining, welding, accessories, fastenings and openings through decking.

B. Samples:
   1. Three of each type of the following products used in the work.
      a. Decking: Six inches by width of material.
      b. Accessories.
      c. Fasteners.

C. Certification:
   1. Certification that welding personnel have been qualified in accordance with AWS D1.1.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products in good condition.

B. Store products so as to preclude corrosion, deterioration and damage.

C. Handle products so as to prevent damage.

1.05 JOB CONDITIONS:

A. Do not apply construction loads, such as roofing materials and aggregate, in excess of the live loads for which the deck is designed.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Steel Decking:
   1. Galvanized: ASTM A653/A653M, Coating G60 or G90, gauge as shown.
   2. Where terne-coated stainless steel is to be installed over decking, fabricate decking with clear space between ribs 1/2-inch wide maximum.

B. Accessories:
   1. Types shown or necessary to complete installation, such as 14-gauge recessed sump pans for roof drains, cover plates where panels abut or change direction and closure plates.
   2. Same gauge and finish as decking, unless otherwise shown or specified.

C. Fasteners: As shown on approved shop drawings.

2.02 FABRICATION:

A. Deck units countersunk at ends to form smooth, flush top surface at overlapping ends, except for 12-gauge and 14-gauge material.

B. Deck units having interlocking side laps, in standard width and longest practicable lengths

C. Steel Roof Deck: Gage and depth as shown.

D. Metal Forming (corrugated):
   1. Maximum Flexural Working Stress: 33,000 psi.
   2. Maximum Roof Deflection: 1/240 of span, c/c of supports, under live load.
   3. Maximum Floor Deflection: 1/360 of span, c/c of supports, under live load.

PART 3 - EXECUTION

3.01 INSTALLATION:

A. Erect steel decking and accessories in accordance with approved shop drawings and manufacturer's recommendations.

B. Place decking units on the supporting steel, align and adjust to final position before permanently fastening.

C. If supporting beams are not in proper alignment or at correct elevation to provide bearing and alignment of deck units; do not place decking units in deficient areas until necessary corrections have been made.

D. Continue decking over three or more spans.

E. Perform welding in accordance with AWS D1.1.

F. Use electric-arc welding to weld deck panels to end supports as shown on the Contract Drawings or on approved shop drawings. Where panel ends meet, provide minimum two-inch overlap and weld to fuse ends of units together.

G. Crimp side joints of adjacent panels and weld at intervals not exceeding three feet.

H. Remove burrs and sharp edges.

I. Where welding occurs through deck, use welding washers and plug welds to ensure proper attachment.

J. Cut bevels and perform other special cutting and fitting at jobsite.

K. Provide necessary support framing and reinforcement and openings for items penetrating deck panels.

L. Coordinate cutting of openings for work of other trades with trades involved.

M. Do not hang mechanical equipment or other loads from steel deck.

N. Repair areas where galvanizing has been damaged by welding or cutting operations using cold galvanizing compound acceptable to the Engineer.

O. Clean galvanized roof sheets with zinc oxide residue or evidence of rusting with solvent and apply zinc-rich paint to restore corrosion resistance.

3.02 CLEAN-UP:

A. Clean up rubbish and debris caused by this work and remove from site.

B. Leave decks and areas surrounding work in broom-clean condition.

END OF SECTION

SECTION 05500

MISCELLANEOUS METAL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing miscellaneous metal, with the exception of ornamental (architectural) metal and metalwork provided as a part of mechanical, electrical and construction systems.

B. Related Work Specified Elsewhere:
1. Concrete, concrete fill and nonshrink grout: Section 03300.
2. Structural steel: Section 05120.
3. Handrails and Railings: Section 05521.
4. Gratings and Floor Plates: Section 05531.
5. Field painting: Section 09920.
6. Concrete formwork: Section 03100.
7. Concrete reinforcement: Section 03200.
8. Wire Mesh Partitions: Section 10605

1.02 SUBMITTALS:

Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

A. Shop Drawings: Detail fabrication and erection of each metal fabrication indicated.

1. Include plans, elevations, sections, and details of metal fabrications and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
2. Manufacturer's standard drawings may be submitted in lieu of Contractor-prepared shop drawings if manufacturer's standard drawings show required details.

B. Certification:
1. Certification that welding personnel are currently qualified in accordance with AWS D1.1.
2. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements for corrosion resistance of Type 316 stainless steel.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. AWS: D1.1.
3. AISC: Specification for Structural Steel for Buildings-Allowable Stress Design and Plastic Design (Do not use plastic design).
4. SSPC: SP 11, Paint 12.
5. FED STD: 595.
6. MS: MIL-P-21035.
7. FS: A-A-462, FF-B-588, FF-H-116, FF-P-395, FF-S-325, RR-T-650, TT-P-86.

8. ASTM: A36, A53, A74, A108, A123, A167, A193, A229, A242, A276, A307, A313, A325, A413,A490, A501, A536, A570, A572, A588, A666, A780, A786/A786M, B 221, B 632, B633, D412, D1187, E488, F 593, F 594, F1554.
9. AGA: The Design and Fabrication of Galvanized Products.
10. ANSI: A14.3
11. ASME: A 17.1, B18.6.3, B18.21.1, B18.22.1.

B. Qualifications of Welding Personnel:
1. Welding: Qualify procedures and personnel according to the following:
a. AWS D1.1, "Structural Welding Code--Steel."
b. AWS D1.2, "Structural Welding Code--Aluminum."
c. AWS D1.3, "Structural Welding Code--Sheet Steel."
d. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification. Such certification is to remain in force for the duration of the welding operations under this Contract.

C. Fabricator Qualifications: A firm experienced in producing metal fabrications similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Coordinate installation of anchorages for metal fabrications. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.04 PROJECT CONDITIONS:

A. Field Measurements: Where metal fabrications are indicated to fit walls and other construction, verify dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating metal fabrications without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products undamaged.

B. Store products so as to prevent rust.

C. Handle products so as to prevent damage.

D. After completion of factory testing, package and ship hatches as directed.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General Requirements:
   1. Insofar as practicable, furnish similar products of a single manufacturer.
   2. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS:

A. Structural steel: Plates, shapes, bars and angles, ASTM A36.

B. Rolled-Steel Floor plate: ASTM A786/A786M; Fabricate raised-pattern floor plates from rolled-steel floor plate, galvanized after fabrication, of thickness and in pattern indicated below:
   1. Thickness: Minimum 1/4 inch, unless otherwise shown or calculated.
   2. Pattern: No. 2, or as selected from manufacturer's standard patterns; flat back.

C. High-strength low-alloy structural steel:
   1. ASTM A242.
   2. Resistance to atmospheric corrosion: Four times that of carbon steel, minimum.

D. Load-carrier beams: ASTM A588.

E. Structural tubing: ASTM A501.

F. Steel Pipe: ASTM A 53, standard weight (Schedule 40), unless another weight is indicated or required by structural loads.

G. Stainless-Steel Sheet, Strip, Plate, and Flat Bars: ASTM A666, Type 304. Type 316L for corrosive environments.

H. Stainless-Steel Bars and Shapes: ASTM A276, Type 304. Type 316L for corrosive environments.

I. Hot-rolled carbon steel sheets and strips: ASTM A570.

J. Pipe, Pipe Sleeves and Pipe Fittings:
   1. Cast iron: ASTM A74, service weight.
   2. Steel: ASTM A53, galvanized unless otherwise shown or specified.

K. Guard Chain: ASTM A413, Class Grade 28, galvanized steel, 9/32-inch thick, complete with stainless-steel eyes, spring-loaded catches and mounting components.

2.03 ALUMINUM:

A. Aluminum Extrusions: ASTM B221, Alloy 6063

B. Aluminum-Alloy Rolled Tread Plate: ASTM B632/B 632M, Alloy 6061.

C. Cast Aluminum.

2.04 COATINGS:

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Zinc-rich paint: MS MIL-P-21035.

C. Electrodeposited zinc coating: ASTM B63

D. Galvanizing repair compound: Stick form, melting point 600F to 650F, GALVABAR or equal.

E. Bituminous coating: Cold-applied asphalt mastic complying with SSPC Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

2.05 FASTENERS:

A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

B. Screws: Material, type and size to suit the purpose; steel, except stainless, cadmium-plated.
1. Stainless steel, ASTM A193, Alloy S30400.

C. Machine bolts: Material, type and size best suited to the purpose. Minimum tensile strength 60,000 psi.
1. Carbon steel: ASTM A307, Grade B, galvanized.
2. Stainless steel: ASTM A193, Class 1A.

D. Toggle bolt: FS FF-B-588.

E. Drive stud: FS FF-S-325, Group 6.

F. Expansion shield: FS FF-S-325 Group I, Type 2, Class 2, Style 1; Group II, Type 3, Class 1; Group IV, Type 1; best suited to the purpose.

G. Screw anchors: Lead or plastic for wood or metal screws.

H. Anchor-bolt sleeve: Corrugated high-density polyethylene plastic.

I. Powder actuated: FS FF-P-395.

J. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
1. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

K. Internally Threaded Steel Anchor: ASTM A108.

2.06 CONCRETE AND GROUT:

A. Nonshrink Grout: Section 03300.

B. Concrete Fill: Normal weight, minimum 3,000 psi structural concrete as required in Section 03300, except limit the max. coarse aggregate size to #8.
   1. Non-slip aggregate: Fused aluminum oxide grits or crushed emery, factory graded and packaged, rust-proof, non glazing and unaffected by moisture and cleaning materials.
   2. Surface hardener: Water-soluble, inorganic fluosilicate compound for curing, hardening and dustproofing fresh concrete.

2.07 FABRICATION, GENERAL:

A. Shop Assembly: Preassemble items in shop to greatest extent possible to minimize field splicing and assembly. 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.

B. Shear and punch metals cleanly and accurately. Remove burrs.

C. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

D. Weld corners and seams continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

E. Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure metal fabrications rigidly in place and to support indicated loads.

F. Cut, reinforce, drill, and tap metal fabrications as indicated to receive finish hardware, screws, and similar items.

G. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

H. Allow for thermal movement resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening up of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

I. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges

J. Remove sharp or rough areas on exposed traffic surfaces.

K. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

2.08 LADDERS:

A. General: Fabricate ladders for locations shown, with dimensions, spacings, details, and anchorages as indicated.
   1. Comply with ANSI A14.3, unless otherwise indicated.
   2. For elevator pit ladders, comply with ASME A17.1.

B. Siderails: Continuous, 1/2-by-2-1/2-inch steel flat bars, with eased edges.

C. Bar Rungs: 3/4-inch diameter steel bars, spaced 12 inches o.c., unless shown otherwise.

D. Fit rungs in centerline of side rails; plug-weld and grind smooth on outer rail faces.

E. Support each ladder at top and bottom and not more than 48 inches o.c. with welded or bolted steel brackets. Size brackets to support design loads specified in ANSI A14.3.

F. Provide nonslip surfaces on top of each rung by coating with abrasive material metallically bonded to rung by a proprietary process.

G. Galvanize ladders, including brackets and fasteners, in exterior locations and in areas with corrosive environments:

2.09 LADDER SAFETY CAGES:

A. General: Fabricate ladder safety cages to comply with ANSI A14.3. Assemble by welding or riveting.

B. Primary Hoops: 5/16-by-4-inch steel flat bar hoops. Provide at tops and bottoms of cages and spaced not more than 20 feet o.c.

C. Secondary Intermediate Hoops: 5/16-by-2-inch steel flat bar hoops, spaced not more than 48 inches o.c. between primary hoops.

D. Vertical Bars: 5/16-by-2-inch steel flat bars secured to each hoop, spaced approximately 9 inches o.c.

E. Fasten assembled safety cage to ladder rails and adjacent construction by welding or riveting, unless otherwise indicated.

F. Galvanize ladder safety cages, including fasteners, in exterior locations and in areas with corrosive environments.

2.10 SHIP'S LADDERS:

A. General: Design in accordance with AISC Specification for Structural Steel for Buildings-Allowable Stress Design, NAAMM Metal Stairs Manual and applicable OSHA requirements.
   1. Minimum live load for stairs: 100 psf.
   2. Stringers: At platforms and landings, extend stringers around perimeters. Close ends with continuously welded closure plates, ground smooth and flush.

B. Provide ship's ladders where shown or indicated. Fabricate of open-type construction with structural-steel channel or steel plate stringers, steel pipe handrails, and steel bar grating treads, unless otherwise indicated. Provide brackets and fittings for installation.

C. Treads, platforms and landings fabricated of steel plate with nonslip surface or steel grating, as shown.

D. As far as practicable, holes for rivets, bolts and screws located in concealed positions.

E. Galvanize ship’s ladder, including fasteners, in exterior locations and in areas with corrosive environments.

F. Comply with applicable requirements in Section 05520 for steel pipe railings.

2.11 SAFETY TREAD:

A. FS RR-T-650, Type C, metallic, nonskid, class and style as shown.

B. Drilled and countersunk to receive flathead screws.

2.12 STEEL LINTELS:

A. Fabricated of structural steel.

B. Multiple members riveted or welded back-to-back or separated by spacers.

C. Shop-painted, except hot-dip galvanized after fabrication where used in exterior walls.

2.12 SHELF ANGLES:

A. Fabricate shelf angles from steel angles of sizes indicated and for attachment to concrete framing. Provide horizontally slotted holes to receive 3/4-inch bolts, spaced not more than 6 inches from ends and 24 inches o.c., unless otherwise indicated.

B. For cavity walls, provide vertical channel brackets to support angles from backup masonry and concrete. Align expansion joints in angles with indicated control and expansion joints in cavity-wall exterior wythe.

C. Galvanize shelf angles to be installed in exterior walls.

D. Furnish wedge-type concrete inserts, complete with fasteners, to attach shelf angles to cast-in-place concrete.

2.13 CORNER GUARD, CURB ANGLE AND BUMPER:

A. Fabricated of structural steel.

B. Shop-painted.

2.14 UNDERGROUND SAFETY WALK:

A. Locking pin: Stainless steel, diameter to fit receptacle in hinge assembly with tolerance not greater than plus-or-minus 1/64 inch.

B. Locking-pin chain: Fabricated of 0.128-inch diameter steel spring wire.

C. Plug-welded in accordance with AWS D1.1.

D. Stainless steel: ASTM A276, Alloy S20200.

E. Bolts and washers: ASTM A325 or ASTM A490, nonrising and vibration-proof.

F. Spring wire: ASTM A229, Class 1 or 4.

G. Ferrous-metal components galvanized after fabrication.

H. Gratings and Floor Plates: Section 05531.

2.15 AERIAL SAFETY WALK:

A. Fabricated of floor plate, diamond pattern, flatback.

B. Abrasive surface on plates, unless otherwise shown.

C. Structural-steel angle frames anchored to supporting structure.

D. Plates in sections of convenient lengths for handling and with finger holes for lifting.

E. Galvanized after fabrication.

F. Bolts: Stainless steel.

2.16 SCREEN AT PLATFORM BENCH:

A. Materials:
   1. Base: Steel, welded.
   2. Bar frame: Steel, welded.
   3. Screen:
      a. Wire cloth: 0.080-inch diameter steel-wire mesh, galvanized after weaving.
      b. Frame: Steel, drilled for fasteners, holes punched for wire mesh and corners welded, galvanized.

B. Fabrication: Insert wire cloth with wires parallel to frame members, with ends of wires through holes in frame and welded to inner surface of channel.

C. Finish: Field-painted in accordance with Section 09920; FED STD 595, Color No. 20040.

2.17 CAST NOSING:

A. Cast aluminum: Cross-hatched units, 4 inches wide with 1-inch lip, for casting into concrete steps

B. Apply bituminous paint to concealed bottoms, sides, and edges of units set into concrete.

2.18 PEDESTRIAN BARRIER:

A. Tubing: Hot-formed square steel. Fabricated as follows:
   1. Heated and bent smoothly without distortion
   2. Joints fully welded as shown.
   3. Intersections coped, fully welded and ground smooth and flush.

B. Plate: Structural steel.

C. Floor-cover flange: Cast steel, as shown.

D. Finish: Shop-coated and finish painted in accordance with Section 09920.

2.19 BOLLARDS:

A. Pipe: Black Steel, ASTM A53, Type E, Grade A, Schedule 80, sized as shown, with 1/4-inch steel-plate cap welded all around and weld ground smooth

B. Eyebolt: 1/4-inch diameter steel rod with 1/2-inch diameter eye.

C. Concrete fill: Section 03300, Class 3000.

D. Coating:
   1. Shop paint.
   2. Finish paint: Aliphatic system as specified in Section 09920.
   3. Hot-dip galvanize exterior bollards in accordance with ASTM A123 before bonderizing and shop priming.

E. Chain: Guard chain, galvanized and painted to match bollard.

2.20 PARKING METER POSTS:

A. Pipe: Black steel, ASTM A53, Type E, Grade A, Schedule 40, two-inch nominal OD.

B. Hot-dip galvanize after cutting to length.

C. See Sections 03100, 03200, and 03300 for concrete footing.

2.21 MISCELLANEOUS ITEMS:

A. Fabricate metal items indicated on the drawings from materials shown or, if not otherwise described, from steel or from galvanized steel wherever exposed to the weather or in contact with concrete or masonry.

B. Make miscellaneous items to the size and configuration indicated, welded or bolted at joints to develop full strength equal to a continuous member, and in every way complete for the intended purpose and finished in appearance.

C. Pylon-Base Ring: Structural steel, galvanized after fabrication.

D. Lifting Eye: ASTM A572, Grade 50, one-inch diameter steel rod, welded, galvanized after fabrication.

2.22 FINISHES:

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   1. Finish metal fabrications after assembly.

B. Galvanizing:
   1. Clean ferrous metal thoroughly before applying zinc coating.
   2. Apply zinc coating to products after fabrication, by hot-dip method, using coating weighing not less than 2.0 ounces per square foot.

C. Shop Paint:
   1. Ferrous metal thoroughly cleaned as recommended by primer manufacturer and in accordance with SSPC SP11 and, except for items to be encased in concrete, given prime coat of paint.
   2. Zinc yellow iron-oxide primer or red-lead base primer applied so as to thoroughly cover surfaces without leaving runs or sags.

D. Stainless Steel: 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.

E. Aluminum: AA-M10 (Mechanical Finish: as fabricated, unspecified).

F. Non-Slip Abrasive Surfaces: SLIP-NOT as manufactured by the W. S. Molnar Company or approved equal. Fabricate from steel plate or bar with abrasive material metallically bonded to steel by a proprietary process. Provide material with coefficient of friction of 0.6 or higher when tested according to ASTM C1028.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Remove foreign substances from surfaces to receive metal items.

B. Protect surrounding surfaces from damage while performing the work of this section.

3.02 INSTALLATION, GENERAL:

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal fabrications to in-place construction. Include threaded fasteners for concrete and masonry inserts, toggle bolts, through-bolts, lag bolts, wood screws, and other connectors.

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

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.03 INSTALLING NOSINGS:

A. Center nosings on tread widths.

B. For nosings embedded in concrete steps or curbs, align nosings flush with riser faces and level with tread surfaces.

3.04 INSTALLING BOLLARDS:

A. Anchor bollards in concrete with pipe sleeves preset and anchored into concrete. After bollards have been inserted into sleeves, fill annular space between bollard and sleeve solidly with nonshrink, nonmetallic grout, mixed and placed to comply with grout manufacturer's written instructions. Slope grout up approximately 1/4 inch toward bollard.

3.05 PAINTING AND REPAIRING COATED SURFACES:

A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finished work, except items encased in concrete.

B. Where shop coat is abraded or burned by welding, clean and touch-up.

C. Touch-up primed surfaces with same material as coating.

D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.

E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
   1. Wire-brush areas to be coated to bright metal.
   2. Apply galvanizing repair compound at rate of two ounces per square foot.

END OF SECTION

SECTION 05511

METAL STAIRS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providingAdjust list below to suit Project.steel stairs with concrete-filled treads, industrial stairs with steel floor plate treads, industrial stairs with steel grating treads.

B. Related Work Specified Elsewhere:
   1. Cast-In-Place Structural Concrete: Section 03300.
   2. Handrails and Railings: Section 05521.
   3. Miscellaneous Metal: Section 05500.
   4. Field Painting: Section 09920.

1.02 PERFORMANCE REQUIREMENTS:

A. Structural Performance: Provide metal stairs capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections. Apply each load to produce the maximum stress in each component of metal stairs.
   1. Treads and Platforms of Metal Stairs: Capable of withstanding a uniform load of 100 lbf/sq. ft. or a concentrated load of 300 lbf on an area of 4 sq. in., whichever produces the greater stress; or higher load if required by the jurisdictional authority where the stair is installed.
   2. Stair Framing: Capable of withstanding stresses resulting from loads specified above in addition to stresses resulting from railing system loads.
   3. Limit deflection of treads, platforms, and framing members to L/360 or 1/4 inch, whichever is less or as required by the jurisdictional authority where the stair is installed.

B. Metal stairs shall be designed in accordance with AISC"s "Specification for Structural Steel for Buildings-Allowable Stress Design," NAAMM's "Metal Stairs Manual" and applicable OSHA requirements.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each.
   1. Product Data: For metal stairs and the following:
      a. Prefilled metal-pan stair treads.
      b. Precast concrete treads.
      c. Nonslip aggregates and nonslip-aggregate finishes.
      d. Steel floor plate.
      e. Grout.
   2. Shop Drawings: Show fabrication and installation details for metal stairs. Include plans, elevations, sections, and details of metal stairs and their connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
   3. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

4. Samples for Initial Selection: Manufacturer's color charts or sections of units showing the full range of colors and patterns for the following products
5. Samples for Verification: For the following products. Prepare Samples from the same material to be used for the Work.
   a. Stair treads with nonslip-aggregate surface finish.
   b. Floor plate treads.
   c. Grating treads.
6. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. ADA: Americans with Disabilities Act.
   3. AGA: The Design and Fabrication of Galvanized Products.
   4. AISC: Specification for Structural Steel for Buildings-Allowable Stress Design
   5. ASME: B18.2.1, B18.6.3, B18.21.1, B18.22.1.
   6. ASTM: A36, A82, A90, A123, A143, A153, A185, A283, A307, A366, A384, A500, A510, A563, A611, B633, C1028, C1107, D1187, E488, F593, F594.
   7. AWS: D1.1, D1.3.
   8. FS: TT-P-664
   9. MS: MIL-P-21305.
   10. NAAMM: Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads, Metal Finishes Manual for Architectural and Metal Products, Metal Stairs Manual.
   11. SSPC: Paint 12, PA-1, SP 3, SP 6/NACE No. 3.

B. Installer Qualifications: Arrange for metal stairs specified in this Section to be fabricated and installed by the same firm.

C. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of metal stairs (including handrails and railing systems) that are similar to those indicated for this Project in material, design, and extent.

D. Fabricator Qualifications: A firm experienced in producing metal stairs similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

E. Welding: Qualify procedures and personnel according to AWS D1.1, "Structural Welding Code--Steel," and AWS D1.3, "Structural Welding Code--Sheet Steel."

1.05 COORDINATION:

A. Coordinate installation of anchorages for metal stairs. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 FERROUS METALS:

A. Metal Surfaces, General: Provide metal free from pitting, seam marks, roller marks, and other imperfections where exposed to view on finished units. Do not use steel sheet with variations in flatness exceeding those permitted by referenced standards for stretcher-leveled sheet.

B. Steel Plates, Shapes, and Bars: ASTM A36.

C. Steel Tubing: Cold-formed steel tubing complying with ASTM A500.

D. Rolled-Steel Floor Plate: ASTM A 786/A 786M, rolled from plate complying with ASTM A 36/A 36M or ASTM A 283/A 283M, Grade C or D.

E. Steel Bars for Gratings: ASTM A36.

F. Wire Rod for Grating Crossbars: ASTM A510.

G. Uncoated, Cold-Rolled Steel Sheet: Commercial quality, complying with ASTM A366/A366M; or structural quality, complying with ASTM A611, Grade A, unless another grade is required by design loads.

H. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy welded.

2.02 FASTENERS:

A. General: Provide zinc-plated fasteners with coating complying with ASTM B633, Class Fe/Zn 25 for exterior use, and Class Fe/Zn 5 where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. Machine Screws: ASME B18.6.3.

D. Lag Bolts: ASME B18.2.1.

E. Plain Washers: Round, carbon steel, ASME B18.22.1.

F. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.

G. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
   1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
   2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

2.03 COATINGS:

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664, selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for

B. Galvanizing (zinc-coating by hot-dipped process): ASTM A90, ASTM A123, or ASTM A143, ASTM A153 or ASTM A384, as applicable.

C. Zinc-rich paint: MS MIL-P-21305.

D. Galvanizing Repair Compound: Stick form, melting point 600-degree F to 650-degree F, GALVABAR or equal.

2.04 CAST ABRASIVE NOSINGS:

A. Fabricate units from cast iron in sizes and configurations indicated and in lengths necessary to accurately fit openings or conditions. Provide units with an integral corundum or silicon carbide abrasive finish. See Section 05500, “Miscellaneous Metals.”

B. Provide anchors for embedding units in concrete, either integral or applied to units, as standard with manufacturer.

C. Apply bituminous paint to concealed bottoms, sides, and edges of units set into concrete.

D. Provide a cross-hatched surface texture, unless other surfaces are indicated.

2.05 GROUT:

A. Nonshrink, Nonmetallic Grout: Factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

2.06 CONCRETE FILL AND REINFORCING MATERIALS:

A. Concrete Materials and Properties: Comply with requirements in Section 03300, "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 3000 psi, limit the max. coarse aggregate size to #8, unless higher strengths are indicated.

B. Nonslip-Aggregate Finish: Factory-packaged and graded abrasive aggregate made from fused, aluminum-oxide grits or crushed emery; rustproof and nonglazing; unaffected by freezing, moisture, or cleaning materials.

C. Welded Wire Fabric: ASTM A185, 6 by 6 inches--W1.4 by W1.4, unless otherwise indicated.

D. Surface Hardener: Water-soluble, inorganic fluosilicate compound for curing, hardening and dustproofing fresh concrete.

2.07 PRECAST CONCRETE TREADS:

A. Concrete Materials and Properties: Comply with requirements in Section 03300, "Cast-in-Place Concrete" for normal-weight, ready-mixed concrete with a minimum 28-day compressive strength of 5000 psi and a total air content of not less than 4 percent or more than 6 percent.

B. Reinforcing Wire Fabric: Galvanized, welded wire fabric, 2 by 2 inches by 0.062-inch-diameter wire; comply with ASTM A185 and ASTM A82, except for minimum wire size.

2.08 FABRICATION, GENERAL:

A. Fabricate and prepare products required to be galvanized in accordance with recommendations of AGA.

B. Provide complete stair assemblies, including metal framing, hangers, struts, clips, brackets, bearing plates, and other components necessary to support and anchor stairs and platforms on supporting structure.Delete subparagraphs below if not required.
   1. Join components by welding, unless otherwise indicated.
   2. Use connections that maintain structural value of joined pieces.
   3. Fabricate treads and platforms of exterior stairs so finished walking surfaces slope to drain.

C. NAAMM Stair Standard: Comply with "Recommended Voluntary Minimum Standards for Fixed Metal Stairs" in NAAMM AMP 510, "Metal Stairs Manual," for class of stair designated, unless more stringent requirements are indicated.
   1. Architectural class, where indicated.
   2. Commercial class, unless otherwise indicated.
   3. Service class, unless otherwise indicated.
   4. Industrial class, where indicated.

D. Shop Assembly: Preassemble stairs in shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation

E. Form exposed work true to line and level with accurate angles and surfaces and straight sharp edges. Shear and punch metals cleanly and accurately. Remove sharp or rough areas on exposed surfaces.

F. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing work.

G. Weld connections to comply with AWS and the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.
   4. Weld exposed corners and seams continuously, unless otherwise indicated.
   5. 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.

H. Form exposed connections with hairline joints, flush and smooth, using concealed fasteners where possible. Use exposed fasteners of type indicated or, if not indicated, Phillips flat-head (countersunk) screws or bolts. Locate joints where least conspicuous.

I. Fabricate joints that will be exposed to weather in a manner to exclude water, or provide weep holes where water may accumulate.

2.09 STEEL-FRAMED STAIRS:

A. Stair Framing: Fabricate stringers of structural-steel channels, plates, or a combination of both, as indicated. Provide closures for exposed ends of stringers. At platforms and landings, extend stringers around perimeters. Close ends with continuously welded closure plates, ground smooth and flush. Construct platforms of structural-steel channel headers and miscellaneous framing members as indicated. Bolt or weld headers to stringers; bolt or weld

framing members to stringers and headers. If using bolts, fabricate and join so bolts are not exposed on finished surfaces.

1. Where masonry walls support metal stairs, provide temporary supporting struts designed for erecting steel stair components before installing masonry.

B. Metal Risers, Subtread Pans, and Subplatforms: Form to configurations shown from steel sheet of thickness necessary to support indicated loads, but not less than 0.0677 inch.

1. Steel Sheet: Uncoated cold-rolled steel sheet, unless otherwise indicated.
2. Directly weld metal pans to stringers; locate welds on side of subtreads to be concealed by concrete fill. Do not weld risers to stringers.
3. Attach cast abrasive nosings to risers. Make nosings full width of tread, with noses flush with riser faces and level with tread surfaces.

C. Steel Floor Plate Treads, Risers, and Platforms: Form to configurations shown from abrasive-surface floor plate of thickness necessary to support indicated loads, but not less than 1/4 inch.

1. Abrasive-Surface Floor Plate: Fabricate from steel plate, with abrasive material metallically bonded to steel by a proprietary process. Provide material with coefficient of friction of 0.6 or higher when tested according to ASTM C1028.
    a. Products: Subject to compliance with requirements, provide one of the following:
        1) Mebac; IKG Borden.
        2) SLIP-NOT; W. S. Molnar Company.
        3) Or equal.
2. Form treads with integral nosing and back edge stiffener. Weld steel supporting brackets to stringers and weld treads to brackets.
3. Fabricate platforms with integral nosings matching treads and weld to platform framing.

D. Floor Grating Treads and Platforms: Form to configurations shown from metal bar grating; fabricate to comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel Stainless Steel, and Aluminum Gratings and Stair Treads."

1. Fabricate treads and platforms from welded steel grating or pressure-locked steel grating with bearing bars and crossbars of sizes to meet the required loads.
2. Surface: Serrated.
3. Finish: Galvanized.
4. Fabricate grating platforms with nosing matching that on grating treads. Provide toeplates at open-sided edges of grating platforms. Weld grating to platform framing.

2.10 STAIR HANDRAILS AND RAILINGS:

A. General: Comply with applicable requirements in Section 05521Delete paragraph above or below.

1. Railings may be bent at corners, rail returns, and wall returns, instead of using prefabricated fittings.
2. Connect railing posts to stair framing by direct welding, unless otherwise indicated.

2.11 FINISHES:

A. General:

1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
2. Finish metal stairs after assembly.

B. Galvanizing:

1. Clean ferrous metal throughly before applying zinc coating.
2. Apply zinc coating to products after fabrication, by the hot-dip method, using coating weighing not less than two ounces per-square-foot.

C. Preparation for Shop Priming: Prepare uncoated or non-alvanized ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed items:
1. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to non-galvanized surfaces of gratings, frames, and supports, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.
1. Do not apply primer to galvanized surfaces.
2. Stripe paint corners, crevices, bolts, welds, and sharp edges.
3. For items shown or indicated to receive paint: Section 09920.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing metal stairs to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing metal stairs. Set units accurately in location, alignment, and elevation, measured from established lines and levels and free from rack.

C. Install metal stairs by welding stair framing to steel structure or to weld plates cast into concrete, unless otherwise indicated.

D. Provide temporary bracing or anchors in formwork for items that are to be built into concrete, masonry, or similar construction.

E. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

F. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.
4. At exposed connections, finish exposed welds and surfaces smooth and blended so no roughness shows after finishing and contour of welded surface matches that of adjacent surface.

G. Install precast treads with adhesive supplied by manufacturer.

3.02 INSTALLING METAL STAIRS WITH GROUTED BASEPLATES:

A. Clean concrete and masonry bearing surfaces of bond-reducing materials, and roughen to improve bond to surfaces. Clean bottom surface of baseplates.

B. Set steel stair baseplates on wedges, shims, or leveling nuts. After stairs have been positioned and aligned, tighten anchor bolts. Do not remove wedges or shims but, if protruding, cut off flush with edge of bearing plate before packing with grout.
   1. Use nonmetallic, nonshrink grout, unless otherwise indicated.
   2. Pack grout solidly between bearing surfaces and plates to ensure that no voids remain.

3.03 INSTALLING STEEL RAILINGS AND HANDRAILS:

A. Adjust handrails and railing systems before anchoring to ensure matching alignment at abutting joints. Space posts at spacing indicated or, if not indicated, as required by design loads. Plumb posts in each direction. Secure posts and railing ends to building construction as follows:
   1. Anchor posts to steel by welding directly to steel supporting members.
   2. Anchor handrail ends to concrete and masonry with steel round flanges welded to rail ends and anchored with postinstalled anchors and bolts.

B. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface. Locate brackets as indicated or, if not indicated, at spacing required to support structural loads. Secure wall brackets to building construction as follows:
   1. For concrete and solid masonry anchorage, use drilled-in expansion shields and hanger or lag bolts.
      a. For hollow masonry anchorage, use toggle bolts.

3.04 PAINTING AND REPAIRING COATED SURFACES:

A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finish work, except items encased in concrete.

B. Where shop coat is abraded or burned by welding, clean and touch-up.

C. Touch-up primed surfaces with same material as coating.

D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.

E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
   1. Wire brush areas to be coated to bright metal.
   2. Apply galvanizing repair compound at rate of two ounces per-square-foot.

END OF SECTION

SECTION 05521
HANDRAILS AND RAILINGS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing Adjust list below to suit Project.steel pipe and tube handrails and railings and PVC pipe handrails and railings.

B. Related Work Specified Elsewhere:
1. Miscellaneous Metal: Section 05500.
2. Metal Stairs: Section 05511.
3. Ornamental Metal: Section 05700.
4. Field Painting: Section 09920
5. Wire Mesh Partitions: Section 10605

1.02 PERFORMANCE REQUIREMENTS:

A. General: In engineering handrails and railings to withstand structural loads indicated, determine allowable design working stresses of handrail and railing materials based on the following: Retain only those requirements below that apply to materials specified in Part 2.
1. Structural Steel: AISC S335, "Specification for Structural Steel Buildings Allowable Stress Design and Plastic Design with Commentary."
2. Cold-Formed Structural Steel: AISI SG-673, Part I, "Specification for the Design of Cold-Formed Steel Structural Members."

B. Structural Performance of Handrails and Railings: Provide handrails and railings capable of withstanding the following structural loads without exceeding allowable design working stresses of materials for handrails, railings, anchors, and connections:
1. Top Rail of Guards: Capable of withstanding the following loads applied as indicated or higher if required by the jurisdictional authority where installed
   a. Concentrated load of 200 lbf applied at any point and in any direction.
   b. Uniform load of 50 lbf/ft. applied horizontally and concurrently with uniform load of 100 lbf/ft. applied vertically downward.
   c. Concentrated and uniform loads above need not be assumed to act concurrently.
2. Handrails Not Serving As Top Rails: Capable of withstanding the following loads applied as indicated or higher if required by the jurisdictional authority where installed:
   a. Concentrated load of 200 lbf applied at any point and in any direction.
   b. Uniform load of 50 lbf/ft. applied in any direction.
   c. Concentrated and uniform loads above need not be assumed to act concurrently.
3. Infill Area of Guards: Capable of withstanding a horizontal concentrated load of 200 lbf applied to 1 sq. ft. at any point in system, including panels, intermediate rails, balusters, or other elements composing infill area or higher if required by the jurisdictional authority where installed.
   a. Load above need not be assumed to act concurrently with loads on top rails in determining stress on guard.

C. Thermal Movements: Provide handrails and railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

D. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.03 SUBMITTALS:

Submit the following for approval in accordance with the General Requirementsand with the additional requirements as specified for each:

A. Product Data: For the following:
   1. Manufacturer's product lines of handrails and railings.
   2. Grout, anchoring cement, and paint products.

B. Shop Drawings: Show fabrication and installation of handrails and railings. Include plans, elevations, sections, component details, and attachments to other Work.
   1. For installed handrails and railings indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.

C. Samples for Initial Selection: Manufacturer's color charts showing the full range of colors available for products with factory-applied color finishes.

D. Samples for Verification: For each type of exposed finish required, prepared on components indicated below and of same thickness and material indicated for the Work. If finishes involve normal color and texture variations, include sample sets showing the full range of variations expected.
   1. 6-inch-long sections of each distinctly different linear railing member, including handrails, top rails, posts, and balusters.
   2. Fittings and brackets.
   3. Assembled sample of railing system, made from full-size components, including top rail, post, handrail, and infill. Show method of finishing members at intersections. Sample need not be full height

E. Product Test Reports: From a qualified testing agency indicating products comply with requirements, based on comprehensive testing of current products.

F. Welding Certificates: Copies of certificates for welding procedures and personnel.

1.04 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. ADA: Americans with Disabilities Act.
   3. AGA: The Design and Fabrication of Galvanized Products.
   4. AISC: S335.
   5. AISI: SG-673, Part I.
   6. ASTM: A36, A53, A90, A123, A143, A153, A384, A500, A780, B633, C1107, D256, D635, D638, D695, D790, E488, E548.

7. AWS: D1.1, D1.3.
8. FED STD: 595.
9. FS: A-A-462, FF-B-588, FF-H-116, FF-P-395, FF-S-325, TT-P-644.
10. NAAMM: Metal Finishes Manual for Architectural and Metal Products, Pipe Railing Manual.
11. SSPC: PA 1, Paint 5, SP 6, SP 7.

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of handrails and railings that are similar to those indicated for this Project in material, design, and extent.

C. Testing Agency Qualifications: An independent testing agency with the experience and capability to conduct the testing indicated, as documented according to ASTM E548.

D. Welding: Qualify procedures and personnel according to AWS D1.1 “Structural Welding Code“Steel,and AWS D1.3,” Structural Welding Code-Sheet Steel”.

E. Source Limitations: Obtain each type of handrail and railing through one source from a single manufacturer.

1.05 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products undamaged.

B. Store handrails and railings in a dry, well-ventilated, weathertight place.

C. Handle products so as to prevent damage.

1.06 PROJECT CONDITIONS:

A. Field Measurements: Verify handrail and railing dimensions by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating handrails and railings without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions.

1.07 COORDINATION:

A. Coordinate installation of anchorages for handrails and railings. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

1.08 SCHEDULING:

A. Schedule installation so handrails and railings are mounted only on completed walls. Do not support temporarily by any means that does not satisfy structural performance requirements.

PART 2 - PRODUCTS

2.01 FERROUS METALS:

A. Metal Surfaces, General: Provide metal free from pitting, seam marks, roller marks, stains, discolorations, and other imperfections where exposed to view on finished units.

B. Steel and Iron: Provide steel and iron in the form indicated, complying with the following requirements:
   1. Steel Pipe: ASTM A53; finish, type, and weight class as follows
      a. Black finish, unless otherwise indicated.
      b. Galvanized finish for exterior installations and where indicated.Type E, Grade A, standard weight (Schedule 40) for rails and extra heavy weight (Schedule 80) for posts, unless another grade and weight are required by structural loads.
   2. Steel Tubing: Cold-formed steel tubing, ASTM A500, Grade A, unless another grade is required by structural loads.
   3. Steel Plates, Shapes, and Bars: ASTM A36.

C. Brackets, Flanges, and Anchors: Cast or formed metal of same type of material and finish as supported rails, unless otherwise indicated.

2.02 POLYVINYL CHLORIDE (PVC) FOR NON-CONDUCTIVE RAILINGS:

A. Custom colored, fade-resistant PVC pipe and fittings, meeting the structural performance requirements with the following minimum properties:
   1. Compressive Strength, ASTM D695: 8,100 psi.
   2. Tensile Strength, ASTM D638: 6,500 psi.
   3. Flexural Strength, ASTM D790: 11,000 psi.
   4. Flexural Modulus, ASTM D790: 350,000 psi.
   5. Izod Impact, ASTM D256: 5.0 ft-lb/in minimum.
   6. Flamability, ASTM D635: Self-extinguishing.
   7. UL Rating: UL 94-V-O, minimum thickness 0.062-inch.
   8. Color: Intergrally pigmented PVC in Brown color, FED STD 595B color 20040.

2.03 FIBERGLASS REINFORCED PLASTIC (FRP) NON-CONDUCTIVE RAILINGS:

A. Fabricated from isophthalic-polyester or vinyl ester resin poltruded fiberglass components with polyurethene UV coating, flame retardant per ASTM E4 Class I, meeting the structural performance requirements and with the following minimum properties:
   1. Compressive Stress, ASTM D695: 30,000 psi.
   2. Tensile Stress, ASTM D638: 30,0000 psi.
   3. Flexural Stress, ASTM D790: 30,0000 psi.
   4. Flexural Modulus, ASTM D790: 1.6 x 106 psi.
   5. Flamability: Self-extinguishing.
   6. Color: Manufacturerâ€™s standard unless otherwise indicated.

2.04 WELDING MATERIALS, FASTENERS, AND ANCHORS:

A. Welding Electrodes and Filler Metal: Provide type and alloy of filler metal and electrodes as recommended by producer of metal to be welded and as required for color match, strength, and compatibility in fabricated items.

B. Fasteners for Anchoring Handrails and Railings to Other Construction: Select fasteners of type, grade, and class required to produce connections suitable for anchoring handrails and railings to other types of construction Indicated and capable of withstanding design loads.
   1. For steel handrails, railings, and fittings, use plated fasteners complying with ASTM B633, Class Fe/Zn 25 for electrodeposited zinc coating.

C. Fasteners for Interconnecting Handrail and Railing Components: Use fasteners fabricated from same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
   1. Provide concealed fasteners for interconnecting handrail and railing components and for attaching them to other work, unless otherwise indicated.
   2. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

D. Cast-in-Place and Postinstalled Anchors: Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E488 conducted by a qualified independent testing agency.
   1. Cast-in-place anchors.
   2. Expansion anchors.

E. Anchoring Devices:
   1. Toggle bolt: FS FF-B-588.
   2. Drive Stud: FS FF-S-325, Group 6.
   3. Expansion Shield: FS FF-S-325, Group I, Class 2, Style 1; Group II, Type 3, Class 1, Group IV, Type 1; best suited to the purpose.
   4. Screw Anchors: Lead or plastic for wood or metal screws.
   5. Anchor-bolt sleeve: Corrugated high-density polyethylene plastic.
   6. Powder actuated: FS FF-P-395.

2.05 COATINGS:

A. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.

C. Galvanizing (zinc-coating by hot-dipped process): ASTM A90, ASTM A123, or ASTM A143, ASTM A153 or ASTM A384, as applicable.

D. Galvanizing Repair Compound: Stick form, melting point 600-degree F to 650-degree F, GALVABAR or equal.

E. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D 1187.

2.06 GROUT AND ANCHORING CEMENT:

A. Nonshrink, Nonmetallic Grout: Premixed, factory-packaged, nonstaining, noncorrosive, nongaseous grout complying with ASTM C1107. Provide grout specifically recommended by manufacturer for interior and exterior applications.

B. Erosion-Resistant Anchoring Cement: Factory-packaged, nonshrink, nonstaining, hydraulic-controlled expansion cement formulation for mixing with water at Project site to create pourable anchoring, patching, and grouting compound. Provide formulation that is resistant to erosion from water exposure without needing protection by a sealer or waterproof coating and that is recommended by manufacturer for exterior use.

2.07 FABRICATION, GENERAL:

A. Fabricate and prepare products required to be galvanized in accordance with recommendations of AGA.

B. Fabricate handrails and railings 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.

C. Assemble handrails and railings in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

D. Form changes in direction of railing members as follows:
   1. By bending.
   2. By radius bends of radius indicated on approved shop drawings.

E. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain cylindrical cross section of member throughout entire bend without buckling, twisting, cracking, or otherwise deforming exposed surfaces of handrail and railing components.

F. Welded Connections: Fabricate metal handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove flux immediately.
   4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces.

G. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.

H. Provide inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with supporting structure.

I. For railing posts set in concrete, provide preset sleeves of steel not less than 6 inches long with inside dimensions not less than Â½ inch greater than outside dimensions of post, and steel plate forming bottom closure, unless indicated otherwise on approved shop drawings.

J. For removable railing posts, fabricate slip-fit sockets from steel tube whose ID is sized for a close fit with posts; limit movement of post without lateral load, measured at top, to not more than one-fortieth of post height. Provide socket covers designed and fabricated to resist being dislodged.
   1. Provide chain with eye, snap hook, and staple across gaps formed by removable railing sections at locations indicated. Fabricate from same metal as railings.

K. Shear and punch metals cleanly and accurately. Remove burrs from exposed cut edges.

L. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated. Form bent-metal corners to smallest radius possible without causing grain separation or otherwise impairing the Work.

M. Cut, reinforce, drill, and tap components, as indicated, to receive finish hardware, screws, and similar items.

N. Provide weep holes or another means to drain entrapped water in hollow sections of handrail and railing members that are exposed to exterior or to moisture from condensation or other sources.

O. Fabricate joints that will be exposed to weather in a watertight manner.

P. Close exposed ends of handrail and railing members with prefabricated end fittings.

Q. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated. Close ends of returns, unless clearance between end of railing and wall is 1/4 inch or less.

R. Toe Boards: Where indicated, provide toe boards at railings around openings and at edge of open-sided floors and platforms. Fabricate to dimensions and details indicated on approved shop drawings.

2.O8 FABRICATION, PIPE RAILINGS AND RAILING GATES:

A. Pipe: Black steel, ASTM A53, Type E, Grade A, standard weight (Schedule 40) for rails and extra heavy weight (Schedule 80) for posts, unless another grade and weight are required by structural loads, 1 inch nominal ID unless otherwise shown on approved shop drawings. Fabricated in accordance with NAAMM," Pipe Railing Manual" and as shown on approved shop drawings.

B. Plates, shapes and bars: Structural Steel.

C. Intersections neatly coped, fully welded and ground smooth.

D. Heated and bent smoothly, without distortion.

E. Galvanized after fabrication.

F. Hardware:
   1. Hinges: FS FF-H-116, Type 2127H, US2H finish.

2. Cane bolt: FS A-A-462.
3. Double-acting latch:
    a. Shop fabricated.
    b. Housing and strike: Steel, ASTM A36.
    c. Turn piece and bolt: Bronze, US10B
    d. Spring: Phosphor bronze.

2.O9 FABRICATION, HANDRAILS:

A. Pipe: Black steel, ASTM A53, Type E, Grade A, standard weight (Schedule 40), 1 inch nomianl ID, unless otherwise indicated on approved shop drawings.

B. Returned to walls at ends with quarter-round bends, with wall flanges welded to bends.

C. Wall brackets included.

D. Galvanized after fabrication.

E. Bonderized and shop primed.

2.10 FABRICATION, PVC NON-CONDUCTIVE RAILINGS:

A. Factory manufactured pipe railing assembly consisting of pigmented PVC pipe with prefabricated connections and bends, and with galvanized steel pipe reinforcing inside the posts. Size and arrangement as shown on approved shop drawings and as determined from field measurements.

B. Deformation Requirement: Support loading required under “Performance Requirements” with a minimum recovery from deflection of 99 percent.

C. Rails and Posts: Two laminated PVC pipes, one inside the other; inner pipe Schedule 80 and extended to receive tee, cross and end fittings; outer pipe Schedule 40.

D. Post Reinforcing: Hot-dipped galvanized steel pipe, Schedule 80, of length to reinforce entire height of railing, sized to fit snugly inside inner PVC pipe and extended at floor to anchor into concrete.

E. Rail Reinforcing: If required for design load, provide hot-dipped galvanized steel pipe, Schedule 40 or Schedule 80 as necessary, of length to reinforce entire length of rail, sized to fit snugly inside inner PVC pipe.

F. Splice Tubes: Schedule 80 PVC pipe to ensure rigid splices in rails and at end fittings.

G. Tee, Cross and End Fittings, and Spacers: Schedule 40 PVC pipe matching rail and post diameter and finish.

H. End Plates: Solid PVC, four-inch diameter Â½-inch thick plate with an integral two-inch long stub of same diameter as splice tube; four pre-drilled countersunk 3/8-inch holes.

I. Welding Solvent: As recommended by manufacturer.

J. Color: Metro Brown 20040. Color extending through thickness of PVC.

K. Grout: Nonshrink as specified, except with 9,000 psi compressive strength.

L. Source: Saftron , Inc. (305)233-5511, or equal.

2.11 FABRICATION, FRP NON-CONDUCTIVE RAILINGS:

A. Factory manufactured tube railing assembly consisting of pigmented FRP tube with prefabricated connections, bends and all fittings. Size and arrangement as shown on approved shop drawings and as determined from field measurements.

B. Rails and Posts: 2-inch X 2-inch X 1/4-inch square tube manufactured by the pultrusion process. All posts and rails shall use the same tube size. All tubing for handrail to have a minimum 1/4" wall thickness.

C. Kickplate: Unless indicated otherwise, provide 4-inch pultruded fiberglass shape.

D. Anchoring devices: Stainless steel anchor bolts or studs, minimum Â½-inch diameter, extending no less than 2 -1/4 inches into the concrete, or as recommended by railing manufacturer.

E. Epoxy: As recommended by railing manufacturer.

F. Color: Manufacturer’s standard color unless otherwise indicated.

2.12 FINISHES, GENERAL:

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

C. Appearance of Finished Work: Variations in appearance of abutting or adjacent pieces are acceptable if they are within one-half of the range of approved Samples. Noticeable variations in the same piece are not acceptable. Variations in appearance of other components are acceptable if they are within the range of approved Samples and are assembled or installed to minimize contrast.

2.13 STEEL FINISHES:

A. Galvanized Handrails and Railings: Hot-dip galvanize exterior steel and iron handrails and railings to comply with ASTM A123. Hot-dip galvanize hardware for exterior steel and iron handrails and railings to comply with ASTM A153/A153M.

B. Galvanizing: Hot-dip galvanize items as indicated to comply with applicable standard listed below:
   1. ASTM A123, for galvanizing steel and iron products.
   2. ASTM A153/A153M, for galvanizing steel and iron hardware.

C. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

D. For galvanized handrails and railings, provide galvanized fittings, brackets, fasteners, sleeves, and other ferrous components.

E. Preparation for Shop Priming: After galvanizing, thoroughly clean handrails and railings of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.

F. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed handrails and railings:
   1. Exteriors (SSPC Zone 1B): SSPC-SP 6, "Commercial Blast Cleaning."
   2. Interiors (SSPC Zone 1A): SSPC-SP 7, "Brush-off Blast Cleaning."Apply shop primer to prepared surfaces of handrail and railing components, unless otherwise indicated. Comply with requirements in SSPC-PA 1, "Paint Application Specification No. 1," for shop painting. Primer need not be applied to surfaces tobe embedded in concrete or masonry.
   3. Do not apply primer to galvanized surfaces.
   4. Stripe paint edges, corners, crevices, bolts, and welds.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Fit exposed connections together to form tight, hairline joints.

B. Perform cutting, drilling, and fitting required to install handrails and railings. Set handrails and railings accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.
   1. Do not weld, cut, or abrade surfaces of handrail and railing components that have been coated or finished after fabrication and that are intended for field connection by mechanical or other means without further cutting or fitting.
   2. Set posts plumb within a tolerance of 1/16 inch in 3 feet.
   3. Align rails so variations from level for horizontal members and from parallel with rake of steps and ramps for sloping members do not exceed 1/4 inch in 12 feet.

C. Adjust handrails and railings before anchoring to ensure matching alignment at abutting joints. Space posts at interval indicated, but not less than that required by structural loads.

D. Where pipe railing is mounted on concrete, attach by means of bolts and expansion shields. If concrete surface upon which posts are to be set is low, use full-size steel shims to bring railing to correct elevation.

E. Fastening to In-Place Construction: Use anchorage devices and fasteners where necessary for securing handrails and railings and for properly transferring loads to in-place construction.

3.02 RAILING CONNECTIONS:

A. Welded Connections: Use fully welded joints for permanently connecting railing components. Comply with requirements for welded connections in "Fabrication" Article whether welding is performed in the shop or in the field.

B. Expansion Joints: Install expansion joints at locations indicated but not farther apart than required to accommodate thermal movement. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.03 ANCHORING POSTS:

A. Use steel pipe sleeves preset and anchored into concrete for installing posts. After posts have been inserted into sleeves, fill annular space between post and sleeve with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions:

B. Form or core-drill holes not less than 5 inches deep and 3/4 inch larger than OD of post for installing posts in concrete. Clean holes of loose material, insert posts, and fill annular space between post and concrete with the following anchoring material, mixed and placed to comply with anchoring material manufacturer's written instructions:
   1. Nonshrink, nonmetallic grout.

C. Cover anchorage joint with flange of same metal as post, attached to post as follows:
   1. Welded to post after placing anchoring material.

D. Leave anchorage joint exposed; wipe off surplus anchoring material; and leave 1/8-inch build-up, sloped away from post.

E. Anchor posts to metal surfaces with oval flanges, angle type, or floor type as required by conditions, connected to posts and to metal supporting members as follows:
   1. For steel pipe railings, weld flanges to post and bolt to metal supporting surfaces.
   2. Install removable railing sections, where indicated, in slip-fit metal sockets cast in concrete.

3.04 ANCHORING RAILING ENDS:

A. Anchor railing ends into concrete and masonry with round flanges connected to railing ends and anchored into wall construction with postinstalled anchors and bolts.

B. Anchor railing ends to metal surfaces with flanges bolted to metal surfaces.
   1. Weld flanges to railing ends.

3.05 ATTACHING HANDRAILS TO WALLS:

A. Attach handrails to wall with wall brackets. Provide bracket with 1-1/2-inch clearance from inside face of handrail and finished wall surface.

B. Locate brackets not more than four feet on centers, or less if required to support structural loads.

C. Secure wall brackets to building construction with 3/8-inch bolts and expansion shields, powder actuated fasteners or toggle bolts, as applicable.

3.06 PVC AND FRP NON-CONDUCTIVE RAILINGS:

A. Install in accordance with approved shop drawings and manufacturer’sprinted instructions.

3.07 PAINTING AND REPAIRING COATED SURFACES:

A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finish work, except items encased in concrete.

B. Where shop coat is abraded or burned by welding, clean and touch-up.

C. Touch-up primed surfaces with same material as coating.

D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.

E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
   1. Wire brush areas to be coated to bright metal.
   2. Apply galvanizing repair compound at rate of two ounces per-square-foot.

3.08 PROTECTION:

A. Protect finishes of handrails and railings from damage during construction period with temporary protective coverings approved by railing manufacturer. Remove protective coverings at the time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 05531

GRATINGS AND FLOOR PLATES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section includes providing Adjust list below to suit Project.steel gratings, corrosion-resistant gratings, and underground safety walk gratings and floor plates.
   1. Related Work Specified Elsewhere:
      a. Structural Steel: Section 05120.
      b. Miscellaneous Metal: Section 05500.
      c. Metal Stairs: Section 05511.
      d. Handrails and Railings: Section 05521.

1.02 PERFORMANCE REQUIREMENTS:

A. Structural Performance: Provide gratings capable of withstanding the following structural loads without exceeding the allowable design working stress of the materials involved, including anchors and connections:
   1. Steel gratings: For walkways, ventilation shafts, light wells and other locations subject to possible vehicular traffic: Capable of withstanding AASHTO HS-20-44 load or higher load if required by the jurisdictional authority where the grating is installed.
   2. Steel gratings: For track drainage pumping stations and other locations subject to foot traffic only: Capable of withstanding a uniform load of 250 lbf/sq. Ft. Limit deflection to 1/200 of span.
   3. Corrosion-resistant gratings: Capable of withstanding a uniform live load as shown or specified.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Product Data: For the following:
      a. Gratings.
      b. Clips and anchorage devices for gratings.
      c. Paint products (if applicable).
   2. Shop Drawings: Show fabrication and installation details for gratings. Include plans, elevations, sections, and details of connections. Show anchorage and accessory items. Provide templates for anchors and bolts specified for installation under other Sections.
      a. For installed products indicated to comply with design loads, include structural analysis data signed and sealed by the qualified professional engineer responsible for their preparation.
   3. Mill Certificates: Signed by manufacturers of stainless-steel sheet certifying that products furnished comply with requirements.
   4. Welding Certificates: Copies of certificates for welding procedures and personnel.
   5. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

1.04 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. ADA: Americans with Disabilities Act.
   3. ASME: B18.21.1, B18.22.1.
   4. ASTM: A36, A90, A123, A143, A153, A242, A307, A384, A510, A570, A536, A563, C633, A653, A780, B633, C1028, D1187, E140, E384, F594.
   5. AASHTO HS-20-44.
   6. AWS: D1.1, D1.3.
   7. FS: RR-G-661.
   8. MS: MIL-P-21305.
   9. NAAMM: MBG 531, MBG 532.
   10. SSPC: PA 1, SP 3, SP 6/NACE No. 3, Paint 12

B. Professional Engineer Qualifications: A professional engineer who is legally qualified to practice in jurisdiction where Project is located and who is experienced in providing engineering services of the kind indicated. Engineering services are defined as those performed for installations of gratings that are similar to those indicated for this Project in material, design, and extent.

C. Fabricator Qualifications: A firm experienced in producing gratings similar to those indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Metal Bar Grating Standards: Comply with applicable requirements of the following:
   1. Non-Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 531, "Metal Bar Grating Manual for Steel, Stainless Steel, and Aluminum Gratings and Stair Treads."
   2. Heavy-Duty Metal Bar Gratings: Comply with NAAMM MBG 532, "Heavy-Duty Metal Bar Grating Manual."

E. Welding: Qualify procedures and personnel according to the following:
   1. AWS D1.1, "Structural Welding Code--Steel."
   2. AWS D1.3, "Structural Welding Code--Sheet Steel."
   3. Certify that each welder has satisfactorily passed AWS qualification tests for welding processes involved and, if pertinent, has undergone recertification.

1.05 PROJECT CONDITIONS:

A. Field Measurements: Where gratings are indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
   1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating gratings without field measurements. Coordinate construction to ensure that actual dimensions correspond to established dimensions. Allow for trimming and fitting.

1.06 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products undamaged.

B. Store products so as to prevent rust.

C. Handle products so as to prevent damage.

1.07 COORDINATION:

A. Coordinate installation of anchorages for gratings, grating frames, and supports. Furnish setting drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General Requirements:
   1. Insofar as practicable, furnish similar products of a single manufacturer.
   2. Metal Surfaces, General: For metal fabrications exposed to view in the completed Work, provide materials with smooth, flat surfaces without blemishes. Do not use materials with exposed pitting, seam marks, roller marks, rolled trade names, or roughness.

2.02 FERROUS METALS:

A. Steel Plates, Shapes, and Bars: ASTM A36.

B. High-Strength Low Alloy Structural Steel:
   1. ASTM A242.
   2. Resistance to atmospheric corrosion: Four times that of carbon steel, minimum.

C. Wire Rod for Grating Crossbars: ASTM A510.

D. Uncoated Steel Sheet: ASTM A570, Grade 33.

E. Galvanized Steel Sheet: ASTM A653, structural quality, Grade 33, with G90 coating.

F. Welding Rods and Bare Electrodes: Select according to AWS specifications for metal alloy to be welded.

G. Ductile Iron: ASTM A536.

H. Grating: Steel, bar and crossbar type as shown, hot-dipped galvanized after fabrication and sizing, FS RR-G-661, Type , Class 1 or 2.

2.03 COATINGS:

A. Shop Primer for Ferrous Metals: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements in FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

B. Zinc-rich paint: MS MIL-P-21305.

C. Galvanizing (zinc-coating by hot-dipped process): ASTM A90, ASTM A123, or ASTM A143, ASTM A153 or ASTM A384, as applicable.

D. Galvanizing Repair Compound: Stick form, melting point 600-degree F to 650-degree F, GALVABAR or equal.

E. Bituminous Coating: Cold-applied asphalt mastic complying with SSPC Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187.

2.04 FASTENERS:

A. General: Provide Type 304 or 316 stainless-steel fasteners for exterior use and zinc-plated fasteners with coating complying with ASTM B 633, Class Fe/Zn 5, where built into exterior walls. Select fasteners for type, grade, and class required.

B. Bolts and Nuts: Regular hexagon-head bolts, ASTM A307, Grade A; with hex nuts, ASTM A563; and, where indicated, flat washers.

C. Plain Washers: Round, carbon steel, ASME B18.22.1.

D. Lock Washers: Helical, spring type, carbon steel, ASME B18.21.1.

E. Expansion Anchors: Anchor bolt and sleeve assembly of material indicated below with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete, as determined by testing per ASTM E 488, conducted by a qualified independent testing agency.
   1. Material: Carbon-steel components zinc-plated to comply with ASTM B 633, Class Fe/Zn 5.
   2. Material: Alloy Group 1 or 2 stainless-steel bolts complying with ASTM F593 and nuts complying with ASTM F594.

2.05 FABRICATION:

A. Shop Assembly: Fabricate grating sections in shop to greatest extent possible to minimize field splicing and assembly. 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.

B. Form from materials of size, thickness, and shapes indicated, but not less than that needed to support indicated loads.

C. Shear and punch metals cleanly and accurately. Remove burrs.

D. Ease exposed edges to a radius of approximately 1/32 inch, unless otherwise indicated.

E. Fit exposed connections accurately together to form hairline joints.

F. Welding: Comply with AWS recommendations and the following:
   1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
   2. Obtain fusion without undercut or overlap.
   3. Remove welding flux immediately.Provide for anchorage of type indicated; coordinate with supporting structure. Fabricate and space anchoring devices to secure gratings, frames, and supports rigidly in place and to support indicated loads.
   4. Fabricate toeplates at height indicated to fit grating units and weld to units in shop, unless otherwise indicated.

2.06 STEEL GRATINGS:

A. Angles or other structural shapes as supports for grating: Structural steel.

B. Grating manufactured by electro-pressure welding or pressure-locking process, forming sound welded or pressure-locked joints at intersection of bars and having bars in the same plane.

C. For walkways, ventilation shafts, light wells and other locations subject to possible vehicular traffic:
   1. Traffic Surface: Plain.
   2. Gratings: Rectangular type subject to loadings identified under “Performance Requirements.

D. For track bed drainage pumping stations and other locations subject to foot traffic only:
   1. Traffic Surface: Serrated.
   2. Gratings: Rectangular type, unless otherwise shown, subject to loadings identified under “Performance Requirements.” Fabricated of 1-1/4-inch by 1/8-inch bearing bars at 1-3/16-inch o.c. and crossbars at 4 inches o.c.

E. Steel Finish: As follows:
   1. Shop primer applied according to manufacturer's standard practice.
   2. Hot-dip galvanized with a coating weight of not less than two ounces per-square foot of coated surface.

F. Fabricate removable grating sections with banding bars attached by welding to entire perimeter of each section. Include anchors and fasteners of type indicated or, if not indicated, as recommended by manufacturer for attaching to supports.
   1. Provide not less than four weld lugs for each heavy-duty grating section, with each lug shop welded to two bearing bars.
   2. Provide not less than four saddle clips for each grating section composed of rectangular bearing bars 3/16 inch or less in thickness and spaced 15/16 inch or more o.c., with each clip designed and fabricated to fit over two bearing bars.
   3. Furnish removable steel gratings equipped with locking lugs and provision for bolting to supporting members with stainless steel bolts.

G. Fabricate cutouts in grating sections for penetrations indicated. Arrange cutouts to permit grating removal without disturbing items penetrating gratings.
   1. Edge-band openings in grating that interrupt four or more bearing bars with bars of the same size and material as bearing bars.

H. Do not notch bearing bars at supports to maintain elevation.

2.07 CORROSION-RESISTANT GRATINGS:

A. Fabricate from high-strength low alloy structural steel.

B. Grating manufactured by electro-pressure welding or pressure-locking process, forming sound welded or pressure-locked joints at intersection of bars and having bars in the same plane.

C. Grating system shall be fabricated to mechanically secure units in place and of such size to permit one-man operation.

D. Traffic Surface: As shown.

E. Gratings: Rectangular type, unless otherwise shown, subject to loadings identified under “Performance Requirements.” Fabricated of 2-inch by 3/16-inch bearing bars at 5-inch o.c. and with crossbars at end of six-foot long units.

F. Subject to compliance with requirements, products are manufactured by Blaw-Knox Company, Irving Grating Company, Reliance Steel Products Company or equal.

2.08 UNDERGROUND SAFETY WALK GRATINGS:

A. Angles or other structural shapes as supports for grating: As shown.

B. Grating bearing bars and end-bearing bar of material shown manufactured by electro-pressure welding or pressure-locking process, forming sound welded or pressure-locked joints at intersection of bars and having bars in the same plane, size and design as shown.
   1. Designed to provide for hinged section of grating bolted to walls. Grating of such size to permit one-man operation and manual position vertically or horizontally.
   2. Structural steel plate hinges bolted to supporting construction with holes and slots as shown.

2.09 FLOOR PLATES:

A. Steel Floor Plates: Form to configurations shown from abrasive-surface floor plate of thickness necessary to support indicated loads, but not less than 1/4 inch.
   1. Abrasive-Surface Floor Plate: SLIP-NOT as manufactured by the W. S. Molnar Company or approved equal:
      a. Surface Texture: Grade 1, fine.
      b. Surface: All metal plasma stream deposition process bonds surface to substrate. Anti-slip primarily martensitic steel surface consisting of a random hatch matrix.
      c. Surface Hardness, Rockwell C Scale, ASTM E 140 and E 384: Minimum of 55.
      d. Bond Strength, Surface to Substrate, ASTM C 633: Minimum of 4,000 psi.
      e. Coefficient of Friction, Anti-Slip Surface: Minimum of 0.6.
      f. UL Listed: Slip-resistant.

2.10 GRATING FRAMES AND SUPPORTS:

A. Steel Frames and Supports: Fabricate from structural-steel shapes, plates, and bars of welded construction to sizes, shapes, and profiles indicated and as necessary to receive gratings. Miter and weld connections for perimeter angle frames. Cut, drill, and tap units to receive hardware and similar items.

B. Equip units with integrally welded anchors for casting into concrete or building into masonry.
   1. Unless otherwise indicated, space anchors 24 inches o.c. and provide minimum anchor units in the form of steel straps 1-1/4 inches wide by 1/4 inch thick by 8 inches long.
   2. Galvanize frames and supports unless otherwise indicated.

2.11 FINISHES:

A. General:
   1. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.
   2. Finish gratings, frames, and supports after assembly.

B. Galvanizing:
   1. Clean ferrous metal throughly before applying zinc coating.

2. Apply zinc coating to products after fabrication, by the hot-dip method, using coating weighing not less than two ounces per-square-foot.

C. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed items:
1. Exteriors (SSPC Zone 1B): SSPC-SP 6/NACE No. 3, "Commercial Blast Cleaning".
2. Interiors (SSPC Zone 1A): SSPC-SP 3, "Power Tool Cleaning."

D. Apply shop primer to uncoated surfaces of gratings, frames, and supports, except those with galvanized finishes and those to be embedded in concrete or masonry, unless otherwise indicated. Comply with SSPC-PA 1, "Paint Application Specification No. 1," for shop painting.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary for securing gratings to in-place construction. Include threaded fasteners for concrete and masonry inserts, through-bolts, lag bolts, and other connectors.

B. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required for installing gratings. Set units accurately in location, alignment, and elevation; measured from established lines and levels and free from rack.

C. Provide temporary bracing or anchors in formwork for items that are to be built into concrete or masonry.

D. Fit exposed connections accurately together to form hairline joints. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Do not weld, cut, or abrade the surfaces of exterior units that have been hot-dip galvanized after fabrication and are for bolted or screwed field connections.

E. Field Welding: Comply with the following requirements:
1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove welding flux immediately.

F. Corrosion Protection: Coat concealed surfaces of aluminum that will come into contact with grout, concrete, masonry, wood, or dissimilar metals with a heavy coat of bituminous paint.

3.02 INSTALLING GRATINGS:

A. General: Install gratings to comply with recommendations of referenced metal bar grating standards that apply to grating types and bar sizes indicated, including installation clearances and standard anchoring details.

B. Attach removable units to supporting members with type and size of clips and fasteners indicated or, if not indicated, as recommended by grating manufacturer for type of installation conditions shown.

C. Use bolts, screws or locking lugs to secure safety walk gratings; do not weld.

D. Consecutively number walkway plate covers with steel stamp after screwed to support channels.

3.03 PAINTING AND REPAIRING COATED SURFACES:

A. Before erection or enclosing construction, paint items that support masonry or will be concealed in finish work, except items encased in concrete.

B. Where shop coat is abraded or burned by welding, clean and touch-up.

C. Touch-up primed surfaces with same material as coating.

D. Where aluminum parts come in contact with concrete or steel, coat contact surfaces of aluminum with bituminous coating.

E. Coat field welds and repair damage to zinc-coated surfaces in accordance with ASTM A780 and as follows:
   1. Wire brush areas to be coated to bright metal.
   2. Apply galvanizing repair compound at rate of two ounces per-square-foot.

END OF SECTION

SECTION 05581

FORMED METAL FABRICATIONS - STATION KIOSKS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies the fabrication and installation of steel cladding and insulated panels for station kiosks.

B. Related Work Specified Elsewhere:

C. Cast-in-Place Structural Concrete: Section 03300.

D. Structural Steel: Section 05120.

E. Structural Steel Metal Decking: Section 05310.

F. Seals and Sealants: Section 07900.

G. Finish Hardware: Section 08710.

H. Glass and Glazing: Section 08800.

I. Metal Doors and Frames: Section 08810.

J. Acoustical Snap-In Metal Pan Ceilings: Section 09520.

K. Field Painting: Section 09920.

L. Kiosk Mechanical Work: Section 15736.

M. Grounding and Bonding: Section 16060.

N. Wire and Cable: Section 16120.

O. Wire Connection Accessories: Section 16125

P. Raceways, Boxes and Cabinets: Section 16130.

Q. Wiring and Control Devices: Section 16145.

R. Circuit Breakers, Panelboards and Load Centers: Section 16440.

S. Lighting Fixtures: Section 16525

T. Kiosks Systems: Section 16733.

1.02 SUBMITTALS:

Submit the following samples for approval in accordance with the Special Conditions and with the additional requirements as specified for each:

A. Shop Drawings:
   1. Details of construction and installation of fabricated items including materials, dimensions, methods of joining, welding, fastening and anchoring.
   2. Obtain approval for minor variations in detail for the purpose of improving fabrication and installation procedures, but not affecting general design for structural stability.

B. Samples: Three of each of the following in each finish to be used in the work:
   1. Sheet metal: Four inches square.
   2. Tubing and extension: Six inch lengths.
   3. Insulated panels: Six inches square. Fabricate to show typical metal panel with fasteners on two edges, opened to expose core material on two edges. Furnish with required finish material on one face and unfinished on other face.

1.03 QUALITY ASSURANCE:

A. Reference Codes and Specifications:
   1. Codes and regulations of the jurisdictional authorities.
   2. ASTM: A36, A501, A526, B221, C272, C518, D696, D1621, E84, E96.
   3. FED STD: 595A.
   4. AWS: D1.1.
   5. MS: MIL-P-21035
   6. SSPC: SP-2, SP-3, SP-10

B. Qualification of Welders:
   1. Employ operators, who have been qualified previously by the test as described by the American Welding Society's Standard D1.1, to perform welding.
   2. Furnish certificates that each operator has passed the tests.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. Deliver products in good conditions

B. Store products so as to prevent corrosion, deterioration, and damage.

C. Handle products so as to prevent damage.

D. Deliver fabricated insulated panels to the site individually wrapped and packed to avoid damage. Protect from water, dirt, and other potentially harmful substances.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. General: Insofar as practicable, furnish products of a single manufacturer.

B. Steel Sheet (Steel Cladding): ASTM A526, coating G235, thickness of sheet as shown.

C. Steel Rods, Bars, and Shapes: ASTM A36.

D. Aluminum Bars: ASTM B221, alloy 6063-T52.

E. Screws: Corrosion resistant, finished to match adjacent material.

F. Pop Rivets: Stainless steel with mandrel head, series 4.

G. Rigid Insulation: Extruded polystyrene rigid foam, Styrofoam HI-115 by DOW Chemical Company, or approved equal, with the following additional requirements:

Flame Spread	ASTM E84	Less than 25.
Compressive strength	ASTM D1621	115-psi minimum at five percent deflection.
Water absorption	ASTM C272	1.0 percent maximum.
Water vapor transmission	ASTM E96	1.0 perm maximum for one-inch thickness
Linear coefficient of thermal expansion	ASTM D696	3.5 times 10^{-5} inches per degree Fahrenheit in a range of minus 260°F to plus 70°F.
Thermal conductivity at 40°F mean	ASTM C518	0.185 BTU/hr/ft^2/degree F/inch, maximum.

H. Adhesive: Rubber-based, solvent-dispersed type, compatible with the insulation and meeting AFG-01 and HUDFHA UM60 Standards.

I. Polyurethane Finish: Polane System by Sherwin-Williams, or approved equal.
   1. Shop primer: Rust-inhibitive vinyl epoxy, Wash Primer Green, P60.
   2. Intermediate high-build coat: Title Clad II Primer, B62.
   3. Finish color coat: Polane, semi-gloss sheen, FED STD 595A Color No. 20040.
   4. Spatter surface texture: Polane T, semi-gloss sheen, Spatter Surface Texture, FED STD 595A, Color No. 20040.

J. Lifting Hardware: Stanley No. 1215, No. 2, or approved equal, minimum 3-1/2 inches by 3-3/4 inches with 2-1/4 inch outside diameter of lifting ring, 19/32-inch overall depth. Thickness of steel minimum 0.083 inches, zinc-plated finish.

K. Miscellaneous fasteners, clips, and angles: Type and size as shown, galvanized and finished to match adjacent material.

L. Galvanizing Repair Compound: Zinc-dust zinc-oxide primer conforming to MS MIL-P-21035.

M. Bituminous Paint, Preformed Tape: Material as approved.

2.02 FABRICATION, GENERAL:

A. Do not start work prior to approval of shop drawings.

B. Verify dimensions before proceeding with work. Obtain measurements at structure.

C. Match mark shop-prepared work to ensure proper assembly and fit in the field.

D. Match exposed work to produce continuity of line and design. Accurately fit and rigidly secure joints in exposed work with hairline contacts. Wherever possible, position holes for fasteners in concealed areas.

E. Coat welds and repair damage to zinc-coated surfaces as follows:

F. Wire brush areas to be coated to bright metal.

G. Apply galvanizing repair compound at a rate equal to two ounces of zinc per square foot. Feather edges of the application.

H. Use only material free from mill scale, flake rust and mill pitting.

I. form and finish items to shape and size with sharp angles and lines. Provide cut-outs to sizes and in locations required.

J. Countersink metalwork to receive the required hardware, and provide proper bevels and clearances.

K. Weld plates on for mounting hardware. Drill or punch holes for bolts and screws. Conceal fastenings wherever practicable.

L. Grind exposed edges of work smooth. Construct joints exposed to weather to exclude water.

M. Provide brackets, lugs, and similar accessories, required for installation, as part of the metal item.

N. Fasteners, Anchors, and Inserts: Use sizes and types shown on approved shop drawings.
O. Bituminous Paint, Preformed Tape: Material as approved.

2.03 FABRICATION, INSULATED PANELS:

A. Steel sheet: Brake-form or die-form as required, free from oil-canning, bends, warps, and other defects. Drill or punch as required for assembly and installation. Continuously weld corners and connections, and grind smooth and flush.

B. Rigid insulation core: One layer for total thickness required. Cut to size and shape to fit over core of panels to thickness shown, tight around perimeter.

C. Assembly: Apply adhesive to steel sheet faces according to manufacturer's recommendation. Provide full adhesive contact between core and face sheets for wall and roof panels. Provide full adhesive contact between core and lower face sheet at floor panels.

D. Glazing members: Screw aluminum bar sections to insulated panels as shown.

E. Install pass-through with door or inside and trim secured on exterior as shown.

F. Install lifting hardware with sheet metal screws, one at each corner of hardware plate.

2.03 FABRICATION, STEEL CLADDING:

A. Form as shown, free from oil-canning, bends, warps and other defects.

B. Drill or punch for attachment to structural members so that fasteners will not be visible after installation of monitoring cabinets.

2.04 FINISH, GENERAL:

A. Prepare surface for priming as follows:

B. Clean bare steel surfaces according to SSPC SP-10 (Near-White Metal Blast Cleaning).

C. Clean galvanized steel surfaces according to SSPC SP-2 (Hand Tool Cleaning) or SP-3 (Power Tool Cleaning) and the recommendation of the paint manufacturer, so as to remove white rust (zinc oxide) but not to remove the galvanizing.

D. Coat welds and repair damage to zinc-coated surfaces as follows:
   1. Wire brush areas to be coated to bright metal.
   2. Apply galvanizing repair compound at a rate equal to two ounces of zinc per square foot. Feather edges of the application.

E. Apply minimum coating as follows to all metals:
   1. First coat, primer: 0.3 mils DFT.
   2. Second coat, intermediate high-build coating: 4.0 mils DFT.
   3. Third coat, finish color coat: 2 mils DFT in brown color, FED STD 595A Color No. 20040. Omit on totally concealed surfaces only.
   4. Fourth coat, spatter surface texture: Texture matching approved sample, in brown color, FED STD 595A Color No. 20040. Omit on totally concealed surfaces only.

F. Apply finish on exposed areas and edges of each insulated panel.

G. Separate dissimilar metals at surfaces of contact with one coat of alkali-resistant bituminous paint or other protective coating to prevent galvanic action.

PART 3 - EXECUTION

3.01 INSTALLATION, GENERAL:

A. Provide anchors and inserts in sufficient number for proper fastening of metal items.

B. Set metalwork accurately, level, plumb, and in true alignment with adjoining work.

C. Drill holes as required for bolts and screws in supports, steel cladding and in insulated panels when in different locations from hole prepared in shop fabrication. Conceal fasteners where possible. Where exposed fasteners are necessary, match fasteners to adjacent metals.

D. Use fastenings and anchors of size and type as shown on approved shop drawings. Conceal fasteners wherever practicable.

E. Provide sealant material as required to seal panels against moisture infiltration, in accordance with Section 07900.

F. Coordinate installation of ornamental metal work with work of other trades.

G. Provide protection against galvanic action between dissimilar metals by completely covering contact surfaces with heavy brush coat of bituminous paint or by separating contact surfaces with preformed tape.

H. Protect exposed metal work throughout work to prevent scratches, stains, discoloration and other damage.

I. Set metal items level, plumb, and in true alignment with adjoining work. Set built-up parts true to line and without sharp bends, twists or kinks.

J. Fasten metal work in place so that items will not be distorted, finish will not be impaired, nor fasteners overstressed from expansion and contraction of metal.

3.02 INSTALLATION, STEEL CLADDING:

A. Apply to structural members by securing in position with sheet metal screws or pop rivets, fastener selections as best suited for purpose intended to provide secure anchorage and stability of cladding material. Locate fasteners at points not visible from the interior or exterior of the kiosk after installation of cabinets.

3.03 CLEAN-UP:

A. Upon completion of installation, clean surfaces of metalwork by procedures recommended by metalwork manufacturer.

B. Clean-up rubbish and debris caused by this work and remove from the site

C. Leave areas surrounding the work in broom-clean condition.

3.04 PAINTING AND REPAIR OF SURFACES:

A. Where finish coat is damaged during shipment or installation, field touch-up damaged areas with air-dry paint of type to fuse with finish material as recommended by manufacturer of finish material/

3.05 ACCEPTANCE TEST/INSPECTION:

A. The table below shall be utilize to preform the acceptance test/inspection for the kiosk construction.

ITEM	PASS	FAIL
Compliance with all requirements in Section 4 and Kiosk Enclosure Fabrication Contract drawings.		
Check for proper structural fit and finish (no sharp metal edges, proper fit at corners etc.)		
Check for proper operation of door and door lock		
Check for proper fit of glass		
Check paint for nicks, scratches and proper application.		
Test and measure to ensure proper voltages (AC) is ± 5% of specified voltage.		
Test AC circuit breakers proper operation.		
Test all lights.		
Test all air conditioning controls and calibrate temperature setting with a thermometer and provide calibration chart.		
Test all heater controls for proper operation.		

END OF SECTION

SECTION 05651

GENERAL TRACK CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This section specifies general track construction procedures and requirements including laying continuous welded rail, joining CWR strings, final alignment and inspection. The Contractor shall comply with all **safety and health regulations** identified in **Section 01450**. Associated train control and traction power Sections are located elsewhere in this Specification.

B. Track construction shall include main/primary track and storage track as indicated on the Drawings, and specified herein.

1.02 RELATED SECTIONS

A. Section 05091 - Rail Welding

B. Section 05652 - Ballasted Track Construction

C. Section 05653 - Direct Fixation Track Construction

D. Section 05654 - Special Trackwork Construction - Ballasted

E. Section 05655 - Special Trackwork Construction - Direct Fixation

F. Section 05656 - Running Rail

G. Section 05658 - Track Appurtenances and Other Track Material

H. Section 05660 - Restraining Rail and Lubricators

I. Section 06130 **-** Timber Ties

J. Section 06131 - Composite (Plastic) Ties

K. Section 06132 - Timber Grade Crossings

1.03 REFERENCES

A. Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

1. American Railway Engineering and Maintenance-of-Way Association, Manual for Railway Engineering, herein referred to as the AREMA Manual, latest edition.
2. American Railway Engineering and Maintenance-of-Way Association, Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio.
3. American Society of Testing and Materials (ASTM).

1.04 SUBMITTALS

A. Submittals shall be in accordance with Section 01300, Submittals of these Specifications.

B. Submittals shall include certificates of compliance, codes and regulations of the jurisdictional authorities as well as other submittals stipulated in these Specifications.

C. Provide five each AREMA approved rail thermometers. Two of the five shall be a quick reading digital type. The thermometers shall become WMATA property.

D. Provide four Geismar RCAT-A1 two-piece combination track levels and gauges, or approved equal, with current calibration. They shall become WMATA property.

E. Provide three Aldon AL-102 combination rolling track gauge readers and digital track levels, equipped with distance counters and carrying cases, or approved equal, with current calibration. They shall become WMATA property.

F. Submit method and equipment for transport of rail.

G. Submit rail end-hardening procedure and the personnel who will perform the end-hardening of the rails in the field.

H. Submit test reports on two samples of field end-hardened rail which shall be tested by an approved independent laboratory.

I. Submit for approval detailed procedures of the following items required in connection with laying and joining CWR strings:

1. String schedule showing length and location of strings.
2. Equipment to be used.
3. Procedure for positioning CWR strings in track, setting gaps between strings and initial fastening.
4. Procedure for lining, gauging and profiling of rails, and tightening of anchor bolts.
5. Procedure for joining CWR strings, including method of obtaining correct gap if joined at a different temperature than at which it was laid.
6. Procedure for destressing/anchoring CWR strings to zero thermal stress temperature, including control of rail movement and installing rail clips for fastening of rail to plates or D.F. fasteners.
7. Special procedure for closing last string with previously anchored rail or special trackwork.

J. Completed and signed Record of CWR Laying Form provided in Section 05651 (Exhibit 05651-C / Part 2 of 2).

1.05 QUALITY ASSURANCE

A. Perform all measures necessary to assure quality of the Work. This shall include source quality control and field quality control requirements specified in these Specifications.

PART 2 - PRODUCTS

2.01 MATERIALS

A. General: All trackwork materials required by the specifications for the track construction, except those furnished by the Authority, shall be furnished by the Contractor.

B. Metal tags to mark the superelevation on curved track shall be made of a corrosive resistant metal such as anodized aluminum or brass. Tags shall be placed at start of superelevation and at every 1/8 inch change until full superelevation is reached.

PART 3 - EXECUTION

3.01 CONSTRUCTION EQUIPMENT

A. Track gauge, guardrail, flangeway width, curve radii, rail sections and special trackwork components are designed for WMATA Metro Rail Vehicle and Crane Car operation. Modify on-track equipment, as required, to operate over this track without causing damage to the track structure. Damages to the track structure shall be repaired by Contractor at his own expense.

B. Clearance for the on-track equipment shall conform to the requirements for vehicle clearances.

C. Contractor's equipment shall not exceed the design loads. Further information concerning vehicle characteristics will be provided by the Authority upon request by Contractor. Verify that proposed equipment meets these requirements.

3.02 MONUMENTATION

A. Monuments will be furnished and installed by other trades to establish the centerline of both the outbound and inbound main track.

B. Monuments will be set at all points of change in horizontal alignment including TS, SC, CS, ST, PC, PT, PCC and SS and on tangents and within curves as needed to provide monuments not more than 1,000 feet apart throughout the work. All adjacent monuments will be intervisible. The location of the monuments will be as stated below:
1. Aerial Structure: On or near track centerline.
2. Underground Sections: Offset outside the track invert section.
3. At-grade Sections: Offset outside the track invert section.

C. The WMATA Engineer will provide the Contractor with identifications and elevations to one thousandth of a foot for all monuments.

D. The use of controls for survey other than the monumentation described above shall be at the Contractor's risk.

3.03 ALIGNMENT AND PROFILE DATA

A. Track shall be constructed conforming to the alignment and profile data shown on the drawings as modified by the requirements in these specifications.

B. Alignment information shown on the drawings refers to geometric control points for the track. Alignment is based on the centerline of track, equidistant between gauge sides of the running rails. Profile refers to top of the lower rail in final position.

C. Construction of direct fixation track shall not begin until final alignment data is available.

3.04 ENGINEERING STATIONING

A. Engineering stationing is not continuous and is subject to equations.

B. Engineering stationing is used to reference all geometric control points.

C. Mathematized alignment data for each track is included in drawings.

3.05 TRACK GAUGE

A. Track gauge will be measured between points 5/8 inch below top of rail on the inside faces of the running rails.

B. Track gauge, except as shown in special trackwork, shall be as follows:
   1. Tangent and curves with radius greater than or equal to 1,425 feet:
      a. Mainline Track: 4 feet, 8-1/4 inches.
      b. Yard Tracks: 4 feet, 8-½ inches.
   2. Curve of radius greater than or equal to 755 feet and less than 1,425 feet:
      a. Mainline Track: 4 feet, 8-1/4 inches.
      b. Yard Tracks: 4 feet, 8-½ inches.
   3. Curve of radius greater than or equal to 350 feet and less than 755 feet:
      a. Yard Track: 4 feet, 8-1/2 inches.
   4. Curve of radius less than 350 feet:
      a. Yard Track: 4 feet, 9 inches
      b. Yard Track with restraining rail: 4 feet, 9-1/4 inches.

3.06 TRACK GAUGE TRANSITIONS

A. Gauge widening at spiraled curves shall begin at the junction of the spiral curve and tangent, proceed toward the circular curve and be completed at the junction of the spiral curve and the circular curve or before. Gauge widening at unspiraled curves shall be done on the tangents and shall be completed at the junction of the tangent and the circular curve.

B. Gauge transitions at special trackwork shall be accomplished by suitable adjustment of the rail on the diverging route side.

3.07 SUPERELEVATION

A. Track curves shall be superelevated as indicated on the drawings.

B. The outer rail shall be elevated above the inner rail, which shall be at the required profile grade line as indicated on the drawings.

C. The superelevation at the tangent-to-spiral point shall be zero and shall increase uniformly through the length of the spiral to full elevation of the outer rail at the spiral-to-curve point. Provide this spiral and superelevation at the ends of simple curves and segments of compound curves as indicated. Attain the superelevation on curves without spirals over equal lengths on the tangent and curve, and increase linearly throughout the rate of change length.

D. Turnouts and crossovers shall not be superelevated, unless specifically noted on the drawings.

E. Track curve information shall be as indicated on the drawings. Shop pre-curved rail shall be marked by the manufacturer for proper installation by the Contractor.

3.08 TRACK TOLERANCES

A. The final gauge, cross level, superelevation, horizontal and vertical alignment of all tracks shall be as specified within the tolerances as shown in **Exhibit 05651-A** for each specific type and class of track.

B. Variations of gauge, cross level and superelevation with respect to tolerances shall be at a rate of change not exceeding 1/8 inch per 31 feet of track.

C. Strings of high strength rail shall be located within plus or minus 20 feet of the locations shown on the drawings.

D. Prior to start of rail installation the Contractor shall furnish to the Engineer three Aldon AL - 102 Combination Rolling Track Level and Gauge Readers equipped with optional distance counters and carrying cases, or approved equal. Also furnish to the WMATA Engineer four Geismar RCAT-A1 two-piece combination track levels and gauges.

3.09 CLEARANCE ENVELOPE

A. The transit car outline in the design of the Metro system is shown in **Exhibit 05651-C** for information.

B. Equipment proposed for use by the Contractor for performance of work under this Contract shall be submitted for approval. The submittal shall include a drawing showing the outline of the proposed equipment superimposed on the transit car outline.

3.10 TYPES OF RAIL

A. Rail for use as running rail shall be 115 RE tee rail in all main/primary tracks and yard/storage tracks.

B. Running rail shall be either standard carbon, head hardened or premium/high strength rail as indicated on the Contract Drawings.

C. Restraining rail shall be 132 RE head hardened or high strength rail in accordance with AREMA requirements. Reference Section 05656 for specific WMATA requirements for running rail.

D. Emergency guard rail: Structural angle, cover plates and base plates shall be as indicated on the Contract Drawings and shall comply with ASTM A36.

E. Special trackwork components, closure rails and ladder track rails shall have premium rails.

F. 115 RE tee rail will be used in the following locations:
   1. Ballasted Main/Primary Track
   2. Ballasted Yard/Storage Track
   3. Direct Fixation Track

3.11 RUNNING RAIL REQUIREMENTS

A. Running rail procurement is covered under Section 05656, Running Rail.

B. Running rail for use in continuous welded rail (CWR) track shall be welded in accordance to Section 05091, Rail Welding.

C. Transport and distribute rail:

1. Rail shall be transported and distributed in such a manner and by use of such equipment that bumping or striking of the rail will be avoided. The method and equipment used by the Contractor shall be subject to approval by the Engineer. Continuous welded rail (CWR) shall be transported and laid in place in an efficient, expeditious manner that will prevent damage to fasteners, rail and structures.
2. Rail should not be dropped or dragged on the track bed. The use of rollers is required to facilitate transporting and reduce the risk of damage to rail, track fasteners, track appurtenances and facilities.

D. Procedure of laying and joining CWR strings: Submit for Engineer's approval the detailed procedure of the following items of work required in connection with laying and joining CWR strings.

1. String schedule showing length and location of strings.
2. Equipment to be used.
3. Procedure for positioning CWR strings in track, setting of gaps between strings and initial fastening.
4. Procedure for lining, gauging, profiling of rails and tightening of anchor bolts.
5. Procedure for joining CWR strings including method of obtaining correct gap if joined at a different temperature than at which it was laid.
6. Procedure for destressing/anchoring strings to zero thermal-stress temperature, including control of rail movement and installing rail clips for fastening of rail to D.F. Fasteners.
7. Special procedure for closing last string with previously anchored rail/special trackwork units.

E. Cutting and drilling of rails:

1. No holes or cuts in the CWR shall be permitted except as shown and specified. Rails shall be cut square and clean by means of rail saws or abrasive cutting disks. No rail is to be cut for the installation of a bonded joint within 5 feet of an electric weld.
2. For joints, 500 KCMIL negative return cables and restraining rail separator blocks, holes shall be located as shown and as directed by the Engineer. Holes shall be cylindrical, of the proper diameter for the bolt required and drilled directly through the web of the rail with an approved rail drill. Holes associated with the restraining rail shall have the additional requirement of split sleeve - cold expansion as specified in Section 05660, Restraining Rail and Lubricators. An approved template shall be used as a guide for drilling holes. In no case shall a joint bar be used for this purpose. All rejected rail holes must be saw-cut from the rail. All holes shall be reamed smooth, ends beveled and burrs removed. Cutting rail or burning holes in rail by use of a torch is prohibited. Accurately space holes for bolting of rail and drill with a rail drill in accordance with the current requirements of AREMA Manual for Railway Engineering, Specifications for Rail Drilling, Bar Punchings and Track Bolts.

F. Beveling of Rail Ends:

1. Bevel rail ends at non-bonded insulated joints in accordance with current AREMA Standard Plan No. 1005.
2. Rail ends in bonded joints shall be beveled in accordance with the joint manufacturer's written specifications. Unless otherwise stated manufacturer's written specifications, rail ends shall be beveled in accordance with AREMA page 4-M-2 "Where rail is to be beveled, it is recommended that such beveling extend 1/16 inch back from the rail end and to a depth of 1/8 inch plus, from the surfaces."

G. End-Hardening

1. In bonded joints, rail ends that are not of head hardened or high strength rail shall be end-hardened in the field. Joints bars and their insulating material shall be removed from rail ends during the end-hardening process.
   a. The end-hardening procedure and the personnel who perform the end-hardening of the rails in the field shall be subject to approval by the WMATA Engineer, which will depend upon the acceptance of two samples of field end-hardening performed according to the approved procedure and by the personnel who will perform the field end-hardening. The two samples of field end-hardened rail shall be tested by an approved independent laboratory. The Contractor shall notify the Engineer 48 hours prior to the performance of field end-hardening of rails.
2. End Hardening Tests:
   a. The two samples shall be tested for Brinell hardness in accordance with ASTM E10, in a grid pattern on the rail head surface of 1/8 inch increments for a distance of six inches from the end of the rail.
   b. The hardness number and location shall be recorded.
   c. After the hardness test is performed, one sample shall be sectioned for one foot along the centerline of rail and the other sample shall be sectioned transversely ½ inch from the end of rail. These cross sections shall be etched to enable the observation of the hardness pattern.
3. Acceptance Criteria:
   a. The hardness measured at a spot on the centerline of the head 1/4 inch to ½ inch from the end of the rail shall show a Brinell hardness number range of 341 to 401 when decarburized surface has been removed.
   b. 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 1-1/2 inch from the end of the rail. The effective hardness zone ½ inch from the end of the rail shall be at least 1/4 inch deep.
   c. A report of hardness determination shall be given to the WMATA Engineer.
   d. The hardness pattern shall be uniform across the top surface of the rail head.
   e. The etched cross sections of the rail shall exhibit a uniformly distributed hardness pattern.

3.12 LAYING CONTINUOUS WELDED RAIL

A. CWR String:

1. At the time each string of CWR is laid on the installed tie plate or D.F. Fastener to its final line and profile in accordance with the approved working drawings submitted under Section 05091, Rail Welding. The temperature of the string and other data shall be measured and recorded. Information to be recorded shall be as shown on **Exhibit 05651-C (Part 1 of 2)**.
2. The strings shall be laid with a gap between them to permit joining and destressing without unnecessary cutting of rail. Each gap shall be based on the temperature of the rail, the length of the string and as specified below.
   a. Only the gap required for the joint shall be provided between the end of the existing rail and the first adjacent CWR strings.
   b. The destressing gap shall be located at the other end of the string, the free end.
   c. Each succeeding string shall be laid with its beginning end even with the end of the gap computed for the previous string, and shall have its corresponding destressing gap located at its free end. See **Exhibit 05651-C (Part 2 of 2)** for record of CWR laying.

B. Rail Temperature and Rail Thermometer:

1. Rail temperature shall be determined by means of reliable AREMA standard rail thermometers as specified in Chapter 5 of the AREMA Manual (latest edition).
   a. Place two (2) rail thermometers on the shaded side of the rail base next to the web and leave in place until no change in the readings are detected, but not less than ten minutes.
   b. Take the average of the two temperature readings at the time of adjusting the gap between rail ends.
2. If the rail temperature deviates from the specified zero thermal stress range, fastening or anchoring of rail shall cease until the rail temperature returns to within the specified range and the rail has been vibrated to relax localized stress build-up.
3. Deliver five (5) each AREMA approved rail thermometers to the Engineer within 30 days after NTP.
4. Two of the five thermometers shall be a quick reading digital type. Thermometers shall become Authority Property.

C. Determining Gap Between Rail Ends:

1. The gap between CWR strings or between CWR and bolted rail shall be determined by the equation: $G=(t-T)(L)(K)+Q$

   Where: G=rail gap in inches;
   t=zero thermal stress temperature for type of track construction (Sections 05652 and 05653);
   T=Average actual rail temperature at time of laying degrees F.;
   L=One-half the sum of the length of the rail being laid and the length of the preceding rail;
   K=Coefficient of thermal expansion for rail steel, (0.000078 inch per foot per degree F.); and
   Q=Rail gap as required by manufacturers of field weld kit in inches. For bonded standard joints, as recommended by the respective manufacturer. For bonded insulated joints, Q equals the end post thickness.

3.03 LINING, GAUGING, AND PROFILING CWR

A. Each CWR string shall be brought to approximate final line, gauge and profile before joining, destressing and anchoring. The procedures specified for ballasted or direct fixation track construction, as appropriate, shall be used

B. Use of Dutchman (Short Rails Between Rail Ends):

1. The Contractor shall insert a dutchman between the ends of all CWR strings, a short piece of rail equal in length to the rail gap (G) minus ½ inch where the rail gap (G) is determined by the formula above. This requirement does not apply if the calculated rail gap (G) is less than 1-1/2 inches. The dutchman shall be inserted at the time the rail is laid to prevent damage to the rail ends during rail laying or other operations requiring the passage of on-track equipment over the rail joints.
2. The short rail shall be removed prior to anchoring, and when the rail temperature results in a calculated closure of the rail gap.

C. Initial Fastening of Rail

1. Prior to use by on-track equipment, newly laid rail shall be fastened at proper gauge at not less than every fifth fastener on tangents and curves of radius greater than 1,900 feet and at every third fastener for curves of radius of 1,900 feet or less.

2. The method of preventing damage due to thermal expansion shall be submitted for approval.

3.14 JOINING CWR STRINGS

A. Before destressing/anchoring each string of CWR, its beginning end shall be joined to the previously anchored string.

B. Main/primary track CWR strings shall be joined in the field by field welding ~~bonded standard joints~~.

C. Yard and secondary track CWR shall be joined by field welding ~~bolted standard joints~~.

D. Joints shall not be placed in the following locations unless specifically shown or specified otherwise:
1. Within 19 feet from the center of bonded or bolted joints in the same rail.
2. Within eight feet of joints in the opposite rail.
3. Within eight feet of shop welds in the same rail.

E. Standard Joint Requirements: Standard joints shall be installed in accordance with Section 05658, Track Appurtenances and Other Track Material.

3.15 DESTRESSING/ANCHORING OF CWR

A. After the beginning end of a string of CWR has been joined to the previously destressed/anchored string, it shall be destressed and immediately thereafter anchored. Installation of the Pandrol e2056 Spring Clips shall be considered as anchoring the rail.

B. Each string shall have its length adjusted for the zero thermal stress temperature, vibrated to relieve internal stresses and be fully anchored.

C. When a CWR string closes on a fully anchored string the fully anchored string shall have its anchors removed for 300 feet and shall be readjusted to zero thermal-stress temperature at the time it is joined.

D. Adjusting Rail for Zero Thermal Stress:
1. Rail shall be adjusted for zero thermal-stress by either heating, cooling or pulling the rail, the adjustment shall be monitored by observing the movement of the rail at its quarter points and free end. The required movement to achieve zero thermal stress shall be computed using the formula given in Article 3.12.C of this specification section.
2. The rail temperature shall be taken as close to the time of destressing as practicable and as specified in Article 3.12.B.
3. The destressing and closing of the gaps shall be obtained by uniformly expanding or contracting the rail string throughout its entire length. The Contractor shall verify this by computing and measuring the required movement at the quarter points and free end of the string. The actual movement shall not differ from the computed required amount of movement equivalent to a temperature difference of 10 degrees F for the length of rail being monitored.
4. At the time of destressing/anchoring the second rail in a track shall be within 5 degrees F (3 degrees C) of the temperature at which the first rail was destressed/anchored.

E. Anchoring: Immediately following the destressing of the rail it shall be anchored by the installation of Pandrol Spring Clips. If the rail moves beyond the allowable range specified herein before it is anchored, the destressing operation shall be repeated and the rail reanchored.

F. Record of Laying, Joining, Destressing/Anchoring: A record of rail laying, joining, and destressing/anchoring data shall be made by the Contractor and be witnessed and approved by the Authority Inspector, for each installed string of CWR. The record shall be made on and include the data shown on **Exhibit 05651-C (Part 1 of 2).**

3.16 FINAL ALIGNMENT AND TRACK INSPECTION

A. The final horizontal and vertical alignment, gauge cross level and superelevation shall be within the specified tolerances.

B. In order to determine the acceptability of finished track, the Authority will make an inspection of the track.

C. Track deviations, as disclosed by the inspection, which exceed specified tolerances shall be corrected by the Contractor at no additional cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

A. Measurement of work specified in this section will be made in the following manner:
   1. General Track Construction: No separate measurement.

4.02 PAYMENT:

A. Compensation for work specified in this section will be made in the following manner:
   1. General Track Construction: Included in the price of work of which it is a part.

TRACK CONSTRUCTION TOLERANCES

TYPE AND CLASS 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, MAIN	±1/8"	±1/8"	±1/4"	±1/8"	±1/4"*	±1/8"
BALLASTED, MAIN	±1/8"	±1/8"	±1/2"	±1/8"	±1/2"*	±1/8"
DIRECT FIXATION, YARD & SECONDARY	±1/8"	±1/8"	±1/2"	±1/8"	±1/4"	±1/8"
BALLASTED, YARD & SECONDARY	+1/4" −1/8"	±1/4"	±1/2"	±1/4"	±1/2"	±1/8"

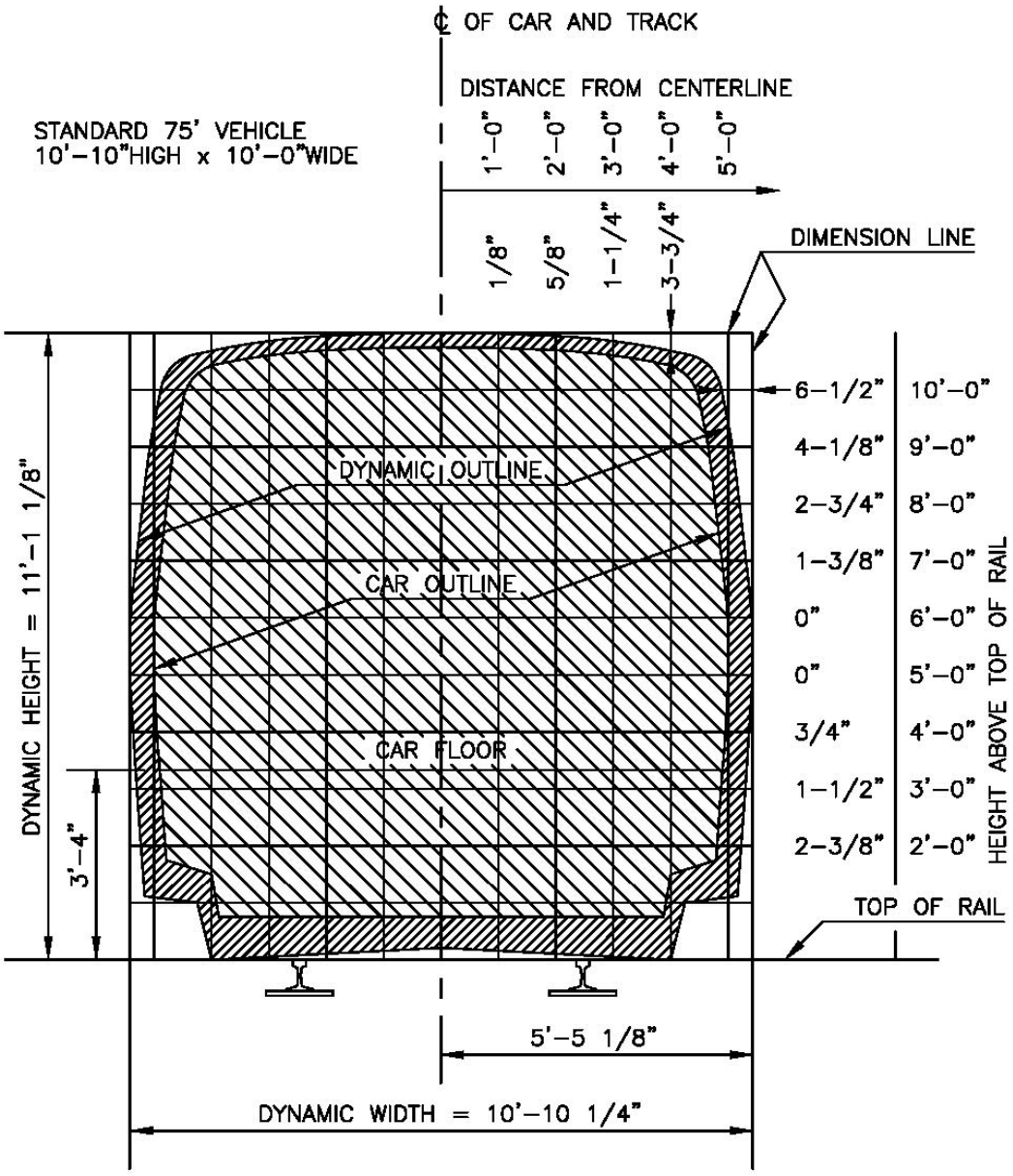
TOTAL DEVIATION IS MEASURED BETWEEN THE THEORETICAL AND ACTUAL ALIGNMENTS AT ANY POINT IN THE TRACK.

* TOTAL DEVIATION IN STATION AREAS SHALL BE 0" TOWARD PLATFORM AND 1/4" AWAY FROM PLATFORM.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

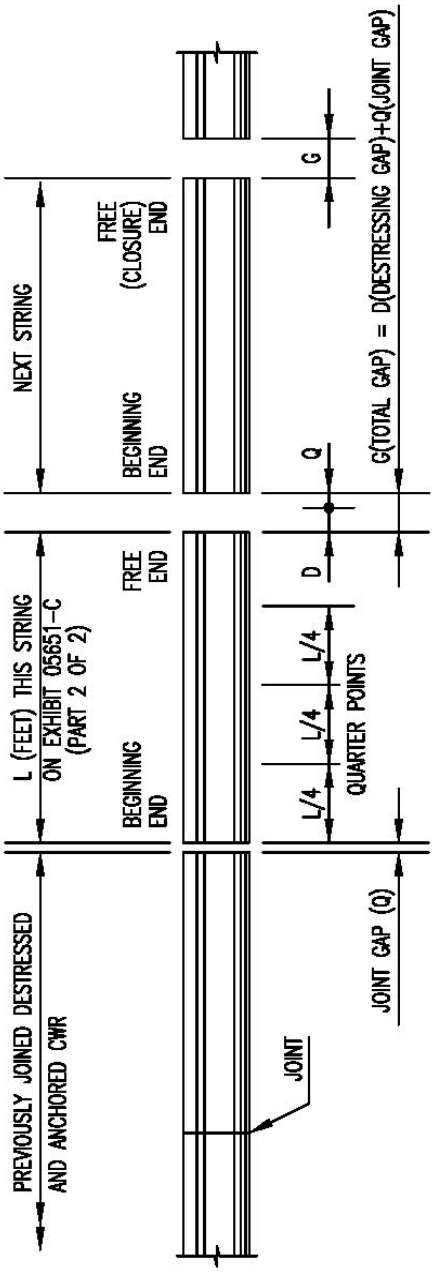
DEPARTMENT OF
TRANSIT SYSTEM DEVELOPMENT
OFFICE OF
ENGINEERING & ARCHITECTURE

TRACK CONSTRUCTION TOLERANCES
EXHIBIT 05651–A



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	DESIGN VECHICLE DYNAMIC OUTLINE DIAGRAM TANGENT TRACK EXHIBIT 05651 –B



ACCURACY

L = NEAREST FOOT
D,G,Q = NEAREST 1/16 INCH
T = NEAREST DEGREE F

D = (60-T) (0.000078L)

D = DESTRESSING GAP IN INCHES
T = RAIL TEMP, DEGREES F
L = STRING LENGTH IN FEET
Q = JOINT GAP IN INCHES

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF
TRANSIT SYSTEM DEVELOPMENT
OFFICE OF
ENGINEERING & ARCHITECTURE

RECORD OF C.W.R. LAYING
EXHIBIT 05651-C (PART 1 OF 2)

GENERAL INFORMATION

STRING: (String Number) _____
TRACK: (Inbound or Outbound) _____
RAIL: (Right or Left) _____
BEGINNING STATIONING: _____
ENDING STATION: _____
STRING LENGTH (L): _____

LAYING DATA

DATE LAID: _____
TIME LAID: _____
AIR TEMP: _____
CWR STRING TEMP (T): _____
COMPUTED GAP REQUIRED AT FREE END (G): _____
ACTUAL GAP LEFT AT BEGINNING END (G OR Q): _____
JOINT TYPE TO BE INSTALLED AT BEGINNING END (Q): _____

JOINING DATA

	BEGINNING END	CLOSURE END (WHEN NEEDED)
DATE JOINED:		
TIME JOINED:		
AIR TEMP:		
CWR TEMP:		
GAP AT START:		

METHOD OF ADJUSTING GAP FOR BEGINNING END JOINT: _____
(A = CUT IN/OUT PIECE; B = MOVE ENTIRE STRING)

DESTRESSING/ANCHORING DATA

DATE DESTRESSED/ANCHORED: _____
TIME DESTRESSING STARTED: _____
AIR TEMP AT START: _____
CWR TEMP (T) AT START: _____

MOVEMENT FOR DESTRESSING (D)

	COMPUTED	MEASURED (ACTUAL)
1/4 POINT:		
1/2 POINT:		
3/4 POINT:		
FREE END:		

CWR TEMP AT COMPLETION: _____
AIR TEMP AT COMPLETION: _____
TIME ANCHORING COMPLETED: _____

CONTRACTOR'S REPRESENTATIVE: _____

ENGINEER'S REPRESENTATIVE: _____

DATE SUBMITTED: _____

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	RECORD OF C.W.R. LAYING EXHIBIT 05651 –C (PART 2 OF 2)

END OF SECTION

SECTION 05652

BALLASTED TRACK CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The work in this Section shall include the construction of ballasted track as indicated on the drawings and as specified in these specifications.

B. The construction of ballasted track shall include:
1. Preparation of subgrade and placement of sub-ballast and ballast.
2. Hauling of construction materials.
3. Distribution and spacing of ties.
4. Laying, destressing and joining of continuous welded rail (CWR) strings
5. Construction of ballasted track

C. The above construction is encompassing and includes all pertinent trackwork related items associated with track construction such as the standard and insulated joints; rail cutting and stress adjustment; tamping, surfacing lining and gauging and all other operations necessary to construct an acceptable completed track structure.

D. Unless otherwise shown or specified, trackwork within limits of ballasted special trackwork units is not included in this Section.

1.02 RELATED SECTIONS

A. Section 02726 - Sub-Ballast.

B. Section 02727 - Ballast.

C. Section 05091 - Rail Welding.

D. Section 05651 - General Track Construction.

E. Section 05654 - Special Trackwork Construction - Ballasted.

F. Section 05656 - Running Rail.

G. Section 05658 - Track Appurtenances and Other Track Material.

H. Section 05660 - Restraining Rail and Lubricators.

I. Section 06130 - Timber Ties.

J. Section 06131 - Composite (Plastic) Ties.

K. Section 06132 - Timber Grade Crossing.

1.03 REFERENCES

A. Codes and regulations of the jurisdictional authorities.

B. American Railway Engineering and Maintenance-of -Way (AREMA), Manual for Railway Engineering (latest edition), herein referred to as the AREMA Manual are as follows:
   1. Chapter 4, Part 1, Rail Drilling, Bar Punching and Track Bolts.
   2. Chapter 5, Part 4, Specifications for Track Construction.

C. American Society of Testing and Materials (ASTM).

1.04 SUBMITTALS

A. Submittals shall be specified in Section 01300, Submittals. The following submittals shall be made and submitted by Contractor:
   1. Detailed descriptions of construction procedures required for the work specified in this Section.
   2. Samples required for the work specified in this Section.
   3. Test results required for the work specified in this Section.
   4. Working Drawings showing the proposed method for temporary fastening of rail during installation.
   5. Required rail temperature record forms for rail laying and rail fastening operations.
   6. Five (5) each AREMA approved thermometers as specified in Section 05651, General Track Construction, Article 3.12, Laying Continuous Welded Rail.
   7. Method and equipment for transport of rail.
   8. Submit for approval detailed procedures of the following items required in connection with laying and joining CWR strings:
      a. String schedule showing length and location of strings.
      b. Equipment to be used.
      c. Procedure for positioning CWR strings in track, setting gaps between strings and initial fastening.
      d. Procedure for lining, gauging and profiling of rails.
      e. Procedure for joining CWR strings, including method of obtaining correct gap if joined at a different temperature than at which it was laid.
      f. Procedure for destressing/anchoring CWR strings to zero thermal stress temperature, including control of rail movement and installing rail anchors and spiking rail down.
      g. Special procedure for closing last string with previously anchored rail or special trackwork.
   9. Completed and signed Record of CWR Laying Form provided in Section 05651 (Exhibit 05651 C / Part 2 of 2).

1.05 QUALITY ASSURANCE

A. In order to determine the acceptability of the installation, the Contractor shall make a survey of the completed track, and provide the Engineer with a copy for review. Deviations from the drawings which exceed tolerances specified in Section 05651, General Track Construction, shall be corrected by the Contractor at no additional cost to WMATA.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The following track materials shall be furnished by the Contractor and any additional items necessary to construct an acceptable, completed track structure.
   1. Sub-ballast
   2. Ballast

3. Ties
4. Special Trackwork
5. Running Rail
6. Track Appurtenances and Other Track Material
7. Metal Tags (to mark superelevation)
8. Restraining Rail and Lubricators (as required)
9. Bumping Posts (as required)

PART 3 - EXECUTION

3.01 GENERAL

A. All ballasted main/primary track shall be constructed with Pandrol spring clips, elastic fastener tie plates punched for four 7/8 inch screw spikes and four 7/8 inch screw spikes.

B. Track within the limits of ballasted special trackwork units shall be constructed as specified for Special Trackwork Construction.

C. Ballasted track construction includes realignment of existing tail tracks to meet with the new track alignments to be extended.

D. Ballasted track construction includes placing sub-ballast and ballast, distributing and lining ties; installing, anchoring, and joining CWR strings, raising and lining track; and other incidentals as required and as specified for General Track Construction as modified

3.02 TOLERANCES FOR BALLASTED TRACK

A. Deviation from the gauge, cross level, superelevation, horizontal alignment and vertical alignment shall not exceed the tolerance specified.

3.03 PLACEMENT OF SUB-BALLAST

A. Subballast shall be distributed, placed and compacted in accordance with Section 02726, Subballast.

B. Prior to placement of subballast all trash and debris shall be removed from subgrade.

C. Subgrade shall be clear and void of tire ruts, large stone or other deleterious objects before placement of subballast.

D. Subgrade shall be dry before placement of subballast.

3.04 INITIAL LAYER OF BALLAST

A. Ballast shall be distributed, placed and compacted in accordance with Section 02727, Ballast.

B. An initial layer of ballast shall be uniformly distributed over the finished subballast and compacted before tie distribution. The ballast shall not be distributed on the roadbed until the subballast has been approved. Subballast fouled or distributed by the Contractor's operations shall be repaired by the Contractor at no additional cost to the Authority.

C. The initial layer of ballast shall be limited to a total compacted depth that will establish the track surface at least four inches below final grade, with further provision that each compacted lift shall be a maximum depth of four inches.

D. The ballast depth shall conform to the cross sections shown. Each lift of ballast shall be uniformly spread. Each lift of ballast shall be fully compacted by a self-propelled pneumatic-tired roller or a vibrating compactor.

E. The self-propelled pneumatic-tired roller shall have a minimum gross weight of nine tons and the vibratory compactor shall have a minimum weight of 5,000 pounds capable of applying a dynamic load of 18,000 pounds or more. The equipment selected by the Contractor shall be subject to approval by the Engineer.

3.05 DISTRIBUTION AND SPACING OF TIES

A. All ties shall be carefully distributed and properly spaced on the initial layer of ballast with every fourth tie being a contact rail tie unless otherwise specified or shown.

B. Care shall be exercised in the placement of contact rail ties to ensure the proper offset for contact rail supports.

C. Unnecessary handling, distribution and reloading of ties shall be avoided. To the extent practicable, ties shall be distributed in proper position for use without further handling. They shall be unloaded in a manner that will not damage the ties. In no case shall ties be dropped. Ties shall be moved only with tie tongs or by leverage with a bar.

D. Ties shall be installed radially on curves and at right angles to the centerline of tangent track at the designed spacing prior to rail installation. The lined side shall be the outside of each track for all main and yard/storage lead tracks. Main track shall be considered double track regardless of separation.

E. Contact rail ties shall be installed to properly support the contact rail on the side of the track as shown. The line end shall be lined with the adjacent ties.

F. Ties damaged as a result of improper handling by the Contractor and rejected by the Engineer shall be removed and replaced with new ties.

G. Timber ties shall be adzed only with the Engineer's approval and shall be installed with the heartwood face down.

H. Tie Boring:

1. All timber or composite (plastic) ties shall be bored in the field. Timber tie boring shall be performed with the heartwood face down. For cut spikes, the holes shall be 9/16 inch in diameter and not less than five inches nor more than six inches deep. For screw spikes, the ties shall be bored as directed by the manufacturer or as directed by the Engineer. The location and number of holes shall conform to the location and number of spikes required for the type of track or special trackwork unit in which the tie is to be installed. Boring of holes in excess of the number of spikes used will not be permitted.
2. A tolerance of plus or minus 1/16 inch will be permitted in the distance between spike holes. The spike holes shall be located in such a manner that each tie plate will be centered on the tie at a right angle to the rail when the spikes are driven into place. A tolerance of 1/8 inch in the centering of the holes across the width of the tie will be permitted. Timber tie holes shall be treated with pentachlorophenol oil or creosote immediately after boring.

I. Tie Spacing

1. Ties shall be spaced on an average of 27 inch centers, for main track unless otherwise shown.

2. Tie spacing at approach slabs shall be as shown.
3. Tie spacing on restraining rail track shall be on an average of 24 inch centers.
4. Tie spacing shall be as specified or shown with a tolerance of plus or minus 1 inch.

3.06 LAYING CONTINUOUS WELDED RAIL (CWR)

A. Laying, anchoring and joining CWR shall be as specified.

B. Zero Thermal Stress Temperature
1. The rail shall be anchored at a temperature of 85 deg. F plus 5 deg. for minus 10 deg. F (30 deg. C plus 3 deg. C or minus 6 deg. C).
2. The temperature of opposite rails when anchored shall be within 5 deg. F (3 deg. C) of each other.

C. Fastening Rail To Ties
1. Materials for fastening rail to ties shall be as specified for Track Appurtenances and OTM.
2. Tie plates shall be installed under running rails on all ties. Spiking pattern shall be as follows:
   a. Pandrol Tie Plates - 4 screw spikes
3. Prior to installing tie plates, the contact surfaces of the tie plates shall be cleaned to allow full bearing of the tie plate upon the tie. Tie plates shall be centered on the tie and placed normal to the centerline of the rail so that the outside shoulder of the plate will have full bearing against the base of rail.
4. Spikes shall be started vertically and square and driven straight. Straightening of spikes will not be permitted. Spikes bent during driving shall be withdrawn and the holes plugged with treated tie plugs as specified for Track Appurtenances and OTM.

D. Rail Anchoring: Installation of Pandrol spring clips shall be considered as anchoring the rail.

3.07 SURFACING AND LINING

A. Ballasting
1. Following the assembly of the track, ballast shall be unloaded in the tie cribs and shoulders of the track structure to restrain movement or buckling of the track due to temperature changes.
2. Such ballast unloading shall provide an adequate amount of ballast for the track raise with sufficient surplus to continue to hold the track after the raise.

B. Surfacing
1. Track surfacing shall be done by methods which will prevent undue bending of the rail or straining of the joints.
2. The amount of track lift shall not exceed four inches nor endanger the horizontal or vertical stability of the track. The track shall be given at least two raises of not less than one inch nor more than three inches each raise.
3. All ties pulled loose during surfacing shall be replaced to full bearing against the rail and properly secured.
4. Track surfacing will not be permitted until the cribs are filled with ballast nor will surfacing be permitted when the ambient temperature is higher than 95 deg. F.

C. Tamping
1. Tamping of ballast shall be done with approved power tamping equipment of the vibratory squeeze type. Control or cycling of the power tamper shall provide the maximum proper compaction of ballast uniformly along the track.

2. The ballast shall be thoroughly tamped on both sides of the tie from a point 15 inches inside the rails to the ends of the tie, with the exception of contact rail ties where tamping shall be only to a point opposite the ends of the adjacent cross tie. Tamping will not be permitted at the center of the tie outside of the above stated limits. For each tie, tamping shall proceed simultaneously inside and outside both running rails on both sides of the tie.

D. Final Surface and Alignment

1. The final surface and alignment of all track shall be within the specified ballasted track construction tolerances, executed by machines with automatic lining equipment or with combined lifting, lining and tamping equipment. Final tamping and lifting shall be effected by equipment fitted with tamping heads between axles or of arch -bar construction.
2. After the final surfacing and alignment of track is completed the ballast shall be dressed to conform to the ballast section shown and as directed by the Engineer. The portion of sub-ballast outside the toe of slope of the ballast shall have a smooth, even surface, sloped as shown.
3. A manual dressing, as directed by the Engineer will be required to ensure a one inch clearance between the base of rail and top of ballast.

E. Ballast Compaction

1. Following tamping and lining, but prior to installation of contact rail and insulators, the crib and shoulders of all track shall be compacted by a machine specifically designed to compact the crib and shoulders simultaneously. The compactor shall operate on all shoulders and in those cribs where special trackwork components do not interfere with the operation of the machine. After compaction of ballast no further shaping of the ballast section will be permitted except as directed by the Engineer.
2. The crib compacting tool work faces shall measure nine inches by 14 inches with the nine-inch dimension parallel to the rail. Crib compacting tool work faces shall appear as flattened V's when viewed normal to the nine-inch dimension and the depth of the V shall be 3/4-inch plus or minus 1/16-inch. There shall be a minimum of eight crib compacting tools, two on each side of each rail. The shoulder compacting tool work faces shall conform to the designed ballast section outline from 1-1/2 inches beyond the tie ends horizontally to the beginning of the 2:1 shoulder slope, continuous to within six inches of the ballast toe at the sub-ballast The length of work faces in the direction of travel shall not be less than 33 inches, with flared ends in the direction of travel to avoid plowing of ballast shoulders. For superelevated and spiraled sections, the shoulder tools shall be adjustable such that the 2:1 ballast shoulder slope will be maintained as shown.
3. The compacting tool work faces shall vibrate with a frequency between 2200 and 3000 Hertz. The vibrational amplitude shall be between 0.058 inch and 0.117 inch. The vibrating work faces shall apply a pressure between 14 psi and 21 psi to the surface of the ballast. The pressure applied shall be the same for all operations and remain constant throughout the job and shall monitored by a permanently affixed calibrated pressure gauge. The compacting tools shall be applied to both crib and shoulders for a period of between three and six seconds duration at each crib successively.

F. Ballast Inspection: The Contractor, shall remove a maximum of one percent of the ties, selected at random by the WMATA Engineer, to allow inspection of the ballast compaction beneath the ties to determine the variables of each piece of tamping and compaction equipment and for spot checking of the production work.

G. Superelevation Marker Tags

1. The required amount of superelevation in ballasted tracks shall be shown on metal marker tags affixed to the tops of ties.

2. Tags shall be placed at start of superelevation to show zero superelevation and at every 1/8 inch change until full superelevation is reached.
3. Tags shall be fastened with two nails to the top of the nearest tie approximately one foot inside the high rail and shall be placed so they can be read while facing against the traffic, on tracks of assigned direction. Tags shall be placed at the point of full superelevation so that they may be read facing the high rail, to plainly indicate the authorized full superelevation.
4. Tags shall be made of a corrosive-resistant metal such as anodized aluminum or brass. Fastening nails shall be of the same material as the tags.
5. Tags shall be stamped in 1/8 inch increments from zero superelevation to maximum superelevation. Whole numbers and fractions shall be stamped in characters ½ inch minimum in height.
6. Tags shall be a minimum of .050 inches thick, 1-1/4 inches wide and two inches long.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

A. Measurement of work specified in this section will be made in the following manner:
   1. Ballasted Track Construction: No separate measurement.

4.02 PAYMENT:

A. Compensation for work specified in this Section will be made in the following manner:
   1. Ballasted Track Construction: Included in the price of work it is a part.

END OF SECTION

SECTION 05653

DIRECT FIXATION TRACK CONSTRUCTION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The work specified in this Section shall include the construction of direct fixation (DF) track, as indicated on the Drawings. Direct fixation track construction (DFTC) includes the requirements for qualifying the construction methods; surface preparation of existing concrete and stirrups; forming, placing, and curing reinforced track concrete; installing DF rail fasteners; and installing continuous welded rail (CWR).

B. Direct fixation track construction is comprised of the installation of grout pads and direct fixation rail fasteners, installing running rail, anchoring, joining CWR strings and other incidentals as specified. The track shall be constructed as specified for General Track Construction (GTC) and as specified herein.

C. Direct fixation track construction shall use resilient spring clip direct fixation fasteners, vibration attenuating direct fixation fasteners and “Stiff” direct fixation fasteners with slip-in Pandrol shoulders within Special Trackwork where shown. Type of fastener to be installed at a given location shall be as indicated on the contract drawings.

D. Prior to start of DFTC all under track drains and invert conduits shall be proofed with a mandrel. Following completion of DFTC all under track drains and invert conduits shall again be proofed with a mandrel to demonstrate that the Contractor’s operations have not plugged the drains or conduits.

E. Prior to the second proofing of track drains, but after all other work is complete, the underground portions of direct fixation track shall be thoroughly washed two separate times, including inbound and outbound tracks, overhead, sidewalls and invert. Washing equipment shall be capable of attaining at least 2500 psi nozzle pressure and shall be approved by the Engineer prior to start of washing.

1.02 RELATED SECTIONS

A. Section 05651 - General Track Construction

B. Section 05091 - Rail Welding

C. Section 05655 - Special Trackwork Construction - Direct Fixation

D. Section 05656 - Running Rail

E. Section 05657 - Direct Fixation Rail Fasteners

F. Section 05660 - Restraining Rail and Lubricators

1.03 REFERENCES

A. American Railway Engineering and Maintenance-of-Way Association (AREMA), Volumes I and II (latest edition). Items particularly noted in the AREMA Manual are as follows:
   1. Chapter 4, Part 1, Rail Drilling, Bar Punching, and Track Bolts.
   2. Chapter 5, Part 4, Specifications for Track Construction.

B. American Association of State Highway and Transportation Officials (AASHTO):
   1. AASHTO M148
   2. AASHTO T277

C. American Society for Testing and Materials (ASTM):
   1. ASTM A325 - Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
   2. ASTM A449 - Standard Specification for Quenched and Tempered Steel Bolts and Studs.
   3. ASTM C33 - Standard Specification for Concrete Aggregates.
   4. ASTM C39 - Standard Specification for Compressive Strength of Cylindrical Concrete Specimens.
   5. ASTM C109 - Standard Test Method for Compressive Strength of Hydraulic Cement Mortars (Using 2 inch Cube Specimens).
   6. ASTM C150 - Standard Specification for Portland Cement.
   7. ASTM D2240 - Standard Test Method for Rubber Property - Durometer Hardness.
   8. ASTM D2936 - Standard Test Method for Direct Tensile Strength of Intact Rock Core Specimens (C900 - STM for Pullout Strength of Hardened Concrete).

D. Steel Structures Painting Council (SSPC):
   1. Specification SP1 - Solvent Cleaning
   2. Specification SP5 - White Metal Blast Cleaning.

1.04 SUBMITTALS

A. A work plan shall be submitted for approval prior to the beginning of construction. The work plan shall include a step-by-step construction sequence accompanied by descriptions and sketches as needed to describe the following:
   1. The method of laying out the work including grout pads, inserts and fasteners, to result in finished track meeting alignment requirements within the specified tolerances.
   2. The method of preparing concrete invert surfaces to obtain the specified bond of grout pad to invert.
   3. The method of locating and drilling insert holes and setting inserts to specified position and elevation. Include hole diameter and depth.
   4. The details for securing the fastener inserts in the trackbed invert including the following:
      a. Brand/manufacturer of each component.
      b. Temperature range of substrate for setting inserts and curing anchor material supported by test data.
      c. Wetness range for placing and curing anchor material.
      d. Packing, storing, handling, proportioning, mixing and placing details.
      e. Hole cleaning, brushing, blowing and drying details.
      f. Insert cleaning and degreasing details.
      g. Method for measuring and controlling substrate temperature during setting and curing of material.
   5. Details of the insert including shop drawings or catalog cuts and certification of chemical composition and physical characteristics to verify compliance with these specifications.
   6. The details of the grout pad sizes, and procedures for forming, mixing, placing and curing including items 4. a. thru d. and g. above.
   7. The grout mix design identifying materials, proportions and additives.
   8. Curing materials for grout pads.

9. Required rail temperature record forms for rail laying and rail fastening operations.
10. Five (5) each AREMA approved thermometers as specified in Section 05651, General Track Construction, Article 3.12, Laying Continuous Welded Rail.
11. Method and equipment for transport of rail.
12. Submit for approval detailed procedures of the following items required in connection with laying and joining CWR strings:
    a. String schedule showing length and location of strings.
    b. Equipment to be used.
    c. Procedure for positioning CWR strings in track, setting gaps between strings and initial fastening.
    d. Procedure for lining, gauging and profiling of rails.
    e. Procedure for joining CWR strings, including method of obtaining correct gap if joined at a different temperature than at which it was laid.
    f. Procedure for destressing/anchoring CWR strings to zero thermal stress temperature, including control of rail movement and installing rail anchors and spiking rail down.
    g. Special procedure for closing last string with previously anchored rail or special trackwork.
13. Completed and signed Record of CWR Laying Form provided in Section 05651 (Exhibit 05651 C / Part 2 of 2).

1.05 QUALITY ASSURANCE

A. The Contractor shall make the following submittals and tests before constructing direct fixation track.

B. Submit a Preliminary Work Plan for approval containing the information specified.
1. Perform grouting material tests.
2. Perform grout pad qualification tests.
3. Perform anchoring material tests.
4. Upon approval of the work plan, DFTC shall proceed using the material, methods and procedures stated in the plan.
5. Quality control tests in the plan shall be performed in the manner and to the intervals specified and the results furnished to the Engineer within 14 days after performing each test.
6. No track construction shall commence prior to approval of the final work plan.

C. Testing of Grouting Materials
1. Test specified shall be conducted on specimens of the proposed materials by an approved independent laboratory. Results of the test shall be submitted for approval.
2. Compressive Test:
    a. Compressive test shall be made on three 3-inch by 6 inch cylinders in accordance with the requirements of ASTM C39.
    b. To be acceptable, the average compressive strength shall not be less than 3500 psi nor more than 6000 psi at 28 days.

D. Grout Pad Qualification Testing
1. The Contractor shall prepare four 1-1/4 inch thick grout pads in each of two areas of the existing trackbed designated by the Engineer. The preparation of the invert, and the placement of grout pads shall be as proposed in the Contractor's work plan. Each area shall exhibit differing invert conditions.

2. The grout pads shall be allowed to cure for 28 days, after which core specimens from grout pads shall be taken of a size as required by ASTM D2936. The perimeter of any hole shall be six inches minimum from any adjacent hole and a maximum of two inches from an edge of the grout pad.
3. The specimens shall be taken at locations as directed by the Engineer. Cores shall be taken using diamond core drills and shall be oriented normal to the grout pad surface with a tolerance of plus or minus one degree.
4. The cores shall be tested in direct tension using methods specified in ASTM D2936. All cores shall be tested to failure. To be acceptable the minimum tensile strength, including the bond shall not be less than 125 psi. If failure occurs in the invert concrete at less than 125 psi an additional core shall be tested.
5. Grout pads from which cores were removed may be used for the final installation providing the cores pass the specified test and the pads are otherwise acceptable. Holes shall be filled with specified grout and the top surface shall be finished to the tolerances of the surrounding grout pad.
6. Grout pads that fail to pass the test shall be completely removed and the holes in the invert shall be patched as specified.
7. The Contractor shall perform insert drilling tests on the grout pads (full depth of insert) to determine optimum insert drilling period. Hole(s) shall be drilled 24 hours, 48 hours, 72 hours, 7days, 14 days, and 28 days after pads are placed. Pads shall be placed in such a manner that insert drilling tests can be performed without affecting adjacent portions of the grout pad to be used for qualification testing. All holes to be filled full depth after test with specified grout. Test results shall be submitted for approval.

E. Fastener Insert Pull-Out Testing
1. Inserts shall be installed according to the work plan in each of two areas of existing concrete trackbed exhibiting different invert conditions as directed by the Engineer. The sites selected and witnessed by the Engineer will be chosen to demonstrate the temperature and wetness limits of the anchoring material.
2. A restrained test shall be performed in each area, in which a 3-1/2 inch square by 1/2 inch thick steel plate, with a 0.9687 inch diameter hole in the center shall be placed over insert on the concrete trackbed. The insert bolt shall be installed and then have an upward vertical load applied, bearing against the steel plate, until a load of 40,000 pounds occurs. The load shall then be released. Six inserts and bolts in each area shall be tested in this manner.
3. For the unrestrained test, the steel plate shall be removed. The insert bolt shall again have an upward vertical load applied, in such a manner that no vertical load is applied to the concrete trackbed within a radius of six inches from the insert until a load of 6,000 pounds is attained.
4. Testing shall be no additional cost to the Authority.
5. Acceptance Criteria for Insert Pull-Out Testing
   a. During the restrained test there shall be no evidence of failure of the insert anchoring system before a load of 40,000 pounds is attained.
   b. During unrestrained test there shall be no evidence of failure by slippage or cracking of the insert anchoring material before a load of 6,000 pounds is attained.

F. Quality Control Requirements
1. The Contractor's Work Plan shall include the Contractor's quality control plan for DFTC. As a minimum, the following quality control measures shall be included:
   a. Three 3-inch by 6-inch cylinders of grout shall be taken from the production mix and cured under the same conditions as the grout pads. At the end of 28 days the cylinders shall be tested in accordance with ASTM C109.

The average compressive strength shall not be less than 3, 500 psi nor more than 6,000 psi. Samples shall be taken from each 200 feet of track constructed or each days work, whichever is less.

b. The grout pad qualification test shall be performed on three cores each 200 feet of track or each day if less than 200 feet of grout are placed per day. The test procedure and acceptance criteria shall be the same as specified in the qualification test.

c. The unrestrained insert pull-out test shall be performed on one insert on each rail every 200 feet. Should the insert or the bond fail, the Contractor shall test every insert in both directions to define, to the Engineer's satisfaction, a zone of defective inserts. All inserts in such a zone shall be made and labeled as directed by the Engineer.

d. All materials or installation determined to be defective in accordance with the quality control program shall be removed and new materials installed and tested in accordance with the quality control program. In the event of a second failure during any retest, the Contractor shall modify his work plan to include corrective actions to be taken before any further work with the failed material is to continue. All removal and replacement shall be at no additional cost to the Authority.

PART 2 - PRODUCTS

2.01 MATERIALS

A. Grout

1. Grout shall have a design strength of 4,000 psi and shall be premeasured, prepackaged, requiring only the addition of water, and shall consist of Portland cement, fine aggregate, coarse aggregate and additives.
2. Grout shall be low-shrink, contain no expansive cement, metallic particles or air entraining agents.
3. Grout shall have been used in like application for not less than three years and perform successfully as specified under quality assurance.
4. The components of grout selected shall meet the following requirements, listed below.
   a. Portland Cement: ASTM C150, Type I or II.
   b. Fine Aggregates: ASTM C33.
   c. Coarse Aggregates: ASTM C33, 3/8 - inch maximum.
   d. Water: Potable
      1) Additives: As recommended by manufacturer and approved
      2) Curing compound: Conforming to AASHTO M148, Type I-D and as recommended by grout manufacturer.

B. Insert Anchoring Material

1. Fox Industries FX-830, polyester resin, Fox Industries FX-816 or equal.
2. Ramset/Red Head EPCON System, Ceramic C Formula with static mix nozzle, two-part epoxy or approved equal.

C. Fastener Anchorage Assembly

1. Insert:
   a. Steel conforming to mechanical requirements of ASTM A449 and chemical composition of ASTM A325, Type 3, or equal, with chromium, nickel and copper in such combination to achieve maximum corrosion resistance consistent with strength and hardness requirements.
      1) Threaded to 1-1/2 inch depth to receive ASTM A325 7/8-inch bolt.

2) Designed and tested to meet 40,000 - pound bolt load without yielding.

3) Washer face bearing against fastener equal to bearing area of A325 heavy hex nut for 7/8-inch bolt.

4) Length and anchorage configuration designed and tested to withstand 12,000 pounds unrestrained pull-out and 250 foot - pounds torque without yielding and with four to five inches embedment in concrete exclusive of grout pad thickness.

5) Each insert furnished with a firmly fixed and easily removable plug or nylon or plastic material to exclude concrete or other materials from entry during transport, handling and installation. Plugs shall be capable of re-insertion and, if re-inserted, shall still exclude concrete or other materials from entry.

6) Inserts shall be coated with an epoxy resin insulating coating, 100-percent dry powder epoxy resin, Scotch Kote Brand Protective Resin No. 206N, Minnesota Mining and Manufacturing Company; Corvel Epoxy ECB - 1363A, Polymer Corporation; or equal. The coating application shall be in accordance with the coating manufacturer's recommendations and as approved, with the following additional requirements:

a) Remove oil, grease and other foreign matter shall be removed by solvent, caustic degreasing or by steam cleaning in accordance with SSPC Specification SP 1.

b) Prepare surface to white metal in accordance with SSPC Specification SP 5.

c) Preheat the inserts to a uniform temperature of not less than 325 deg. F, checking and recording temperature every hour.

d) Dip inserts into fluidized bed of proper temperature and density to provide complete and uniform coverage of surfaces except interior threads when provided.

e) Immediately oven cure at a temperature between 400 deg. F and 425 deg. F for a time which will ensure complete cure of the epoxy resin.

f) The epoxy coating shall be not thinner than 10 mils nor thicker than 20 mils when tested by a magnetic mil gauge at not less than two areas of the insert; epoxy coating having runs, sags or chips will not be acceptable. When tested in accordance with ASTM D2240, epoxy coatings shall have a hardness not less than 85 nor more than Shore D.

2. Bolt:
   a. Furnished with Standard D.F. Fasteners: ASTM A449 for Mechanical Properties; A325 Type 3 for Chemical Properties .
3. Washer:
   a. Furnished with Standard D.F. fasteners.
4. Methyl Methacrylate
   a. Silikal R41si primer by Silikal North America, Inc., FX-821 (mma) by Fox Industries, Inc., or approved equal.
5. Elastomeric (Stiff) Direct Fixation Fastener, F-20 Type, produced by L. B. Foster, or approved equal.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Direct fixation rail fastener

1. Direct fixation rail fasteners shall be installed in pairs, opposite each other within a tolerance of one inch, at right angles to the centerline of track, one fastener under each running rail. Fastener shall be spaced as follows:

Fastener Spacing (Inches)		
All tracks except those listed below.	Average Individual Spacing (Design Spacing)	30
	Average of 20 consecutive fasteners(20 spaces, plus or minus three inches	30
	Maximum Individual Spacing	33
Special Track-work and Joints	Average Individual Spacing (Design Spacing)	As shown
	Maximum Individual Spacing	As shown plus 3 inches

2. The fasteners inserts shall be located 5-1/4 inches from the centerline of rail measured normal to the rail and 1-3/4 inches from the centerline of fastener measured parallel to the rail. The fastener inserts shall be symmetrically located in the upper right quadrant and lower left quadrant of the fastener as referenced along the centerline of rail.
3. A transverse, four-inch, heavy-duty cast-iron pipe, connecting Type 1 drain inlets to the main track drain is located in the concrete invert below the running rail. Where the top of the connecting pipe is less than six inches below the concrete surface at the running rail, the fastener shall be located to provide not less than three inches clearance between the fastener insert holes and the nearest surface of the pipe.
4. The fasteners are designed with a lateral adjustment feature having a range of plus or minus ½ -inch. The range of adjustment is for both construction tolerances and re-gauging, but may not include gauge widening for curves and special trackwork. The Contractor shall install fasteners in such a manner that after final gauging and aligning of the track not less than 1/2-inch of the lateral adjustment range of each fastener remains for tightening of the gauge.

B. Chipping of Concrete Trackbed

1. Trackbed surfaces where grout pads are to be installed shall be chipped to a depth of approximately 1/4-inch to expose aggregate and provide a surface suitable for grout bonding. Chipping equipment and procedures shall be approved by the Engineer.
2. The Contractor shall submit for approval computations for the actual amount of chipping required and the proposed method. No chipping shall be done without prior approval.
3. In areas chipped in excess of that required for the installation of grout pads, the Contractor shall restore the invert to its original grades by filling chipped surface with grout pad material from which the coarse aggregate has been removed, or by filling with approved patching mortar.

4. The Contractor shall, immediately upon completion of the chipping work, clean-up and remove debris and any water resulting from the chipping.

C. Grout Pads

1. Grout pads shall be installed in direst fixation track to provide an even surface for the support of the rail fastener. The pad shall be located and its surface leveled to provide the fastener full bearing support at all positions of lateral adjustment of the fasteners along the entire length of grout pad.
2. Grout pads shall be 20 inches wide, not less than nine feet nor more than 10 feet long. There shall be a minimum of six inches of the existing trackbed exposed between grout pads.
3. Grout pads shall not be constructed over construction joints. Where grout pads overlap as-built drainage troughs, the Contractor shall proceed as directed by the Engineer. For special trackwork, the grout pad shall extend no less than 1/2-inch beyond the elastomer pad and shall be configured to provide adequate trackbed drainage.
4. The grout pad thickness shall be a minimum of 3/4-inch. Contractor shall be responsible for providing grout quantities as needed to a maximum of 3 inches at no additional cost to the Authority. Additional thickness of rail grout pads on curved track shall be computed from invert dimensions shown in typical sections for superelevated track. Grout exceeding the 3-inch maximum on the high rail for superelevation purposes will also be at no additional cost to the Authority.
5. Grout pads over two inches thick shall be reinforced as shown,
6. Except within the limits of special trackwork and unless otherwise directed by the Engineer, grout pads shall be laid to provide the running rails a 40:1 cant toward the center of the track. Cant may vary from 33:1 to 50:1. Pads within the limits of special trackwork shall provide no cant to the rail and shall be flat to plus-or-minus 0.3 degrees.
7. The difference in elevation of two adjacent grout pads on the same rail, adjusted for grade, shall not exceed 1/16 inch.

D. Grout Installation

1. Preparation
   a. The surface shall be clean, sound and free of standing water. Foreign substances and latence shall be removed to expose firmly embedded coarse aggregate.
   b. Divert running water temporarily to achieve water free area to install grout pad.
   c. If a bonding agent is used, the recommendations of the manufacturer of the bonding agent shall be submitted for approval; and once approved, strictly followed in handling, mixing, placing and curing.
2. Forms
   a. Forms shall be constructed of coated wood, metal, or equal, and anchored securely. They shall be leakproof and strong enough to retain grout in place. Provision shall be made to give the top of grout pads the specified cant.
   b. Slip forming of grout pads may be used provided the finished grout pad meets all other requirements of the specifications and drawings.
3. Mixing
   a. The components of Portland cement grout, in the approved proportion, shall be mixed thoroughly to ensure even distribution of components.
   b. Mixing shall be done as near the grouting site as possible.
   c. Water added shall be the maximum required to achieve the design water content, including the moisture entrained in the aggregate. Water is not available in the tunnels /cut and cover box structures.

Water for mixing grout and all other purposes shall be provided from sources outside of the tunnels/cut and cover box structures.

d. Material temperature shall be within the approved limits set by the manufacturer. Once mixed, grout not placed within its working time shall be discarded.

4. Placing and Curing

a. The placing of grout shall be as recommended by the grout manufacturer.

b. The grout shall be kept wet and curing compound shall be applied as recommended by the manufacturer of the curing compound.

E. Fastener Insert Installation

1. Drilling Insert Holes

a. Inserts shall be located with sufficient accuracy to ensure compliance with specified tolerances and as required by the rail fastener design.

b. Holes shall be drilled to a depth not greater than 5-1/2 inches in the concrete trackbed below the grout pad and the diameter shall not be greater than 2-1/4 inches. Holes shall be drilled normal, plus-or-minus one degree to the plane of the rail base.

c. The Contractor's method of drilling the concrete trackbed for D.F. inserts shall not spall the concrete, delaminate the grout pads nor compromise structural integrity of the tunnel/cut and cover box structure.

d. Spacing for transverse reinforcing bars in the concrete trackbed is as shown on the Drawings. To decrease the possibility of interference with the drilling of the insert holes, exposed vertical finder studs welded to the transverse reinforcing bars have been provided in all underground D.F. track at longitudinal intervals of 10 feet. As a further aid in locating reinforcement bars, a pacometer is available for loan from the Authority. Special care shall be taken on aerial structures to prevent damage to tensioning cables.

e. In the event any of the following occur, the Contractor shall immediately notify the Engineer and under his direct supervision proceed as follows:

1) If a longitudinal reinforcing bar is encountered while drilling an insert hole, drilling shall be continued until the hole has reached design depth.

2) If a transverse reinforcing bar is encountered while drilling an insert hole before reaching the design depth, the hole shall be relocated a minimum distance of three inches or as directed by the Engineer. Whenever a hole is relocated, the original hole shall be filled with approved insert anchoring material.

3) If the hole is drilled to a depth greater than 5-1/2 inches, it shall be filled with grout or anchor material to the design depth.

f. Insert holes shall be free of dust and debris prior to installation of the inserts. All debris from drilling insert holes shall be removed from the work site without damage to existing facilities. The Contractor shall take measures to prevent clogging of permanent drainage facilities. Prior to completion of the Contract, the Contractor shall ensure that permanent drainage facilities are left free of foreign matter.

2. Setting Inserts

a. Insert holes shall be installed in accordance with the approved procedure and shall be embedded not less than four inches in the concrete trackbed below the grout pad.

b. Before the installation, inserts shall be free of rust, dirt and other deleterious substances.

c. Inserts shall be set normal plus-or-minus one degree to the plane of the rail base. The insert and anchoring material surface shall be no higher than zero inch and not lower than 1/32 inch from the top plane of the grout pad.

3. Setting Fasteners
   a. Fasteners shall be placed on grout pads and secured by the use of bolts. Anchoring of a string of CWR in direct fixation track shall be accomplished by installing devices furnished by the fastener manufacturer, which are for the purpose of holding the rail on the fastener. The installation of the direct fixation fastener shall be in accordance with the fastener manufacturer's recommended installation procedure.
   b. Rail fasteners shall be kept clean and free of dirt, grout and other substances which could reduce the electrical-insulating characteristics of the fastener. Inserts shall be kept free of rust, dirt and other substances. The use of shims is prohibited unless specifically approved by the Engineer on a case by case basis.

F. Laying Continuous Welded Rail on Direct Fixation Rail Fasteners
1. Laying, anchoring and joining of CWR shall be as specified for General Track Construction with the following additional requirements:
   a. Zero Thermal Stress Temperature
   b. The rail in underground direct fixation track shall be installed, joined and anchored to produce zero thermal-stress in the rail at 60 deg. F plus-or-minus 10 deg. F (16 deg. C plus-or-minus 6 deg. C).
      1) Aerial, at-grade and approach slab rail shall be anchored at a temperature of 85 deg. F plus 5 deg. F or minus 10 deg. F (30 deg. C plus 3 deg. C or minus 6 deg. C).
      2) The temperature of opposite rails when anchored shall be within 5 deg. F (3 deg. C) of each other.
   c. Lining Direct Fixation Track
      1) Rail shall be brought to final line and grade with the rail bearing against the field side shoulder (TPI Fastener) or centered between the rail clamps (Lord Fasteners) of the fastener; the rail or fastener shall then be moved laterally to obtain corrected line and gauge. The anchor bolts shall then be tightened.
      2) Anchor bolts on all direct fixation rail fasteners under a string of CWR shall be fully tensioned in accordance with the approved installation procedure before anchoring of CWR string is begun.
   d. Tensioning Anchor Bolts
      1) Bolts shall be in tightening motion when the torque is measured. Torque wrenches shall be accurate within plus-or-minus 10 foot-pounds. Calibration of a torque wrench in order to translate the tension requirement into the foot-pound setting shall be determined by laboratory test in an accurate device capable of indicating actual bolt tension from each lot to be installed.
      2) Final bolt tension shall be 30,000 pounds with a tolerance of plus 10 percent and minus 20 percent.
      3) Calibration of wrenches shall be by tightening, in a device capable of indicating actual bolt tension, not less than three bolts taken from each lot to be installed.
      4) Power wrenches shall be adjusted to stall or cut out at the required tension.
      5) If manual torque wrenches are used, the torque indication corresponding to the calibrated tension shall be noted and used for the installation of the tested lot.
      6) Calibrate wrenches immediately prior to bolt tensioning operation and every six months thereafter, including two (2) Authority owned torque wrenches.

e. Joining and Anchoring CWR Strings

1) After lining the CWR in underground, aerial, at-grade or approach slab direct fixation track it shall be joined, de-stressed and anchored as specified in General Track Construction.

G. Sealing Aerial Structure Grout Pads

1. Description: All direct fixation aerial structure grout pads shall be sealed with two coats of methyl methacrylate.
2. Surface Preparation
   a. Complete within 24 hours prior to sealing of pads.
   b. Clean existing sides of grout pads and 6 inches of invert adjacent to pads of loose materials, oils, greases, and other foreign substances.
   c. Use high pressure (minimum 500 psi) water blast to clean pad sides and surrounding perimeter of invert.
   d. Remove water and debris with compressed air from which the oil has been removed.
   e. Dry surface around pad by torch when directed by the Engineer. The pad and surrounding area shall be surface dry.
3. Application
   a. Apply to previously prepared surface.
   b. Apply only during dry weather and not sooner than 48 hours after precipitation ceases. Do not perform work when ice crystals are present in concrete voids.
   c. Apply primer with brushes on the dry clean surface. Apply primer evenly to obtain a closed, sealing film on the four sides of each pad and on a three inch perimeter of invert adjacent to the pad.
   d. Apply primer quickly and continuously, without returning to areas already primed.
   e. Apply first primer coat to sides of pads and invert in liberal quantities, especially at bond line.
   f. Apply second primer coat not sooner than 30 minutes after the first application.
4. Safety Precautions
   a. The uncured primer is flammable. Take appropriate precautions. After curing, the primer will not support combustion.
   b. The primer may present a minimal dermatological hazard to certain individuals. Persons involved in mixing and application of the primer must wear protective clothing such as, but not limited to, rubber gloves and goggles.
   c. In general, all accident prevention regulations with respect to flammable materials, presently in force, must be observed. A dry chemical ABC fire extinguisher shall be on hand while products are in use.
   d. Component B is flammable and a strong irritant. Handle with appropriate precautions. Protective gear, not limited to goggles, rubber gloves and rubber boots must be worn.
   e. Provide an eyewash facility.
   f. Smoking is prohibited on the job site.
   g. If contact with skin occurs, wash immediately with soap and water, and contact a physician. If contact with eyes occurs, immediately flush with water for 15 minutes and contact a physician.
   h. Wash contaminated clothing before reuse; discard contaminated shoes.
5. Quality Control
   a. Surface Seal Test
      1) The WMATA Engineer will visually inspect the surface of the treated pads and invert with the Contractor.

2) Acceptance Criteria: No voids or cracks which could absorb water are allowed.
3) Remedial Measures: Repair pads showing insufficient treatment with additional coat (s) of methyl methacrylate.

PART 4 -MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of work specified in this Section will be made in the following manner:
1. No separate measurement.

4.02 PAYMENT

A. Compensation for work specified in this Section will be made in the following manner:
1. Included in the price of the work of which it is a part.

END OF SECTION

SECTION 05654
SPECIAL TRACKWORK CONSTRUCTION - BALLASTED

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The work in this Section shall include the construction of ballasted special trackwork as indicated on the Contract Drawings and as specified.

1.02 RELATED SECTIONS

A. Section 02726 - Sub-Ballast

B. Section 02727 - Ballast

C. Section 05091 - Rail Welding

D. Section 05651 - General Track Construction.

E. Section 05652 - Ballasted Track Construction

F. Section 05656 - Running Rail

G. Section 05658 - Track Appurtenance and Other Track Material

H. Section 05659 - Special Trackwork

I. Section 06130 - Timber Ties

J. Section 06131 - Composite (Plastic) Ties

1.03 REFERENCES

A. Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

1. American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering herein referred to as AREMA Manual (latest edition).
2. American Railway Engineering and Maintenance-of-Way Association (AREMA), Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio (latest edition).

1.04 SUBMITTALS

A. The Contractor shall develop and submit for the Engineer's approval a detailed installation plan, including sketches, for all special trackwork installation. Particular emphasis should be placed on alignment and clearances, and methods of checking each.

B. Submittals shall be as specified in Section 01300, Submittals. The following submittals shall be made by the Contractor:

1. The name(s) of the suppliers and manufacturers for the special trackwork components.

2. Shop drawings for the various types of special trackwork and supporting drawings.
3. Installation and maintenance instructions by the manufacturer for the various trackwork components.
4. Detailed description of construction procedures required for the work specified in this Section submitted at least 30 calendar days before beginning the work.
5. Test results required for the work specified in this Section and related work specified elsewhere.

C. Shop Drawings for all Special Trackwork Construction (Ballasted Track) shall be transmitted with paper copies and CADD (latest version) to WMATA as per the requirements of the contract.

1.05 QUALITY ASSURANCE AND SAFETY

A. In order to determine the acceptability of the installation, the Contractor shall make a survey of the special trackwork and provide the Engineer with a copy of the report. Deviations from the drawings or specifications which exceed tolerances specified shall be corrected by the Contractor at no additional cost to the Authority.

B. Switch points shall mate and rest under the undercut stock rail and provide a continuous contact with stock rail the length of the machined point rail face adjacent to the stock rail.

C. Switch points shall bear on all slide plates as shown by grease marks and feeler gauges in the thrown operating position.

D. Operation of switch point shall be unrestricted and allow for smooth switch machine operation with current draw to suit WMATA's standard switch machine.

E. Contractor's Work Trains:
1. Contractor shall not operate his work trains over special trackwork until it has been assembled and secured in place to the satisfaction of the Engineer.
2. Switch points shall be secured to the satisfaction of the Engineer before work trains or other on-track equipment are passed over turnouts.

F. WMATA, or its representatives, reserve the right to visit the producers facility during usual business hours unscheduled to: a) observe panel or special trackwork assemblies and material, b) observe sampling and inspection procedures, b) obtain samples of the prepare material being produced and shipped, and c) review plant inspection methods, quality control procedures, equipment and examine inspection test results of current and previous tests.

1.06 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall handle all special trackwork materials in such a manner as to prevent damage during loading, transporting, unloading, storing and installing.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall supply the special trackwork turnouts and crossings as listed on the Contract Drawings, including all materials necessary to provide a complete installation.

B. The following materials in accordance with the bills of materials on the drawings for special trackwork and general track construction shall be furnished as described, including but not limited to:
   1. Sub-Ballast
   2. Ballast
   3. Running Rail
   4. Track Appurtenances and Other Track Material
   5. Special Trackwork
   6. Timber Ties / Composite (Plastic) Ties

C. Other materials:
   1. Switch stands, connecting rods and associated hardware as shown on the Drawings.
   2. Furnish a dry graphite lubricant for application to the riser plates. The lubricant shall have low electrical conducting properties.
   3. Furnish switch machines, operating rods and switch machine mountings for power operated turnouts, as described in Division 16 of the Contract Specifications.
   4. Furnish all additional track materials required within the special trackwork limits to construct an acceptable, completed special trackwork structure as specified herein.

PART 3 - EXECUTION

3.01 GENERAL

A. Construction of special trackwork on ballasted track shall be as specified and shall comply with the applicable portions of Ballasted Track Construction (BTC), Section 05652.

B. Ballasted special trackwork will be factory assembled on all switch ties. After Authority inspection and approval, the switch will be shipped in one piece, except for long ties.

C. The remainder of the unit will be disassembled and the switch ties banded into bundles identified as to turnout, crossing and location in accordance with the special trackwork installation drawings prepared by the fabricator.

D. Tracks through the center diamond of crossovers shown as CWR shall be high strength rail. Through main line tracks between turnouts of crossovers shown as CWR shall be standard rail.

E. Lubrication
   1. At the time of installation all sliding surfaces of special trackwork assembles shall be lubricated with an approved dry-film graphite lubricant.
   2. Vertical switch rod clips shall be greased in accordance with the manufacturer's recommendations.
   3. The specified lubrication shall be maintained as necessary to ensure proper operation of all components throughout the duration of this Contract.

F. Adjustments
   1. The Contractor shall make all mechanical adjustments, including those required for train control and switch machine installation, as directed by the Engineer prior to the final acceptance of special trackwork to ensure that special trackwork units are in alignment to their plates and proper operating condition.

G. Switch Machine: Switch machines and operating rods will be furnished and installed by other trades.

H. Switch Rods: Adjust for throw as illustrated in the contract documents.

I. Rail Ends: Rail ends to be connected to CWR will be drilled in the field.

J. Joints

1. All furnished joints required to assemble the turnout shall be installed by the Contractor. All rail joint bolts are to be torqued as per specifications.
2. All joints, standard or insulated, connecting a turnout to other trackage shall be furnished and installed by the Contractor. This normally consists of one pair of joints ahead of the point of switch and two pairs of joints beyond the frog; one pair on the through track and one pair on the turnout track.

3.02 SUB-BALLAST

A. Sub-Ballast shall be as specified in Section 02726, Sub-Ballast.

3.03 BALLASTING

A. Ballast shall be uniformly tamped under both sides of each tie, directly under each running rail and for a distance of 15 inches on both sides of the rail.

B. The top of the ballast section shall be one inch below the base of rail throughout special trackwork units except in the cribs between the point and heel of the switch rails, where the ballast level shall be three inches below the base of the rail.

C. Additional clearance at vertical switch rods shall be provided as needed to allow unrestricted movement. The width and slope of the shoulders shall be as shown.

3.04 SWITCH TIES

A. Switch ties shall be spaced and lined as shown.

B. Ties shall be lined at right angles to the centerline of the thru-main line tangent track.

C. The line side for all turnout units is the side on which the straight stock rail is located. The line side for diamond units is designated by the special trackwork fabricator and indicated on his installation drawings. Tie end on the line side are the line ends.

D. Switch tie spacing shall have a tolerance of plus or minus ½ inch with the exception of the switch machine ties which shall have a tolerance of plus or minus 1/4 inch.

E. Ties shall be added only with approval of the Engineer.

F. All ties will be bored for 7/8" screw spikes.

G. The Contractor will adz switch timbers to compensate for minor warpage and thereby provide correct rail surfacing only at the Engineer's direction. Adzing shall be at no additional cost to the Authority.

3.05 PLATES

A. All plates shall be located as shown.

B. Elastic Fastener (Pandrol) tie plates shall be used at all support locations not having special frog or switch plates or AREMA standard-gauge switch plates.

C. All plates shown within the limits of ballasted special trackwork will be factory assembled on the switch ties.

D. Ties will be bored to accommodate all spike locations in all plates.

E. Where plates span two or more ties, spikes will not be installed and the plates will be shipped separate from the ties.

F. All plates occupying one tie including standard tie plates shall be spiked to the tie.

3.06 SPIKING

A. Spiking of ballasted special trackwork shall be as specified for BTC with the following additional requirements:
   1. All spikes holes shall be pre-bored.
   2. A sufficient number of 7/8 " screw spikes are to be furnished with each turnout to complete its field assembly.

3.07 ANCHORING

A. Upon installation of the Pandrol spring clips, special trackwork units shall be considered anchored.

3.08 TOLERANCE

A. Tolerances shall conform to the AREMA Portfolio and Manual, unless modified by these specifications and drawings.

B. The gauge, cross level, superelevation, and horizontal and vertical alignment of ballasted special trackwork shall be as shown and specified.

C. Tolerances shall be as specified for ballasted track construction.

D. Switch points in normal position shall be square within 5/8 inch.

E. At the Engineer's direction, the Contractor shall be required to provide some spike lining in the pre-plated tolerances. Minor spike lining will be allowed only after the Contractor has demonstrated that the switch points and frogs have been correctly oriented. This shall be at no additional cost to the Authority.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of work specified in this Section will be made in the following manner:
   1. No separate measurement.

4.02 PAYMENT

A. Compensation for work specified in the Section will be made in the following manner:
   1. Included in the price of work of which it is a part.

END OF SECTION

SECTION 05655

SPECIAL TRACKWORK CONSTRUCTION - DIRECT FIXATION

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. The work specified in this Section shall include: the construction of direct fixation special trackwork as indicated on the Contract Drawings and as specified.

1.02 RELATED SECTIONS

A. Section 05091 - Rail Welding

B. Section 05651 - General Track Construction

C. Section 05653 - Direct Fixation Track Construction

D. Section 05656 - Running Rail

E. Section 05657 - Direct Fixation Rail Fasteners

F. Section 05658 - Track Appurtenances and Other Track Material

G. Section 05659 - Special Trackwork

1.03 REFERENCES

A. Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

1. American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering herein referred to as AREMA Manual (latest edition).
2. American Railway Engineering and Maintenance-of-Way Association (AREMA), Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio (latest edition).

1.04 SUBMITTALS

A. The Contractor shall develop and submit for the Engineer's approval a detailed installation plan, including sketches, of all special trackwork installation. Particular emphasis should be placed on alignment and clearances, and methods of checking each.

B. Submittals shall be as specified in Section 01300, Submittals. The following submittals shall be made by the Contractor:

1. The name(s) of the suppliers and manufacturers for the special trackwork components.
2. Shop drawings for the various types of special trackwork and supporting drawings.
3. Installation and maintenance instructions by the manufacturer for the various trackwork components
4. Detailed description of construction procedures required for the work specified in this Section submitted at least 30 calendar days before beginning the work.
5. Test results required for the work specified in this Section and related work specified

elsewhere.

6. Copies of AWS welder qualification certificates.

C. Shop Drawings for all Special Trackwork Construction (Direct Fixation Track) shall be transmitted with paper copies and CADD (latest version) to WMATA as per the requirements of the contract.

1.05 QUALITY ASSURANCE AND SAFETY

A. In order to determine the acceptability of the installation, the Contractor shall make a survey of the special trackwork and provide the Engineer with a copy of the report. Deviations from the Drawings which exceed tolerances specified shall be corrected by Contractor at no additional cost to the Authority.

B. Switch points shall mate and rest under the undercut stock rail and provide a continuous contact with stock rail the length of the machined point rail face adjacent to the stock rail

C. Switch points shall bear on all slide plates as shown by grease marks and feeler gauges in the thrown operating position.

D. Operation of switch point shall be unrestricted and allow for smooth switch machine operation with current draw to suit WMATA's standard switch machine.

E. Contractor's Work Trains

1. Contractor shall not operate his work trains over special trackwork until it has been assembled and secured in place to the satisfaction of the Engineer.
2. Switch points shall be secured to the satisfaction of the Engineer before work trains or other on-track equipment are passed over turnouts.

F. WMATA, or its representatives, reserve the right to visit the producers facility during usual business hours unscheduled to: a) observe special trackwork assemblies and material, b) observe sampling and inspection procedures, b) obtain samples of the prepare material being produced and shipped, and c) review plant inspection methods, quality control procedures, equipment and examine inspection test results of current and previous tests.

1.06 DELIVERY, STORAGE AND HANDLING

A. The Contractor shall handle all special trackwork materials in such a manner as to prevent damage during loading, transporting, unloading, storing and installing.

PART 2 - PRODUCTS

2.01 MATERIALS

A. The Contractor shall supply the special trackwork turnouts and crossings as listed on the Contract Drawings, including all materials necessary to provide a complete installation.

B. The following materials in accordance with the bills of materials on the drawings for special trackwork and general track construction shall be furnished as described, including but not limited to:

1. Running Rail
2. Direct Fixation Rail Fasteners
3. Track Appurtenances and Other Track Material
4. Special Trackwork

C. Other materials:
   1. Switch stands, connecting rods and associated hardware as shown on the Drawings.
   2. Furnish a dry graphite lubricant for application to the riser plates. The lubricant shall have low electrical conducting properties.
   3. Furnish switch machines, operating rods and switch machine mountings for power operated turnouts, as described in Division 16 of the Contract Specifications.
   4. Furnish all additional track materials within the special trackwork limits to construct an acceptable completed special trackwork structure as specified herein.

PART 3 - EXECUTION

3.01 GENERAL

A. Construction of special trackwork on direct fixation track shall be as specified and shall comply with the applicable portions of Direct Fixation Track Construction (DFTC), Section 05653.

B. Direct fixation special trackwork will be factory pre-assembled in accordance with Special Trackwork, Section 05659, for Authority inspection and approval. The special trackwork will then be packaged and shipped in accordance with the specifications.

C. Tracks through the center diamond of crossovers shown as CWR shall be high strength rail. Through main line tracks between turnouts of crossovers shown as CWR shall be standard rail.

D. Lubrication
   1. At the time of installation all sliding surfaces of special trackwork assembles shall be lubricated with an approved dry-film graphite lubricant.
   2. Vertical switch rod clips shall be greased in accordance with the manufacturer's recommendations.
   3. The specified lubrication shall be maintained as necessary to ensure proper operation of all components throughout the duration of this Contract.

E. Adjustments
   1. The Contractor shall make all mechanical adjustments, including those required for train control and switch machine installation, as directed by the Engineer prior to the final acceptance of special trackwork to ensure that special trackwork units are in alignment to their plates and proper operating condition.

F. Switch Machine: Switch machines and operating rods will be furnished and installed by others.

G. Switch Rods: Adjust for throw as illustrated in the contract documents.

H. Rail Ends: Rail ends to be connected to CWR will be drilled in the field.

I. Joints
   1. All furnished joints required to assemble the turnout shall be installed by the Contractor. All rail joints are to be torqued as per specifications.
   2. All joints, standard or insulated, connecting a turnout to other trackage shall be furnished and installed by the Contractor. This would usually be one pair of joints ahead of the point of switch and two pairs of joints beyond the frog; one pair on the through track and one pair on the turnout track.

3.02 CHIPPING

A. Chipping of the concrete trackbed shall be as specified for DFTC.

3.03 PLACING OF GROUT PADS

A. Grout pads shall be cast in place and shall conform to the requirements shown and specified for DFTC.

B. Grout pads shall be coordinated with the Engineer to provide clearance for ATC wayside equipment.

C. Grout pads shall be placed prior to installation of special trackwork.

3.04 DRILLING ANCHOR HOLES

A. Anchor stud holes for special plate anchorage assemblies shall be drilled at the locations shown within a tolerance of plus or minus 1/16 inch.

B. Insert holes for direct fixation rail fasteners within special trackwork units and holes for special plate anchorage assemblies shall be as specified for DFTC and as follows.

1. Special plate anchorage assembly holes shall be drilled 4-1/2 to 5-1/2 inches deep, 1-1/8 to 1-3/4 inches in diameter, and normal to the concrete surface plus or minus one degree.
2. The base plate may be used as a guide for drilling anchor bolt holes.
3. All debris shall be removed.

3.05 SETTING ANCHOR ASSEMBLY

A. The Anchor Assembly for special plates shall be specified in Section 05658, Track Appurtenances and Other Track Material, and as shown. They shall be set normal to the concrete surface plus or minus one degree and shall be installed using the bolt anchoring material and procedures as specified, tested and approved for DFTC.

3.06 SECURING SPECIAL PLATES

A. During installation of special plates, anchor bolts shall be fitted with protective sleeves to prevent thread damage. Anchorages for special plates shall be assembled as shown.

B. After the grout pads and anchoring material have attained sufficient strength as determined by the Engineer, anchor bolts shall be tightened until the spring washer coils have a gap of 0.075 inch, plus or minus 0.005 inch. The tightening shall be verified to the satisfaction of the Engineer by the use of a feeler gauge.

C. Rail clamp bolts shall be torqued to 21,000 pounds tension. The Contractor shall furnish and calibrate torque wrenches and feeler gauges to check the torquing of anchor bolts and rail clamp bolts. Torque wrenches shall be accurate within plus or minus 10 foot-pounds. The feeler gauges and the calibration of torque wrenches shall be subject to approval.

D. Frog guard rail plates shall be field-welded to frog plates by an AWS qualified welder.

3.07 DIRECT FIXATION RAIL FASTENERS

A. Direct fixation rail fasteners of the type shown (standard or stiff) shall be installed in special trackwork at all support locations where special plates are not shown. The installation shall comply with the requirements for DFTC.

3.08 TOLERANCES

A. Tolerances shall conform to the AREMA Portfolio and Manual, unless modified by these specifications and drawings.

B. The final gauge, cross level, superelevation, horizontal alignment and vertical alignment of direct fixation special trackwork shall be as specified for direst fixation track construction for GTC.

C. Tolerances shall be as specified for direct fixation track construction.

D. Switch points in normal position shall be square within 5/8 inch.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of work specified in this Section will be made in the following manner:
   1. No separate measurement.

4.02 PAYMENT

A. Compensation for work specified in the Section will be made in the following manner:
   1. Included in the price of work of which it is a part.

END OF SECTION

SECTION 05656

RUNNING RAIL

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section specifies manufacture and delivery of standard and head hardened (high strength) 115RE steel running rail for use in transit track.

1.02 RELATED SECTIONS

A. Section 05091 - Rail Welding

B. Section 05651 - General Track Construction

C. Section 05652 - Ballasted Track Construction

D. Section 05653 - Direct Fixation Track Construction

E. Section 05654 - Special Trackwork Construction - Ballasted

F. Section 05655 - Special Trackwork Construction - Direct Fixation

G. Section 05658 - Track Appurtenances and Other Track Material (OTM)

H. Section 05659 - Special Trackwork

1.03 REFERENCE STANDARDS

A. Work shall be performed in accordance with the following applicable Codes, Regulations, Reference Standards and Specifications.
   1. The American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering, herein referred to as the AREMA Manual, Volume 1, Chapter 4, Rail (latest edition).
   2. American Society for Testing and Materials (ASTM)
      a. ASTM E10 Standard Method of Brinell Hardness for Metallic Materials
      b. ASTM A578 Ultrasonic Testing

1.04 SUBMITTALS

A. Submit to the Engineer a description of the method of transport for approval prior to shipment.

B. Mill Inspection:
   1. Make specified tests and inspections at the mill prior to shipment.
   2. Submit to the WMATA Engineer all information required of the Steel Rail Inspection Form shown in Exhibit A.
   3. Provide free access for the WMATA Engineer to all fabrication and test facilities where work is being performed for this Contract.

C. Provide rail test records, including mechanical properties tests, hardness measurements, ultrasonic test records and all other required test documentation, for informal review during the in-plant inspection.

1.05 QUALITY CONTROL

A. Develop and maintain a quality control program regulating methods, procedures, and processes to ensure compliance with standards of quality required by the Contract Documents.

B. Within 30 days after the effective date of the Notice of Proceed, submit for approval of the WMATA Project Manager a detailed narrative explaining the Quality Control program and procedures to be utilized for the work and a description of the organization to be used on the Contract.

C. Records of all inspection work by the Contractor shall be kept complete and available to the Engineer during the performance of the Contract; and to such other agencies and for longer periods as may be specified elsewhere in the Contract.

D. Perform all tests and analyses specified in Chapter 4 of the AREMA Manual and submit the results in accordance with this Section.

E. Ultrasonically test all rail for internal defects in accordance with ASTM A578.

F. Testing shall conform to the requirements of the AREMA Specifications for Steel Rails

G. Make all rail tests and inspections at the mill prior to shipment. Assume full responsibility for all testing indicated. Give the Engineer sufficient notice when testing in any form is proposed so he may witness the tests.

H. Provide the Engineer free entry at all times to the manufacturer's mill to inspect the processing and testing of rail while work on this Contract is being performed.

I. Perform all tests specified herein at no additional cost.

J. Testing must be witnessed and certified by a qualified independent testing firm or individual.

K. Qualification of Testing Personnel:
   1. Personnel performing tests and inspections shall be qualified for such work by virtue of prior experience or training.
   2. Personnel performing nondestructive testing shall be qualified and certified in accordance with SNT-TC-1A. Only persons certified for NDT Level I and working under a NDT Level II person or persons certified for NDT Level II shall perform nondestructive testing.

L. Testing Equipment. Testing equipment shall be in good operating condition, of adequate capacity and range, and accurately calibrated. Testing equipment calibration shall be certified and traceable to recognized national standards such as the National Institute of Standards and Technology. Such certified calibration test reports must be made available to the Engineer upon request.

M. Test Report.
   1. A report of test results of each test shall be submitted which includes rail section, rail type, heat number, test name, identity of test sample, test procedure references, specified requirements, actual test results, non-conformance if any, and interpretation of the results. The format for the test report shall be arranged so that the data is presented in an orderly manner.
   2. The rail mill's standards, computer generated, test reports may be used.

3. Copies of calibration certificates shall be submitted with the initial test reports. If test equipment is recalibrated while work is being performed, calibration certificates shall be submitted for the recalibrated test equipment with test reports of the first tests performed after recalibration. In lieu of submitting calibration certificates, the manufacturer may maintain the certificates at its facility available to the Engineer at all times during the performance of the contract and for a three year retention period thereafter.

N. The Engineer shall be notified in writing not less than ten (10) business days in advance of dates scheduled for any tests or inspections. The Engineer retains the right to witness the tests or conduct visual inspection prior to rail loading at the plant.

1.06 DELIVERY, HANDLING AND STORAGE

A. Handle rails carefully to avoid damage.

B. Load rail head up with the branding on all rails facing in the same direction.

C. Sort and load rails together according to their markings. Do not intermix rails of different markings in loading. If there are not sufficient rails of one marking for a full car, smaller groups consisting of tiers of different markings may be loaded onto one car.

D. Load all rails of the same radius together in the same or adjacent tiers.

E. Load rails with adequate wood strips between the tiers or rail to prevent damage in transit.

F. Delivery shall be F.O.B. job site in the Washington Metropolitan Area as directed by the Engineer.

PART 2 - PRODUCTS

2.01 RAIL

A. Standard Rail
1. Rail Section and Weight shall be new 115 RE rail section, and shall be in conformance with AREMA Recommended Rail Sections, 115 RE Rail Section and Specifications for Steel Rails, latest edition.
2. Rail shall be suitable for joining into continuous welded strings using both electric flashbutt and exothermic welding methods.
3. The steel shall be cast by a continuous casting process, or by other methods approved by the Engineer.
4. Length:
   a. The standard length of rails shall be either 78 or 80 feet, or as specified.
   b. Up to 10 percent of the total tonnage accepted for each individual rolling will be accepted for each individual rolling will be accepted in shorter lengths of 79, 78, 77, 75, 70, 65 and 60 feet.

B. High Strength (Head Hardened) Rail
1. High strength rail shall meet all of the requirements of Standard Rail and as follows:
   a. High strength rail shall be either head hardened or fully heat treated.
   b. High strength rail shall conform to all requirements for high strength rail specified in the AREMA Manual for Railway Engineering, Chapter 4 (latest addition).

c. Rails shall have a Brinell Hardness between 341 and 397 BHN. A maximum hardness of 410 BHN may be exceeded in accordance with AREMA rail standards; however, if 410 BHN is exceeded, the manufacturer must examine the microstructure in the head, at 100X or higher, and confirm a that a fully fine pearlitic microstructure is maintained and demonstrated in the head with certified test results. The manufacturer is to provide certified test results, prior to shipment and acceptance, for any BHN Brinell Hardness exceeding 410 BHN.

d. Minimum tensile strength: 140,000 psi.

e. Minimum yield strength: 95,000 psi.

f. No untempered martensite shall be present within the rail.

PART 3 - EXECUTION

3.01 GENERAL

A. A mill certificate shall be furnished to the Engineer containing the following data:

1. The identity of each rail in a charge by heat, ingot and letter.
2. The identity of each equivalent sample by heat.
3. The dates of all phases of heat treatment for each charge.
4. A listing of the accepted and rejected rail in each charge.
5. Rail section and type.
6. Number of pieces in each heat.
7. Chemical analysis.
8. List of Brinell Hardness readings.
9. Ultrasonic test results.
10. Macrotech test results.
11. Submit a storage procedure covering, as a minimum, the following subjects for storage of running rail at the manufacturer's facility:
    a. Handling methods in and out of storage, including crane and details of lifting rig.
    b. Environmental conditions.
    c. Inventory control procedures.
    d. Security of stored materials.

B. Product Data and Test Program. Submit the following for review and approval by the Engineer prior to rail production in accordance with the approved schedule:

1. Steel manufacture process description for making and casting or teaming the steel.
2. Hydrogen elimination process description for hydrogen elimination.
3. Production records and production test results. Submit the following for review and approval by the engineer at the time of each shipment.
4. Rail inspection results for each test and inspection specified by AREMA and herein.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of work specified in this Section will be made in the following manner:

1. No separate measurement.

4.02 PAYMENT

A. Compensation for work specified in the Section will be made in the following manner:

1. Included in the price of work of which it is a part.

END OF SECTION

SECTION 05657

DIRECT FIXATION RAIL FASTENERS

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. Work under this Section covers furnishing all labor, materials, and equipment for the manufacture, testing, fabrication and delivery of direct fixation rail fasteners for installation in underground box structures, aerial structures and at-grade slabs. Specification and supply of these fasteners does not include rail clips and anchor bolt assemblies.

1.02 RELATED SECTIONS

A. Section 05651 - General Track Construction

B. Section 05653 - Direct Fixation Track Construction

C. Section 05655 - Special Trackwork Construction - Direct Fixation

D. Section 05656 - Running Rail

1.03 REFERENCES

A. American Society for Testing and Materials (ASTM)

ASTM A325
ASTM A536
ASTM A563
ASTM A615
ASTM B117
ASTM B633
ASTM C31
ASTM C39
ASTM C172
ASTM D257
ASTM D297
ASTM D395
ASTM D412
ASTM D429
ASTM D471
ASTM D518
ASTM D570
ASTM D573
ASTM D624
ASTM D1149
ASTM D1229
ASTM D2084
ASTM D2240
ASTM E10
ASTM E18
ASTM E23
ASTM E162
ASTM E320

B. Rubber Manufacturers Association (RMA) Handbook
RMA Publication Rubbers Handbook

C. Society of Automotive Engineers (SAE)
SAE J434

1.04 SUBMITTALS

A. Contractor's Shop Drawings and Data
1. Submittals shall be as specified in Section 01300: Submittals
2. Submit Shop Drawings and other data, including design calculations, which are required by the Specifications or which are necessary to adequately perform the work. Shop Drawings are to be complete and detailed.
3. Submit all drawings, data and schedules in accordance with the specified time requirements. If time requirements are not specified, submit in timely manner to permit no less than 21 days for appropriate review by the WMATA Engineer.
4. Contractor submittals shall be checked, coordinated, and approved by the Contractor before they are submitted for the approval of the Engineer. Submittals lacking Contractor's approval may be returned to the Contractor for resubmission.

B. Samples:
1. Unless otherwise indicated, submit not less than two identical samples of the direct fixation fastener.
2. Label each sample indicating:
   a. Contract Name and Number.
   b. Name of Contractor and Subcontractor.
   c. Material or equipment represented.
   d. Source.
   e. Name of producer and brand.
   f. Reference Specifications Section and Article Number.

C. Quality Control Program Plans
1. Quality assurance/control plan as specified herein.
2. Test program plan as specified herein.

D. Qualification Test Results
1. Submit the following for review and approval prior to commencing fastener manufacture.
   a. Certification of the elastomer samples used in the qualification testing.
   b. Elastomer qualification test results for each test specified herein.
   c. Fastener body metal qualification test results for each test specified herein.
2. Submit qualification test results within 14 days after completing of testing. Submit elastomer certification with the elastomer qualification test results.

E. Production Test Results
1. Submit the following for review and approval prior to shipping each fastener production lot.
   a. Certification of the elastomer samples used in the production testing of each production lot as detailed herein.
   b. Elastomer production test results for each test specified herein.
   c. Fastener production test results for each test specified herein.

F. Submit the method and materials of packaging for shipment and storage no later than 60 days prior to the initial shipment.

1.05 QUALITY CONTROL

A. Develop and maintain a quality control program regulating methods, procedures, and processes to ensure compliance with standards of quality required by the Contract Documents.

B. Within 30 days after the effective date of the Notice to Proceed, submit for approval of the Project Manager a detailed narrative explaining the Quality Control Program and procedures to be utilized for the work and a description of the organization to be used on the Contract. All work undertaken by the Contractor before approval of his quality control program will be at the Contractor's risk. The Project Manager will monitor the Contractor's methods, procedures, and processes for compliance with the approved program.

C. Keep complete records of all inspection work by the Contractor available to the Project Manager during the performance of the Contract; and to such other agencies and for longer periods as may be specified elsewhere in the Contract.

D. WMATA, or its representatives, reserve the right to visit the producers facility during usual business hours unscheduled to a) observe sampling and testing procedures, b) obtain samples of the prepare material being produced and shipped, and c) review plant inspection methods, quality control procedures, equipment and examine test results of current and previous tests.

1.06 DESIGN REQUIREMENTS

A. The direct fixation rail fasteners shall have the following primary functions:
1. Support the running rail and secure it to the concrete trackbed using the minimum number of parts possible.
2. Provide vertical, lateral and longitudinal stability, and provide for vertical and lateral adjustments.
3. Provide a specific longitudinal restraint.
4. Provide electric insulation for the rail, thus isolating it from the concrete trackbed.
5. Isolate vibrations and attenuate noise generated by the moving wheel of the vehicles on the rails.

B. Fastener and Its Components:
1. The fastener shall be for 115 RE Rail section.
2. The rail hold-down spring clips shall be considered part of the fastener.
3. The body of the fastener is a metal base element and a metal top element with an elastomeric pad bonded between them. Bonding shall occur during the vulcanization process.
4. The fastener body anchorage assembly shall be comprised of two female type anchorage inserts for embedment into the epoxy grout on a concrete track bed and two anchor bolts for securing the fastener body to the anchor inserts and to the concrete track bed.
   The fastener body anchorage design shall not pass through the top plate and shall anchor thru the bottom plate only.
5. The rail hold down assemblies shall be designed so that when removed, the rail may be lifted vertically until it is completely free of the rail fastener without disturbing the horizontal or vertical alignment of the rail fastener body.
6. The rail fastener body design shall provide on each side of the rail base a positive means of preventing more than 1/8 inch total lateral movement of the rail base relative to the fastener in event of failure or loosening of one or both rail hold-down assemblies.

The design feature shall be integral cast into the top plate component at a minimum height of 9/32 inches from the top of the rail seat and shall extend across the entire width of the fastener body in the direction longitudinal to the running rail on both field and gage sides.

7. The rail hold-down assembly device shall not be dependent on elastomeric components in torsion.
8. Bonding of any part of the rail fastener to the grout pad will not be permitted.
9. Longitudinal and lateral restraint properties of the rail fastener shall be identical in both directions
10. The stability of the rail fastener in the lateral direction shall not be dependent solely upon the strength of the bond of the elastomer to metal.
11. Molding:
    a. Contractor's name or trademark shall be molded into the elastomer.
    b. Each cavity in a mold shall have a cavity identification mark which is molded into the elastomer. If more than one mold is used, then each cavity in a mold shall have a mold identification mark which is molded into the elastomer.
    c. Each molding cycle which produces one or less fasteners from each cavity in a mold is a heat.
    d. Consecutive heats from a mold shall be numbered consecutively.
    e. The elastomer's production batch number and the heat number shall be marked on each fastener in a permanent manner. The marking shall be visible in the installed position.
    f. The location and method of marking of identification data shall be shown on a shop drawing.
    g. In an orderly manner, each mold/heat/cavity permutation shall be assigned a unique sequential part number and part numbers shall be assigned to lots.
    h. A tabulation of lot, part, batch, mold, heat and cavity shall be developed as part of the Quality Assurance Program.
12. Welding shall not be used.
13. The base of the fastener is parallel to the rail seat so as to provide no cant to the rail. The slope tolerance is plus and minus 0.37%. The rail seat area is flat having maximum convexity and concavity of less than 0.001 inch per inch when measured from a straight edge.
14. Anchor bolts
    a. The fastener includes anchor bolts, 7/8 inch in diameter, for securing the fastener to the concrete trackbed under a tension of 30,000 pounds per anchor bolt.
    b. The anchor bolts will be threaded into female threaded inserts set in the concrete trackbed.
    c. Anchor bolts, including washers, and threaded inserts shall be considered parts of the fastener.
    d. The fastener is also capable of being anchored by placement over 7/8 - inch threaded studs.
    e. The anchor bolts engage not less than one inch and not more than one and one -half inches of the threaded insert in the installed position.
    f. Other than the standard protective coating applied by the bolt and insert manufacturers, no oil, sealant or other compound shall be applied to the threads.
15. The bottom of the base element shall be free of elastomer except that minimal flashing will be acceptable providing it does not interfere with retention of proper anchor bolt tension.

16. Except as required to meet other requirements specified herein, elastomer surfaces shall be smooth with a finish and appearance equal to or better than an F-3 designation in accordance with the RMA Handbook.
17. The rail fastener shall be comprised of as few components as is economically and technically feasible for ease of assembly, disassembly and maintenance, and shall be designed to permit installation and replacement of the entire assembly or any of its components by one man using standard, ~~conventional hand tools~~ by one man using conventional hand tools.
18. The overall distance between the base of the rail fastener and the base of the rail with the rail fastener in the installed position shall be 1-1/2 inches (desired) with 1-3/8" minimum and 1-3/4" maximum distances.
19. When completely assembled, the overall dimension of the rail fastener, including the elastomer, shall stay within a design envelope of 10 inches maximum in width measured parallel to the rail and 18 inches in length measured normal to the rail.
20. The fastener body anchorage assembly shall provide for two anchor bolts, each 7/8 inch in diameter, for securing the fastener to the epoxy grout pad and concrete track bed. The anchor bolts shall be symmetrically located as shown in Figure A with respect to the rail fastener body center lines. As shown in **Exhibit A** the anchorage assembly bolts shall be located in the upper right-hand quadrant and low left-hand quadrant of the rail fastener as referenced along the centerline of rail. The rail fastener shall also be designed to be capable of being anchored by placement over existing 7/8-inch threaded stud bolts in lieu of the anchor bolts and female anchor inserts. The adjustment washers shall be designed so that they can be used for either the anchor bolts or the threaded studs.
21. The underside of the rail fastener body shall be a flat, continuous plane with no projections below the top of the grout pad.
22. No portion of the completely assembled rail fastener, including the rail clips and anchor bolts, shall extend any higher than 3-1/2 inches measured vertically from the base of the rail centerline.
23. Recesses in the rail fastener shall be free draining in all positions of lateral adjustment up to a maximum actual superelevation of 4-1/2 inches.
24. The rail fastener body shall provide an electrical leakage distance of not less than 1-1/8 inch measured from the grounded portion of the fastener to the charged portion by the most direct path that does not pass through an insulating material. The minimum distance of separation between any point of the top plate to the bottom plate shall be ½ inch and shall contain a full and complete section of elastomer material. The entire top and side surfaces of the metal plates of the fastener body shall contain a minimum coating of 1/16 inch, exclusive of the serrated area of the fastener body anchorage location.

C. Damping of Force
1. The direct fixation rail fastener shall be designed to provide damping of lateral and vertical forces transferred to anchor bolts
2. The fastener plates shall have full bearing on the elastomer in all positions of lateral adjustment and shall have a means of preventing displacement of the elastomer under operating conditions
3. The stability of the fastener in any direction shall not be dependent solely upon the strength of any bonding of the elastomer to metal.

D. Adjustment Requirement.
1. Lateral Adjustment:
~~2. The rail fastener shall provide a minimum of plus or minus ½ inch rail lateral adjustment in 1/8 inch increments. All lateral adjustment shall be provided at the anchor bolts.~~.

The rail fastener body shall provide a means of 1" total lateral adjustment having a range of plus or minus ½ inch via a serrated mechanism at each anchor location. Serration shall be vertical, a minimum of 5/32" high, and integrally cast into the bottom plate. The bottom of the vertical serration shall be raised a minimum of 1/8 inches above the top of the bottom plate. Together with a serrated adjustment washer, the system shall allow adjustment in either lateral direction in increments of 1/8". Friction alone as a means of adjustment will not be permitted. The serration shall have not less than three interlocking serrations engaged in any position of lateral adjustment. The adjustment feature shall be integral with the rail anchorage assemblies.

2. Friction shall not be used as a means for adjustment or for preventing lateral movement.
3. If lateral adjustment employs serrations on any component, each serrated interface shall have at least three engaged serrations. There shall be a minimum of three linear inches of serration engagement per fastener. Serrations shall be machined or cast to a minimum depth of 1/16 inch. Cap plates, if used, shall cover the opening to any ground potential in every position of adjustment and form a reasonable seal to prevent the intrusion of dirt, metallic particles, and other material.
4. Each rail fastener shall be furnished with all components required for all specified increments of lateral adjustment. Components of the rail fastener shall not be replaced or added to the basic configuration in order to laterally adjust the rail.

E. Vertical Adjustment:
1. Vertical rail adjustment capability shall be a minimum of ½ inch in 1/16 inch increments, provided by shims.
2. All requirements of these Specifications shall be satisfied for all increments of fastener adjustment.

1.07 FASTENER QUALIFICATION TESTING

A. General:
1. The qualification tests specified herein shall be performed by an independent testing facility approved by the WMATA Engineer and shall be a member of the American Council of Independent Laboratories. Qualification testing may be performed at any test facility, including such facilities at the contractor's plant, provided they meet the approval of the WMATA Engineer and satisfy the requirements of the American Council of Independent Laboratories "Manual of Practice, Quality Control System" - Requirements for Testing and Inspection Laboratory, and ASTM E320. Testing equipment shall be in good repair, of adequate capacity and shall be accurately calibrated. Copies of calibration certificates shall be submitted to the WMATA Engineer. The WMATA Engineer shall be notified not less than 14 days in advance of dates scheduled for quality control tests. All testing shall be performed at no additional cost to the Authority and is to be performed post-award and prior to manufacture of production quantities. Previously approved and supplied product design meeting the requirements of this specification shall be exempt from the Qualification Testing. Production Testing as specified shall be performed.
2. Prior to testing, the Contractor shall submit shop drawings detailing the rail fastener components and a detailed description of the steps required for its complete installation as well as the replacement of individual components. Upon approval by the WMATA Engineer of the shop drawings and installation description, rail fasteners shall be fabricated for testing.
3. Before beginning any tests, a detailed description of all tests shall be submitted to the WMATA Engineer for approval. The description shall completely detail the test procedure and shall include drawings showing the relationship of the fastener and all significant components of the testing equipment, including the test block and anchor bolts.

4. From a lot of not less than twenty standard direct fixation fasteners, sixteen will be selected at random by the WMATA Engineer. If additional fasteners are necessary to meet these test requirements they shall be furnished at no additional cost to the Authority.
5. Each of the fasteners selected for testing shall be carefully measured and examined to determine the compliance with these specifications and the approved shop drawings.
   Upon satisfactory completion of this examination eight fasteners will be retained by the Authority and the remaining eight fasteners shall be returned to the Contractor for execution of the Qualification Performance Tests by an independent laboratory.
6. Except as otherwise specified herein, each test shall be performed on two completely assembled rail fasteners at thirty inch center-to-center spacing, with a section of 115RE rail not less than 42 inches long mounted and clipped thereon. Before assembly, all parts shall be cleaned and dried. The fastener shall be assembled as shown in the approved shop drawings and installation description, and all threaded elements shall be tensioned as specified. The test fasteners shall be mounted on a concrete test block and anchored with 7/8 inch diameter ASTM A325, "Standard Specifications for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength", threaded stud bolts to simulate field installation.
   The anchorage shall not fail under loadings imposed by any test specified below.
7. The concrete test block shall be reinforced concrete with dimensions as shown on **Exhibit D**.
   The concrete shall have a minimum 28 day strength of 4,000 pounds per square inch as determined by ASTM C39, "Compressive Strength of Cylindrical Concrete Specimens". The reinforcing steel shall be Grade 60 per ASTM A615, "Standard Specifications for Deformed and Plain Billet-Steel Bars for Concrete Reinforcement".
8. Two pairs of threaded stud bolts shall be drilled and epoxied into the concrete test block. The stud bolts shall project 3-1/2 inches out from the top surface of the concrete. The stud bolts shall be positioned as they would be in track for two fasteners 30 inches apart measured parallel to the rail. The holes for the dowels shall be 1-1/8 to 1-3/4 inch diameter and 5-1/2 inches deep. The epoxy to be used shall provide a minimum unrestrained pullout strength of 20,000 pounds. As an alternate, the stud bolts may be replaced wit 7/8 inch anchor bolts and female inserts epoxy grouted into the concrete block.
9. Before commencing any tests the rail fastener(s) shall be stabilized at a temperature of 24 degrees C, plus or minus 6 degrees C for a minimum of four hours.
10. Should any fastener assembly fail a test, perform the entire sequence of test on the eight new fastener assemblies. Should a fastener assembly from a sample lot fail a test, the entire lot is rejected and the Contractor is to provide a new random sample lot to the WMATA Engineer, from which a sample of eight fasteners will be returned to the Contractor for testing by the independent laboratory. If the design of the fastener must be modified to pass any test, shop drawings of the new design shall be submitted to and approved by the WMATA Engineer before retesting is continued. Manufacture at least ten fastener assemblies of the new design and perform all tests on the new fastener design. Continue the revision, approval and test cycle until the fastener assemblies are accepted. Four (4) weeks is allotted for redesign, approval, and testing commencement. The Authority reserves the right to terminate the contract for default should the Contractor fail to develop an approved fastener within a reasonable amount of time after award so as to prevent their capability of complying with the delivery schedule.

1.08 ELASTOMER QUALIFICATION TESTING

1. Each test listed below shall be performed on two specimens.
2. The specimens used for the test shall be certified by the Contractor to have been taken from the production size batch used for making the fastener and to have cured in a manner equivalent to the cure used for the fastener.

3. Prior to the testing, all elastomer specimens shall be conditioned for not less than two days at 23 degree C plus or minus 2 degree C and 50% plus or minus 5% relative humidity

4. Tests performed on specimens are:

   a. Hardness Test - The Durometer A hardness shall be between 45 and 55 as measured in accordance with ASTM D2240, "Indentation Hardness of Rubber and Plastics by Means of a Durometer".

   b. Tensile Strength and Ultimate Elongation Test - When tested in accordance with ASTM D412, "Tension Testing of Vulcanized Rubber", the tensile strength shall be 2,350 psi or greater and the ultimate elongation shall be ~~500~~ 400 percent or greater.

   c. Compression Test - The elastomer shall be tested for 22 hours in accordance with ASTM D395, Method B to determine the percent of compression set. The test shall be conducted at 70 degree C. And the set shall not exceed 25 percent.

   d. Accelerated Aging of Rubber Test - In accordance with ASTM D573, "Accelerated Aging of Vulcanized Rubber", the test sample shall be aged for 70 hours at 70 degree The percentage of decrease of tensile strength shall not exceed 25 percent; the percentage of decrease of ultimate elongation shall not exceed 25 percent; and the change in hardness, measured on the Durometer A scale, shall not exceed 10 points.

   e. Resistance to Ozone Cracking Test - Test specimens shall be prepared in accordance with Procedure A of ASTM D518, "Resistance to Surface Cracking of Stretched Rubber Components". The test specimens shall be tested in accordance with ASTM D1149, "Accelerated Ozone Cracking of Vulcanized Rubber", at a temperature of 40 degree C and at an ozone partial pressure of 50 mPa. The elastomer shall not exhibit any cracking when examined in accordance with ASTM D1149 at the end of a 100-hour exposure.

   f. Compression Set at Low Temperature Test - When tested at minus 10 degree C for 70 hours in accordance with ASTM D1229, "Low Temperature Compression Set of Vulcanized Elastomers", the compression set at 30 minutes after release (t@30 reading) shall not exceed 37 percent

   g. Oil Absorption Test -

      1) One test shall be conducted with IRM 903 (No. 3) oil at 23 degree C for 70 hours. The volume change for the No. 3 oil shall not exceed 60 percent.

      2) A second test using a different sample shall be conducted with IRM 903 (No. 1) oil at 23 degree C for 70 hours in accordance with ASTM D471, "Change in Properties of Elastomeric Vulcanizates Resulting from Immersion in Liquids", to determine the volume change of the elastomer. The volume change for the No. 1 oil shall not exceed 10 percent.

   h. Adhesion to Metal Test - This test shall be performed on specimens of elastomer which are to be bonded in the finished fastener in accordance with ASTM D429, Method A, "Adhesion of Vulcanized Rubber to Metal", the failure must be entirely Type R (eg. Elastomer tears before bond fails). The metal substrate, preparation, adhesive and bonding process shall be the same as that used for the manufacture of the direct fixation rail fastener.

   I. Resistance to Tearing Test - When tested in accordance with ASTM D624, "Standard Test Method for Rubber Property - Tear Resistance", the resistance to tearing shall be not less than 100 pounds per inch.

   j. Flame Spread and Smoke Generation Test - The elastomer shall be tested in accordance with ASTM E162, "Standard Test Method for Surface Flammability of Materials Using a Radiant Heat Energy Source", to determine the Flame Spread Index$_s$.

The elastomer shall be tested in accordance with NFPA No. 258-1982, Smoke Generated by Solid Materials Test, in both the flaming and nonflaming modes to determine the Smoke Generation Specific Optical Index, D_s. The elastomer shall not exhibit any flaming drippings when tested. No acceptance criteria are specified for the Flame Spread Index, L_s and the Smoke Generation Specific Optical Index, D_s. These indices shall be reported to the Authority for information only.

k. Electrical Resistivity Test - Prepare a fully assembled fastener and apply 500 V dc. to the rail head for three minutes with all anchor bolts and metal base elements grounded. The elastomer shall be tested and measured in accordance with ASTM D257 "Standard Test Method for D-C Resistance or Conductance of Insulating Materials", to determine the resistivity of the elastomer. Next, remove the fastener from the test block and immerse it in potable water for 70 hours at 70 degrees C. Immediately after removal from the water immersion, without drying and with no portion of the fastener less than 35 degrees C, reinstall the fastener on the test block and test for electrical resistance and impedance. For testing under wet conditions, immerse elastomer in potable water with a resistivity of 1,000 to 1,500 ohm-cm. Adjust resistivity of potable water if required by addition of sodium chloride. The minimum volume resistivity under dry condition shall be 10^{12}-ohm-cm and 10^{11}-ohm-cm under wet condition.

l. Water Absorption Test - The elastomer shall be tested in accordance with ASTM D570, "Standard Test Method for Water Absorption of Plastics" , to determine the change in weight of elastomer due to absorption of water. Immerse specimens in distilled water for 24 hours at a temperature of 23 degree C prior to testing. The elastomer shall have a maximum increase in weight of 1.0 percent.

~~5. When tested in a Monsanto Oscillating Disk Rheometer the rheology data shall fall within the limits shown on **Exhibit H**~~

~~6. When tested with a Fisher-Young Gravitometer, the specific gravity shall be 1.19 plus or minus 0.2.~~

l. Rheology (Cure and Strength Indicator) Test -

1) Test the elastomer in accordance with ASTM D2084.

2) During qualification testing a cure curve shall be developed based on the rheology test results for approval by the WMATA Engineer. Specification limits shall be established at several points along the curve for approval by the WMATA Engineer.

3) During production testing the cure curves shall be compared to the qualification test cure curve. The production test curve shall be within the specification limits.

m. Specific Gravity Test -

1) Test the elastomer in accordance with ASTM D297

2) During the qualification testing the specific gravity of the elastomer shall be determined. During the production testing the specific gravity shall be plus or minus 0.02 of the specific gravity determined during the qualification testing.

1.09 FASTENER BODY METAL QUALIFICATION TESTING

A. Prepare three Charpy impact test specimens in accordance with ASTM E23, "Standard Method for Notched Bar Impact Testing of Metallic Materials", from the same metal used for the top and bottom plates of the fastener body. Each metal sample shall have met the minimum impact requirements and be approved by the WMATA Engineer before fastener assembly qualification testing proceeds.

B. Conduct a Charpy impact test on each specimen at a temperature of 21 degree C in accordance with ASTM E23. The fracture energy shall be greater than three foot-pounds. The test report shall include all the information required by ASTM E23. The fracture energy shall be greater than 3 foot-pounds for irons and 15 foot-pounds for steel.

C. High Frequency Resonance Test

1. Suspend the top plate with a nylon, hemp, polyethylene or cotton rope, or an elastomer band of sufficient strength to support the top plate without failure. Mount an accelerometer of mass not greater than 0.05 kg at the center of the rail seat area, with an axis of sensitivity normal to the rail seat. The accelerometer signal shall be appropriately conditioned with a charge amplifier or voltage preamplifier and analyzed with a minimum 400 line spectrum analyzer, while striking an end of the top plate with a hammer in a direction normal to the rail seat plane.
2. The frequencies of the top plate's modes of vibration, identified by maxima in the spectrum of the response of the top plate to hammer impacts, shall be greater than 600 Hz.

1.10 FASTENER ASSEMBLY TESTING

A. Test Sequence:

1. Eight (8) complete rail fastener assemblies are required to conduct the tests. Assemble and mount two fasteners on each concrete block designated as A, B, C, and D. The set of fasteners shall be subjected to the following tests as specified below. All fasteners shall be subjected to each of the static tests as specified below:
2. Fasteners A shall undergo the Vertical and Lateral Repeated Load Test and then undergo the Repeated Load Test With One Anchor Bolt. Fasteners A shall then again undergo each Static Test without replacement of any component.
   For the Longitudinal Restraint Test, the fasteners shall not be disassembled from the rail after the Repeated Load Test with One Anchor Bolt, nor shall the rail hold down assemblies be re-torqued.
3. Fastener B shall be subjected to Dynamic to Static Stiffness Ratio Test, then undergo Heat Aging Process, and then retested through each of the Static Tests without replacement of any component followed by another Dynamic to Static Stiffness Ratio Test.
4. Fasteners C shall be undergo Heat Aging Process and then tested for Uplift Repeated Load Test followed by Corrosion Process. Fasteners C shall then be retested through each of the Static Tests without replacement of any component.
5. Fasteners D shall be tested as specified below for the Push-Pull Test. Fasteners D shall then be retested through each of the tests for Static Tests, without replacement of any component. For the Longitudinal Restraint Test, the fasteners shall not be disassembled from the rail after the Push-Pull Test, nor shall the rail hold down assemblies be re-torqued.

B.. The sequence shall be performed without replacement of any fastener component. ~~Components may be reset and/or tightened after the Repeated Load Test, Push-Pull Test II and Longitudinal Restraint Test.~~

C. Static Tests:

1. Vertical Load Test - A vertical load increasing in increments of 2,000 pounds to a maximum load of 32,000 pounds shall be applied downward at the center of the rail head midway between the two fasteners and normal to the rail.

The load shall be applied at the rate of not less than 200 pounds per minute nor more than 2000 pounds per minute. For each increment of load the vertical deflection of the rail head shall be measured to the nearest 0.001 inch and recorded. The load shall be removed and the final position of the rail head measured and recorded. The recorded values for vertical load vs. deflection shall be plotted on a graph as shown on **Exhibit F**.

Acceptance Criteria -

a. Calculate the fastener stiffness as the slope of a straight line determined by a linear least-squares regression of the load per fastener versus each deflection for load per fastener between 4,000 pounds and 12,000 pounds. The fastener stiffness shall be within 15 percent of 140,000 pounds per inch. The load versus displacement curve shall be within the limits identified in **Exhibit F**.

b. The tangent to load-versus-deflection curve at each load between and including 4,000 pounds and 12,000 pounds per fastener shall be within 10 percent of the fastener stiffness determined above. For the purpose of calculation, the tangent to the load versus deflection curve at each deflection, X_n , and each load , P_n, are approximated as:

$$(P_{n+1} - P_{n-1})/(X_{n+1} - X_{n-1})$$

where P is the load at deflection X_n.

c. Total deflection of the elastomer at the 15,000 pound load per fastener shall not exceed 25 percent of the uncompressed thickness. After removal of the maximum load, the fastener shall return to within 0.005 inch of its original position within one minute.
At no time during the tests shall a fastener component exhibit any sign of failure by slippage, yielding, fracture, or bond failure.

d. Values obtained when this test is repeated, after performance of other tests, shall be within 20 percent of the initial test values.

2. Vertical Uplift Test - A vertical load shall be applied to the center of the rail head midway between the two fasteners and normal to the rail, alternating from a vertical downward load to a vertical upward load. The peak load per cycle shall be increased in increments of 200 pounds each cycle to 4,800 pounds. The loads and deflections shall be continually measured to the nearest 0.001 inch and simultaneously recorded on a load versus time graph and a deflection versus time graph respectively. The load shall be removed and the final position of the rail head measured and recorded. The reaction force to the uplift load shall be applied to the test block on which the fastener is mounted.

Acceptance Criteria - The ratio of the deflection for the total uplift test load to the deflection for the total vertical downward test load shall be between plus 5 percent and plus 135 percent of the deflection for a 4,000 pound downward vertical load as determined from the Vertical Load Test. When the vertical load is continuously varied from vertical downward loads to uplift loads, there shall be no indication of backlash or free play at times when the load or the deflection changes direction. After removal of the maximum load, the rail shall immediately return to within 0.005 inch of its original position. At no time during the test shall any fastener component, including the anchorage to the test block, exhibit any sign of failure by slippage, yielding or fracture.

3. Lateral Load Test - While applying a vertical load of 27,000 pounds downward at the center of the rail head midway between the two fasteners and normal to the rail, a lateral load, increasing in increments of 1,000 pounds to a maximum load of 18,000 pounds, at a rate of 1,000 pounds per minute, shall be applied horizontally to the rail head at a point 0.625 inch below the top of rail at the location of vertical load.

For each load increment, the lateral deflection of the rail head at a point 0.625 inch below the top of rail shall be measured to the nearest 0.001 inch and recorded. The lateral load shall be removed and the final position of the rail head measured and recorded. The recorded values for lateral load vs. deflection shall be plotted on a graph similar to **Figure E**.

Acceptance Criteria - The lateral load versus deflection curve for each fastener shall lie within the envelope shown on **Exhibit G**. The lateral deflection of the rail head for a lateral load of 4,000 pounds per fastener shall not exceed 0.150 inch. The average lateral deflection at maximum load shall not exceed 0.360 inch. After removal of the load, the difference between the original and final positions of the gauge line shall not exceed 0.062 inch. At no time during the test shall any fastener component exhibit any sign of failure by slippage, yielding or fracture.

4. Lateral Restraint Test - A lateral load increasing in increments of 1,000 pounds from zero pounds to 10,000 pounds shall be applied normal to the rail at the base of rail midway between the two fasteners.

   The lateral deflection of the rail shall be measured at the intersection of the centerline of the fastener and the gauge line of the rail to the nearest 0.001 inch and recorded after each increment of loading.

   Acceptance Criteria - At no time during the test shall any component of the fastener show signs of slippage, yielding, or fracture. The difference between the original and final positions of the gauge line shall not exceed 0.062 inch. The lateral deflection of the rail when fully loaded shall not exceed 0.125 inches from original gauge line of the rail.

5. Longitudinal Restraint Test - During the longitudinal restraint test, the rail ends shall be supported on a roller or other low friction supports, properly elevated to prevent the longitudinal load from binding the rail in the fastener.

   A load shall be applied longitudinally at the centerline of rail at the base of the rail increasing in increments of 500 pounds up to a total of 7,000 pounds or until the rail deflects 0.6 inch from the initial condition, whichever occur first. The rate at which load is applied shall be approximately 1,000 pounds per minute. Each load increment shall be maintained constant at a minimum of 30 seconds or until the longitudinal deflection of the rail ceases before increasing the load to the next increment. For each load the longitudinal deflection of the rail relative to the fastener shall be measured to the nearest 0.001 inch and recorded. The longitudinal load shall be removed at slippage of rail and the final position of the rail measured and recorded. The recorded values for longitudinal load vs. deflection shall be plotted on a graph as shown on **Exhibit H**.

   Acceptance Criteria - The longitudinal load vs. deflection curve, when plotted on **Exhibit H**, shall lie entirely within the shaded area. The difference between the original and final positions of the rail shall not exceed 0.125 inch plus the slippage distance of the rail. At no time during the test shall any fastener component exhibit any sign of failure by slippage, yielding, bond failures or fracture except that slippage which may occur between the rail clip and the rail.

6. Voltage Withstand Test - Prepare a fully assembled fastener and apply a DC potential of 15KV between the rail head and the metal base plate of the fastener body for one minute.

Acceptance Criteria - The elastomer shall withstand this test with no visible damage such as splits, cracks, pinholes or fractures, and no evidence of arcing, arc tracking, or other voltage breakdown.

7. Electrical Resistance & Impedance Tests -

a. Electrical Resistance Test - Mount a completely assembled fastener on 1/4 inch thick metallic ground plate sized to extend ½ inch beyond all edges of the fastener.

1) Dry Resistance - 24 hours prior to testing, store the assembled fastener in a clean, dry environment with ambient temperature of 60F to 80F and 50 to 70 percent humidity. Apply 100 volts DC between the rail head and the ground plate for three minutes. Measure the applied voltage and the resulting current flow, or directly measure the resistance with an accuracy of plus or minus two percent.

2) Wet Resistance - Perform this test on the same fastener that passed the Dry Resistance Test. Place the assembled fastener in a nonmetallic trough or suitable container.

Size the container such that there is a minimum of two inches between the sides and bottom of the fastener/ground plate assembly and sides and bottom of the container. Pour water into the container to a level midway up to the rail web covering all surfaces of the fastener. Maintain this level of immersion for 10 minutes. The water resistivity shall be 1,000 to 1,500 ohm-cm (use potable water and adjust resistivity by addition of sodium chloride). Drain water from container to a level ½ inch below the ground plate, and without drying or otherwise disturbing the fastener, apply 100 volts DC to the rail head and ground plate and calculate the resistance within 15 seconds. Repeat measurement and calculation every five minutes for the first hour and every ten minutes for the second hour.

3) Electrical Impedance Test - On a fully assembled fastener, apply a potential of 50 volts AC to the rail head for three minutes for each increment of measurement for frequencies from 20Hz to 10kHz, in increments of 20Hz up to 100 Hz, 200 Hz to 1,000 Hz, and 2,000 Hz up to 10kHz. Measure the impedance after three minutes with an accuracy of plus or minus two percent and record for each frequency.

Acceptance Criteria (for Electrical Resistance & Impedance Tests) -

a. Dry DC Resistance - not less than 20 megohms.

b. Wet DC Resistance - not less than one megohms for the average of three consecutive readings within two hours after draining. The difference between each of the three readings and the average reading shall not exceed 10 percent of the average reading.

c. The minimum impedance for any frequency between 100 hz through 10 khz shall not be less than 9,500 ohms.

8. Vertical and Lateral Repeated Load Test - Loads shall be applied to the rail head in such a manner as to produce a vertical downward load of 28,000 pounds, and lateral loads midway between the two fasteners, 0.625 inch below top of rail, of 8,000 pounds to the gauge side of the rail head and 5,000 pounds to the field side of the rail head. The application of the lateral loads shall be alternated, each combined with alternate application and release of the vertical load, a total of three million complete cycles. Application of the field side load and then the gauge side load with two applications of the vertical load constitutes one cycle.

The frequency shall be regulated to prevent the temperature of the components from exceeding 70 degree C. Re-torqueing of threaded elements subsequent to the completion of 500,000 cycles of loading will not be permitted without the written approval of the WMATA Engineer.

Acceptance Criteria - The fastener shall withstand the three million cycles of load application with no evidence of failure by slippage, yielding, wear, grooving or fracture at any time during the test.

9. Repeated Load Test with One Anchor Bolt - After completion of the Vertical and Lateral Repeated Load Test, the fastener shall be reassembled as specified using only the original components previously subjected to testing. The Vertical and Lateral Repeated Load Test shall then be repeated with a minimum of 15,000 cycles with the gauge side anchor bolt loosened to a minimum of 1/4 inch gap.

Acceptance Criteria - The fastener and concrete block shall withstand the 15,000 cycles of loading with the gauge side anchor bolt loosened with no evidence of failure by slippage, yielding or fracture.

10. Heat-Aging Process - Fully assemble a fastener as specified above except the anchor bolts need not be installed and age the fastener in an air oven for a period of 166 hours at a temperature of 70 degree C using the aging methods specified in ASTM Designation D573, "Accelerated Aging of Vulcanized Rubber by the Oven Method". This is a conditioning process for the fasteners that will be further tested as indicated in **Exhibit E**.

11. Corrosion Process - Expose the fastener body, without loose components, to a five percent solution in accordance with ASTM B117, “Standard Test Method for Salt Spray (Fog) Testing”, for 500 hours. This is a conditioning process for the fasteners that will be further tested as indicated in **Exhibit E**.

12. Uplift Repeated Load Test - The rail fasteners, fully assembled as specified above, shall have loads applied to the rail head in such a manner as to produce alternating vertical downward load of 20,800 pounds and a vertical upward load of 4,800 pounds at the centerline of the rail and midway between the two fastener normal to the rail. The application of the two vertical loads shall constitute one complete cycle and shall be applied for a minimum of 1.5 million cycles. The frequency shall be regulated to prevent the components' temperature from exceeding 70 degree C. Retorqueing threaded elements subsequent to completion of 500,000 cycles of loading will not be permitted.

Acceptance Criteria - The fastener shall withstand 1.5 million complete cycles of load application with no evidence of failure. Upon visual inspection, no component of the fastener, shall exhibit any evidence of failure by yielding, slippage or fracture.

The rail shall exhibit no evidence of wear of grooving that would contribute to a failure of the rail under operating conditions.

13 Push-Pull Test - During the Push-Pull Test, the rail ends shall be supported on rollers or other low friction supports, properly elevated to prevent the longitudinal load from binding the rail in the fasteners. A cycling longitudinal load shall be applied to the centroid of the rail at one end to deflect the rail plus and minus 3/4 inch about the initial position for a total of 50 cycles.

Immediately afterward, a cycling load equal to 80% of the ultimate slippage loads as recorded in the longitudinal restraint test shall be applied for a total of 25,000 pushing and pulling cycles. Repositioning of the rail clips at anytime will not be permitted.

Acceptance Criteria - The fastener shall withstand 25,000 cycles of loading with no evidence of failure. Upon visual examination, no component of the fastener, shall exhibit any evidence of failure by yielding slippage or fracture, except that slippage may occur between rail clips and rail but not between rail clips and the fastener body.. The rail shall exhibit no evidence of wear or grooving that would contribute to rail failure under operating conditions.

14. Dynamic to Static Stiffness Ratio Test - Using the same assemblage as noted in the Vertical Load Test, Apply an oscillating downward load at the centerline of the rail head and the centerline of the fastener so as to produce a sinusoidal load alternating between 8,000 and 18,000 pounds at a rate of between 10 and 20 hertz.

Continuously record the load and deflection versus time on a high speed oscillograph or high speed digital recorder. After a minimum of 1,000 cycles, determine the dynamic stiffness from the ratio of peak-to-trough force to peak-to-trough deflection from the recorded data.

Between five to ten minutes after completion of the dynamic stiffness measurement and removal of all load , apply a vertical load beginning at zero pounds and increasing in 2,000 pound increments to a maximum of 20,000 pounds, at a rate not less than 200 pounds per minute nor more than 2,000 pounds per minute, at the centerline of the fastener assembly. For each increment of load between 2,000 and 20,000 pounds, record the vertical deflection of the rail head to the nearest 0.001 inch. The static stiffness of the fastener shall be the difference in load divided by the difference in deflection between 8,000 and 18,000 pounds.

Acceptance Criteria - The dynamic stiffness shall not exceed 1.5 times the static stiffness.

1.11 DELIVERY, HANDLING AND STORAGE

A. Fasteners shall be packed and shipped in a manner that shall prevent a load on any fastener from exceeding 1,000 pounds.

B. Fasteners shall not be stored by the Contractor in a wet location or where the ambient temperature will exceed 120 degree F.

C. Fasteners shall be packaged on wood pallets and wrapped in minimum 6 MIL plastic to permit outdoor storage in a secured area. Rail hold-down assemblies, shoulders, bolts, nuts and other loose items shall be packaged by component type in secure shipping kegs or boxes and clearly identified. The method and materials of packaging shall be submitted for approval by the WMATA Engineer.

D. The Contractor shall replace all fasteners damaged during packaging, pre-delivery storage and shipping without additional cost to the Authority.

E. Fasteners shall be delivered FOB to Authority furnished storage sites as directed by the WMATA Engineer to the Washington Metropolitan area. Unloading and final storage will be by others. Provide the WMATA Engineer two weeks notice prior to any fastener delivery.

F. Fasteners used in the production quality control testing shall be packed and labeled separately from the rest of their lot.

PART 2 - PRODUCTS

2.01 MATERIAL REQUIREMENTS

~~A. Fastener components shall comply with the following material requirements:~~
~~1. Metal Plate~~
~~a. The top, bottom and cover plates shall be metal castings of grade 65-45-12 ductile iron per ASTM A-536.~~
~~b. The chemical composition shall meet the acceptable level per SAE J434.~~
~~c. The Brinell hardness in accordance with ASTM E-10 shall be within 156-217 BHN range per SAE J434. The microstructure shall be within limits set by SAE J434. The fracture energy at 21.1C in accordance with ASTM E-23 shall be greater than 3 foot-pounds.~~
~~d. The test report shall include all information listed in paragraph 12 of ASTM E E23.~~
~~2. Elastomer: Elastomer shall be a blend of 85% natural rubber and 15% chloroprene and shall comply with the following requirements:~~

A. Fastener Body:
1. Metal Components:
a. Both the metal top plates and bottom plates shall be one-piece ductile iron. The minimum thickness of the top plate shall be ½ inch and 3/8 inch for the bottom plate.
b. The ductile iron castings shall be minimum Grade 65-45-12 in accordance with ASTM A536, “Standard Specifications for Ductile Iron Castings”. The chemical composition shall meet the acceptable level per SAE J434, “Automotive Ductile Iron Castings”. The Brinell hardness when tested in accordance with ASTM E10, “Standard Test Method for Brinell Hardness of Metallic Materials”, shall be within 156-217 BH range per SAE J434.
2. Elastomer:
a. The minimum thickness of the elastomer between the top plate and the bottom plate parallel to the rail seat shall be ½ inch .
b.. The elastomer shall be neoprene or natural rubber or a blend of neoprene and natural rubber.
3. Manufacturing Tolerances:
a. Manufacturing tolerances for the fastener shall be as shown in Table 1.

Table 1 - Direct Fixation Fastener Manufacturing Tolerances

DIMENSION	TOLERANCE
Length and width	Plus or minus 1/8 inch
Height	Plus or minus 1/32 inch
Squareness	All angles within plus or minus 1/32 inch
Centering of holes	Plus or minus 1/32 inch
Diameter of holes	Plus or minus 1/32 inch
Durometer Shore A	Plus or minus 5

Serration depth	Plus or minus 1/64 inch
Serration spacing	Plus or minus 1/64 inch
Width between shoulders at rail base	Plus 1/16 inch or minus zero inch

B. Rail Hold Down Assembly: Rail clip shall be a resilient spring clip type such as the Pandrol e-2056 (left handed) and as specified herein. Spring-wedge type rail clips will not be permitted. Rail clip shoulder shall be cast as integral part of the metal top plate. Welding of the rail clip shoulder to the top plate will not be permitted.

1. Materials - Rail clips shall be forged from alloy steel bars and heat treated to achieve the minimum spring action holding power as specified herein.
2. Minimum Design Criteria:
   a. Clips must be one piece, threadless and detachable.
   b. There shall be two clips to each complete rail fastener assembly.
   c. Holding force shall be generated by spring action.
   d. Surface hardness of clips shall be between 44 and 48 HRC.
   e. The range of vertical hold down force (toe load) per clip shall be between 2,100 and 3,000 lbs. with a total force range of 4,200 to 6,000 lbs. per rail seat.
   f. The minimum static longitudinal slip per complete rail fastener assembly, with two clips shall be 3,000 lbs.
   g. Field installation and removal of clips shall be accomplished by one man using standard track tools or by commercially available equipment.
   h. Clip shall be proven design and produced by an ISO 9000 certified manufacturer with a minimum of ten years documented in-track experience in the United States.

C. Rail Anchorage Assembly - Anchor bolts shall be 7/8 inch diameter, carbon steel, electroplated with zinc in accordance with ASTM B633, Type II, SC 4.

~~D. Clip bolts shall be heavy hex structural, Type 3, ASTM A325.~~

~~1. The one-sixteenth-inch shims shown on **Exhibit D** shall be made of steel and shall provide full bearing support to the bottom of the fastener.~~

~~2. Rail clip shall be in accordance with AISI 5160 and shall have a Rockwell hardness between 44 degree C and 48 degree C in accordance with ASTM E18.~~

~~**2.02 STIFF DIRECT FIXATION FASTENER SYSTEM**~~

~~A. The Stiff Direct Fixation Fastener System shall consist of the following components:~~

~~1. Fastener body (elastomeric tie plate), part number J - 16281- 1 as manufactured and previously supplied to WMATA by Lord Corporation, Erie, PA.~~

~~2. Pandrol Slip in Shoulder as manufactured and previously supplied to WMATA by Pandrol, Inc. and shown on their Drawing No. 5705, "Cast Shoulder to Suit Lord Plate" for 115 RE Rail, two per fastener body.~~

~~3. Pandrol Spring Clip, Type PR602A, two per fastener body.~~

~~4. Anchor bolt, heavy hex structural, Type 3, ASTM A325 7/8" - 9 x 3 -1/4", two per fastener body.~~

~~5. Washer, hardened weathering steel, ASTM F436, 2" O.D., 0.94" I.D. and 1/8" thick, two per fastener body.~~

~~6. Anchor insert as specified in Section 05653, Direct Fixation Track Construction, 2.01.C.1, two per fastener body.~~

2.02 VIBRATION ATTENUATING DIRECT FIXATION FASTENER (EGG TYPE)

A. The Vibration Attenuating Direct Fixation Fastener or egg-type fastener shall be manufactured by Advanced Track Products, Inc. (ATP), and previously supplied to the Authority or an approved equal.

B. In addition to being highly resilient, the fastener must provide:

1. Vertical and lateral stability to the rail
2. Longitudinal restraint to the rail
3. Electrically isolate the rail from the trackbed
4. Satisfactory service life comparable to that expected of standard direct fixation fasteners.

~~**2.03 ELECTRICALLY INSULATED BALLASTED TRACK FASTENERS (EIBTF)**~~

~~A. Electrically Insulated Ballasted Track Fasteners (EIBTF) shall be as manufactured by L. B. Foster, Co., and previously supplied to the Authority, or an approved.~~

~~B. Fasteners include fastener bodies, rail clips and screw spikes.~~

~~**2.04 F-17 DIRECT FIXATION FASTENER**~~

~~A. As applicable, and if specified, the Standard Fastener F-17 design shall be as shown on the Contract Drawings~~.

PART 3 - EXECUTION

3.01 FASTENER TESTING - SOURCE QUALITY CONTROL

A. Test Plan:
1. Tests specified herein shall be performed in accordance with the approved test plan.
2. The Contractor shall notify the WMATA Engineer fourteen days in advance of the commencement of testing including preparation of the test equipment for testing.

3. Testing shall be performed in the presence of the WMATA Engineer unless otherwise approved in writing by the WMATA Engineer.

B. Starting Tests and Procedures:
1. After a test sequence is begun, it shall be completed.
2. In the event of failure of a test rig component, the WMATA Engineer shall determine if the failure was attributable to the fastener.
3. If the fastener did contribute to the failure, or if there is doubt, then, with the approval of the WMATA Engineer, the testing shall cease and the test report shall be submitted with all findings.
If the fastener did not contribute to the failure, the component shall be replaced and the testing continued.

C. Configuration for Testing:
1. Testing Setup and Preparation:
a. Except for specific tests noted herein, ~~four~~ eight fasteners complete with the modified rail section, as shown in ~~**Exhibit C**~~ **Exhibit A** and of length as determined ~~from **Exhibit D,**~~ shall be used.
b. Before assembly, the fasteners shall be clean and dry.

c. The fasteners shall be spaced one inch apart.

d. The fasteners shall be mounted and anchored on a test block and the spring clips shall be positioned to hold the modified rail section.

e. The anchor bolts shall be torqued to 300 foot-pounds.

f. All reactions to load shall be through the fasteners to the test block.

g. The test block shall be of reinforced concrete with female threaded inserts cast or set on it to receive the 7/8-inch fastener anchor bolts. The top surface of the test block shall be a flat plane with a wood float finish and with the face of the inserts set parallel to the surface with a tolerance of plus zero above and minus 1/32-inch below the surface.

1) Concrete: The strength of the concrete shall be 4,000 psi as determined from standard test specimens taken in accordance with ASTM C31 and ASTM C172 and cured and tested in accordance with ASTM C39. Rebar shall be placed as shown in Exhibit D.

2) Inserts:

a) Inserts shall be of corrosion resistant steel threaded to 1-1/2 inch depth to receive ASTM A325 7/8-inch bolts and shall meet 40,000-pound bolt load.

b) Washer face bearing of the insert against the fastener shall be equal to the bearing area of an A563 heavy nut for 7/8-inch bolt.

c) Length and anchorage configuration shall withstand 12,000 pounds unrestrained pullout and resist 250 foot-pounds torque without yielding.

d) Inserts shall be coated with an epoxy resin insulating coating, 100-percent dry powder epoxy resins, Scotch Kote Brand Protective Resins No. 203, Minnesota Mining and Manufacturing Company; Corvel Epoxy ECB-1363A, Polymer Corporation; or equal.

2. Instrumentation:

a. Instrumentation for all required deflection and rotation measurements shall be designed so as to measure each rail motion parameter relative to the test block.

b. Each instrument shall be designed to measure the motion intended with minimum effects on the data from other motions.

D. Temperature: Before commencing, and during all tests, the fastener shall be stabilized at an ambient temperature of 22 degrees C, plus or minus 5 degrees C unless otherwise specified.

~~E. Spring Rate and Deflection Test:~~

~~1. The set of fasteners shall be tested as follows:~~

~~a. The four fasteners shall be loaded and have the deflections measured as shown in **Exhibit D**. The modified rail section shall be instrumented for rotation about its longitudinal axis. The total vertical and lateral response loads will be the sum of the load values measured on the two vertical and lateral load cells between the loading rams and the load points. **Exhibit E** shows the vertical and lateral response loading as a function of time. The vertical load points shall be loaded equally with a vertical load that varies as shown by Curve V. The occurrence of one wave as shown by Curve V shall be considered as one cycle. The lateral load points shall be loaded equally with a lateral load that varies as one cycle. The lateral load points shall be loaded equally with a lateral load that varies as shown by Curve L. The~~

vertical and lateral loads shall occur simultaneously as shown in **Exhibit E**. The direction of the lateral load shall reverse, as shown by Curve L and Reverse Curve L in **Exhibit E,** with every cycle. There may be a no load pause between cycles of no longer than one half of the cycle length.

b. The fasteners shall be pre-loaded with 1,000 cycles of Case 1 loading. After the pre-load cycles, the instruments used to monitor deflection and rotation shall be zeroed in a no-load condition. Then the Case 1 loading shall be cycled 10 times during which data of vertical and lateral loads, deflections and rotation as functions of time shall be analog graphs shall be recorded directly from the instrumentation's output signal. At the completion of the 10 cycles the load shall be removed and data shall be continuously collected for one minute after the loads are removed.

c. The test data shall be presented in both analog and digitized form. The analog graphs shall be drawn at a rate of not less than 100 mm per second during the 10 cycles and not less than one mm per second during the one minute period after the loads are removed. The vertical scale shall be set to make full use of a strip chart which is at least 40 mm wide per channel. Analog graphs of loads (for each load cell), deflections (for each deflection) and rotations at each end shall include calibration (scales) and annotation which fully describe the graphs. Digitized data shall show vertical and lateral fastener loads, average vertical deflection, average lateral deflection at base of rail, and average rotation values at every 0.01 seconds for each cycle and at one minute of rest after release of the loads. The fastener load shall be computed as one fourth of the total response load. The digitized data may be a computer printout formatted similar to **Exhibit F.** The lateral deflection to be reported in **Exhibit F** is the average value at the base of the rail.

d. All deflection and rotation instrumentation shall measure, relative to the test block, to the nearest 0.001 inch and 0.02 degrees, respectively. The instrumentation for measuring the response loads (the total load applied to all four fasteners) shall have an accuracy of plus and minus two percent or plus and minus 50 pounds whichever is larger. The test operator shall perform the tests so that the instrumentation indicates that the response load is within plus and minus 100 pounds of the specified loads.

e. The fastener shall also be tested as in the preceding steps a. through d. with the loads shown for Case 2 on **Exhibit E**.

2. Fastener Test Set to Satisfy Acceptance Criteria: Each fasteners in a four fastener test set shall satisfy the following acceptance criteria.

a. The fastener shall demonstrate response repeatability for each loading case. Repeatability shall be demonstrated if the deflections for a fastener at each load level indicated by the lettered points on Curves V and L do not vary by more than plus or minus 0.002 inch or plus or minus seven percent whichever is larger, from the average for the 10 cycles. Once repeatability has been demonstrated, the fifth cycle of the 10 recorded shall be chosen from each of the loading cases for further analysis as follows:

b. For each case, the spring rate for the fastener shall be determined from the maximum downward vertical fastener load (first occurrence of Point B, **Exhibit E**, Curve V) and the downward vertical fastener deflection which occurs at that time. The average spring rate for the four fasteners shall be between 90,000 and 100,000 pounds per inch.

c. The digital data shall be grouped into increments in the following manner:

1) Vertical:

a) Three equal time increments from zero deflection near 0.20 seconds to peak deflection near Point B (**Exhibit E**, Curve V) at 0.36 seconds.

b) One increment from peak deflection near Point B (**Exhibit E**, Curve V) at 0.36 seconds to peak deflection near Point

C (**Exhibit E**, Curve V) at 0.43 seconds.

c) One increment from peak deflection near Point C (**Exhibit E**, Curve V) at 0.43 seconds to peak deflection near Point B (**Exhibit E**, Curve V) at 0.50 seconds.

d) Three equal time increments from peak deflection near Point B (**Exhibit E**, Curve V) at 0.50 seconds to zero deflection near 0.66 seconds.

2) Lateral:

a) Three equal time increments from zero deflection near 0.20 seconds to peak deflection near Point E (**Exhibit E**, Curve L) at 0.36 seconds.

b) Two equal time increments from peak deflection neat Point E (**Exhibit E**, Curve L) at 0.36 seconds to Point F (**Exhibit E,** Curve L) near 0.50 seconds.

c) Three equal time increments from Point F (**Exhibit E**, Curve L) at 0.50 seconds to zero deflection near 0.66 seconds.

3) Incremental Spring Rates:

a) Linear regression shall be used to determine the incremental fastener spring rate for each increment fastener spring rate for each increment as previously defined. The incremental spring rates shall be shown **Exhibit F.** The minimum incremental spring rate shall not be less than 80 percent for vertical and 70 percent for lateral of the maximum incremental spring rate for the first three increments beginning near 0.20 seconds. The criteria shall be applied individually to both the vertical and lateral data for Cases 1 and 2.

d. The vertical deflection at Point A on Curve V for Cases 1 and 2 shall not be less than 0.000 inches and shall indicate a deflection in the up direction.

e. Maximum elastomer compressive and shear strains shall not exceed 25 percent and 50 percent respectively for Case 1 shown on **Exhibit E**.

f. The peak average lateral deflections measured six inches above the rail base for Case 2 shall be between 0.322 and 0.344 inches and for Case 1 shall be between 0.186 and 0.228 inches. The maximum angle of rotation of the modified rail section about the longitudinal axis shall bot exceed 0.5 degree for Case 1.

g. After completion of the loading cycles and with one minute of rest with no load, the vertical deflections shall not exceed 0.005 inch and the average lateral deflections at both the rail base and six inches above the base shall not exceed 0.01 inch.

h. The rail base shall remain in full contact with the rail seat of the fastener during the cycling.

i. The analog data shall show uniform deflection and load indicating no free play.

j. At no time during the test shall any fastener component, including the anchorage to the test block, exhibit any sign of failure by slippage, yielding or fracture. Analog data shall be reviewed for indications of slippage, yielding or fracture.

k. When this test is repeated in the test sequence the deflections shall not have increased by more than 10 percent and the spring rate shall not have decreased by more than 10 percent from the initial performance.

F. Longitudinal Restraint Test:

1. On a set of fasteners for the “first loading” a load shall be applied longitudinally to the rail, at the intersection of the rail centerline and the bottom of the base of the rail, with increasing increments of 1,000 pounds until the rail deflects 1.0 inch from the initial

condition relative to the test block. For each load, the longitudinal deflection relative to the test block for the rail and each fastener shall be measured to the nearest 0.001 inch and shall be recorded. The longitudinal load shall be removed and the final position (after one minute) of the rail and of each fastener shall be measured and recorded. After resetting the deflection gauges to zero the test shall be repeated in the opposite direction for the "second loading". For each direction the recorded values for longitudinal load versus rail deflection and average fastener deflection shall be plotted on a graph as shown in **Exhibit G**. Deflection gauges shall be zeroed with no load applied to the rail (the original position). Each load increment shall be maintained constant within plus or minus two percent of nominal or plus or minus 50 pounds, whichever is greater, until the longitudinal deflection of the rail ceases before the data is read and recorded. The longitudinal deflection shall be determined as having ceased when the deflection rate is less than 0.001 inch per 30 seconds.

2. Test Acceptance Criteria.

a. For the "first loading", the longitudinal load versus rail deflection curve, when plotted in **Exhibit G**, shall lie entirely within the limits defined by the "Upper Limit" and the "Lower Limit, First Loading".

b. For the "Second Loading" the "Upper Limit" and the "Lower Limit", Second Loading" limits shall be used

c. The slippage between the rail and fastener shall not occur prior to 0.15 inches of rail deflection relative to the test block.

d. The difference between the original and final average fastener deflections shall not exceed 0.125 inch.

e. At no time during the test shall any fastener component exhibit any sign of failure by slippage, yielding, or fracture, except that slippage which may occur between the fastener and the rail.

G. Electrical Resistance Test:

1. Fasteners and All Components:

a. Each of the four fasteners with all components shall be immersed for 70 hours in boiling distilled de-ionized water. The fasteners shall be fully enveloped in the boiling action.

b. After removal from the water, with surface air drying and with the fastener at a temperature in the range of 29 deg. C plus or minus 6 deg. C, each fastener shall be installed separately on test block, with a 0.25 inch thick steel ground plate dimensioned large enough and situated to extend a minimum of 0.25 inches beyond the periphery of the fastener and located between the fastener and the test block, and tested for electrical resistance.

c. With both anchor bolts of a fastener grounded to the ground plate, 100 volts dc shall be applied between the rail head and the ground plate for three minutes. The actual current flow shall be measured to the nearest 0.1 microampere and recorded.

d. Then 1,000 volts dc shall be applied between the rail head and ground plate for two hours, after which 100 volts dc shall be applied again for three minutes and the actual current flow shall be measured, as above, and recorded.

e. A potential of 50 volts RMS ac shall be applied between the rail head and ground plate for three minutes for each increment of measurement for frequencies from 20 Hertz to 10 kilohertz in increments of measurement of 20 Hz up to 100 Hz; 200 Hz up to 1 kHz; and 2kHz up to 10 kHz. The impedance after three minutes after three minutes shall be determined with an accuracy of plus or minus two percent and recorded for each frequency.

2. Acceptance Criteria:

a. The maximum current for 100 volts dc shall be 1.0 microampere.

b. The minimum impedance for any frequency with 50 volts RMS ac shall be 10,000 ohms.

H. Repeated Load Test:

1. The test fasteners shall be loaded and instrumented as described for the Spring Rate and Deflection Test except that in **Exhibit E** (2 of 2), Cases 4 and 5 shall be used and the direction of the lateral load, Curve L, shall not be reversed at any time. The direction of the lateral load relative to the fasteners shall be the same for both cases.
2. No adjustments (re-torqueing, re-application or resetting) of any component during this test shall be made without approval from the Engineer. All adjustments shall be reported.
3. For every two cycles of testing each case shall be cycled one time. Each case shall be cycled a total of 90,000 cycles. The analog and digital instrumentation and recording devices for the lateral and vertical response loads and deflections shall be operative and used to monitor the test. At 10,000 and 179,000 total cycles, 100 continuous cycles of vertical and lateral response loads and deflections shall be recorded as analog load data and shall be reported in the test report. Of the 100 cycles, one sample of each of the two cases shall be digitized in increments of 0.01 seconds and reported in the test report as shown in **Exhibit F**. The digitized data may be formatted similar to **Exhibit F** with a computer printout.
4. Acceptance Criteria:
   a. At no time during the test shall any fastener component, including the anchorage to the test block, exhibit any sign of failure by slippage, yielding or fracture.
   b. More than a 10 percent increase in deflection or decrease in spring rate during the test is a sign of failure.
   c. The final anchor bolt
   d. torque shall not be less than 290 foot-pounds for any bolt.
   e. On the end of the fastener from which the maximum lateral load is directed, the elastomer shall be free of blemishes and blisters.
   f. On the other end, a surface blister or blemish no longer than 3/4 inch in length is acceptable and in the cut out region parallel to the rail, for the shimmed fasteners only, tears may occur with a maximum depth of 5/16 inch.
   g. Bottom holes shall be free of all tears.

I. Push-Pull Test II

1. Application of Cyclical Longitudinal Load
   a. A cyclical longitudinal load shall be applied at the rate of one cycle per second to the base of the rail at the rail centerline to slip the rail relative to the top metal element plus and minus ½ inch about the initial position for a total of 2,000 cycles. A different cycle rate may be submitted for approval.
   b. No adjustment (retorqueing, re-application or resetting) of any component during the cycling shall be made without approval of the Engineer. All adjustment shall be reported.
2. Acceptance Criteria.
   a. At no time during the test shall any component of the fastener shown signs of failure by yielding, fracture or slippage except for slippage of the rail relative to the fastener.
   b. The rail shall exhibit no evidence of wear, polishing, or grooving that would contribute to rail failure under operating conditions.
   c. Minor polishing or grooving due to removal of mill scale and surface irregularities that occurs due to the slippage of the rail through the fastener will not be cause for rejection subject to approval by the Engineer.

E. Production Quality Control:

1. General - Following successful completion of the qualification tests, acceptance of the qualification test reports by the WMATA Engineer, and start of the fastener assembly manufacturing, Production type quality control sampling and testing shall be conducted and performed by an independent testing facility approved by the WMATA Engineer and shall be a member of the American Council of Independent Laboratories. Elastomer samples and fastener assemblies shall be selected from regular production and subjected to testing to ensure that high quality standards are maintained and that design requirements set forth in these specifications are met through the completion of the production process.
2. Production Elastomer Tests -
   a. Samples of elastomer from every mixed batch of material used in the manufacture of production fastener shall be tested to verify compliance of the elastomer batch mix with the following testing requirements:
      1) Hardness Test
      2) Tensile Strength and Ultimate Elongation Test
      3) Specific gravity : and
      4) Cure Characteristic in accordance with ASTM D2084 or an equivalent industry accepted standard.
   b. Certificate of Compliance from the supplier of the elastomer shall be submitted to the Engineer guaranteeing compliance of the elastomer with requirements of these specifications.
3. Fastener Assembly Tests
   a. Production quality control testing of fasteners shall be performed on two (2) fasteners from the first 50 fasteners and on two (2) fasteners from each production lot. A production lot is defined as a quantity of manufactured and completed fasteners produced in a continuous run, but not to exceed 5,000 units. As requested, fasteners may be selected for testing by the WMATA Engineer. Permanently mark the fasteners used for production testing and meeting all test requirements as production test fasteners and deliver fasteners to the Authority. These fasteners shall be subjected to the following tests:
      1) Vertical Load Test
      2) Vertical Uplift Test
      3) Lateral Load Test
      4) Lateral Restraint Test
      5) Longitudinal Restraint Test
      6) Voltage Withstand Test
      7) Electrical Resistance Test
      8) Vertical and Lateral Repeated Load Test (500,000 cycles)
   b. The configuration for testing and the acceptance criteria shall be as specified above, and the value obtained for the slope of the load-deflection curve in the Vertical load Test shall be within 20 percent of that obtained in the original compliance testing.
   c. The quality control tests shall commence no later than fourteen days after fabrication of the fastener. Should any fastener fail to meet the test requirements, two additional fasteners from that same production lot shall be tested. In the event any of the two additional fasteners fail, 100 percent of the remainder of the lot shall be rejected or tested and only those successfully passing all tests shall be incorporated in the final delivered quantity.
   d. In addition to the quality control tests and at the discretion of the WMATA Engineer, all components of the rail fasteners shall be subjected to full or partial testing for compliance with these specifications.

The cost of all such additional testing required by the WMATA Engineer

for any component that is proved to comply with these specifications will be at the expense of the Authority. The cost of all such additional testing of any component that is proven not to comply with these specifications shall be at no expense to the Authority.

e. Production quality control testing may be performed at any test facility, including such facilities at the contractor's plant, provided they meet the approval of the WMATA Engineer and satisfies the requirements of the American Council of Independent Laboratories "Manual of Practice, Quality Control System" - Requirements for Testing and Inspection Laboratory, and ASTM E320. Testing equipment shall be in good repair, of adequate capacity and shall be accurately calibrated. Copies of calibration certificates shall be submitted to the WMATA Engineer. The WMATA Engineer shall be notified not less than 14 days in advance of dates scheduled for quality control tests.

f. Two copies of the results of all tests shall be submitted to the WMATA Engineer within seven days after performance of the tests.

4. Acceptance - Final acceptance of production lots of direct fixation rail fasteners will be based upon the fastener and all its components complying with these specifications as determined by the WMATA Engineer, based on the results of the quality control tests and the certified statements submitted to the WMATA Engineer by the Contractor.

3.02 APPROVAL

A. General - Prior to approval of the rail fastener, the Contractor shall submit to the WMATA Engineer the following:

a. Six copies of both the approved shop drawings of the fastener. This information shall give special attention to torqueing of bolts, use of gauges (if required), setting of lateral adjustment devices, and other details of assembly that may not be readily apparent from the shop drawings of the fastener.

b. Three rail fasteners complete with elastomer and all hardware as specified herein.

c. Six copies of certified statements describing the chemical composition of all elastomer components of the rail fastener.

d. Six copies of a certified laboratory report of the results of all Qualification tests specified herein.

B. Alteration of Rail Fasteners - After approval of the rail fasteners by the Authority, no change in the design or manufacturing process shall be made without the written approval of the WMATA Engineer. The WMATA Engineer, at his discretion, may require the testing, certification, and approval of any altered rail fastener at no additional cost to the Authority. All production of rail fasteners which have not been approved by the Authority shall be at the Contractor's risk.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT

A. Measurement of work specified in this section will be made in the following manner:

1. No separate measurement.

4.02 PAYMENT

A. Compensation for work specified in this Section will be made in the following manner:

1. Included in the price of the work of which it is a part.

SECTION 05658

TRACK APPURTENANCES AND OTHER TRACK MATERIAL

PART 1 - GENERAL

1.01 SUMMARY

A. This Section specifies designing, fabricating, testing and furnishing of track appurtenances. The Work specified herein consists of furnishing and installing bonded standard joints, bonded insulated joints, bumping posts, tie plates with resilient rail clips, spikes, tie plugs, emergency guard rail, derail, switch stand, and other track materials required for track construction.

B. All track appurtenances and other track material (OTM) shall be new and conform to the requirements as specified. All materials shall conform to the dimensional requirements for 115 RE rail, as recommended by current AREMA Specifications or as specified.

1.02 RELATED SECTIONS

A. Section 05651 - General Track Construction

B. Section 05652 - Ballasted Track Construction

C. Section 05653 - Direct Fixation Track Construction

1.03 REFERENCES

A. Association of American Railroads (AAR) - Signal Manual

B. American Railway Engineering and Maintenance-of-Way Association (AREMA)
1. AREMA Manual for Railway Engineering, latest edition.
2. AREMA Portfolio of Trackwork Plans

C. American Society of Testing and Materials (ASTM)
1. ASTM A36
2. ASTM A66
3. ASTM A325
4. ASTM D257
5. ASTM D395
6. ASTM D412
7. ASTM D471
8. ASTM D518
9. ASTM D570
10. ASTM D573
11. ASTM D695
12. ASTM D1149
13. ASTM D1229
14. ASTM D2240

D. National Electrical Manufacturers Association (NEMA)
1. NEMA LI 1 Industrial Laminated Thermosetting Products

E. American Institute of Steel Construction
1. Manual of Steel Construction.

1.04 QUALITY ASSURANCE

A. Quality Assurance Program - Refer to Section 05651, General Track Construction, and conform to the requirements of the Quality Assurance Program.

B. Testing Laboratory Services - Refer to Section 01410, Testing Laboratory Services

C. Before permanently installing either bonded standard joints or bonded insulated joints, pre-qualify each crew and its foreman by testing two samples of each type of bonded joint in accordance with the Longitudinal Compression Test specified herein. Prepare test samples in track. The bonded insulated joints tests shall be performed with one sample using high strength rail and the other sample using standard rail. Both bonded standard joint samples shall use high strength rail.

1. The two sample joints shall have a 1/4-inch gap between the rail ends.
2. The joints shall be tested in compression. A load 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.
3. The load shall be increased in these increments until a total load of 650,000 pounds is attained or failure occurs. At each increment of loading, the load and differential movement of the rail and joint bars shall be measured to 0.0001 inch and recorded.
4. The assembled joints may be sawn in half where the rails are butted together. The sawing shall be done in such a manner as to prevent overheating or damage to the bond and the cut shall be perpendicular to the centerline of the top of the rail with a tolerance of plus or minus one degree. A device shall be fabricated so that the reaction at the sawn ends occur only on the face of the joint bars.
5. At no time shall any of the bonded standard rail joints show any indication of slippage before a compressive load of 650,000 pounds is applied to the joint, nor shall the magnitude of the differential movement be more than 1/8-inch in any direction. At the completion of the test, after the load in the rail has been released, the relative position of rail and joint bar shall be within 1/32-inch of its original value.
6. The test shall be performed by an approved independent laboratory. Should any sample joint fail to meet the specified requirements of the test, another joint may be tested or a different manufacturers product may be tested as directed by the engineer. For qualification testing, materials required shall be furnished by the contractor at no additional cost to the Authority.
7. Failure of any test sample disqualifies the responsible foreman for permanent installation work. Assign a new foreman and repeat procedure and test.
8. Bonded insulated joint bar and bonded standard joint bar to conform to:
    a. Fishing height: plus or minus 1/64 inch
    b. Length: plus or minus 1/8 inch
    c. Straightness, as determined by a 36-inch straightedge: plus or minus 1/32 inch
    d. End post thickness: plus or minus 1/64 inch
    e. Projection below base of rail - 1/16 inch
    f. Bolt hole location - as specified in AREMA Manual for Railway Engineering, Chapter 4, for 36-inch joint bar modified to receive 1-1/8 inch bolt.

D. Equipment: Use equipment that is specifically designed to fasten proprietary bolts in bonded joint installation. Use the same equipment for field installation of bonded joints and for assembling test samples.

E. Tolerances

1. Other track material (OTM) to conform to tolerances as per AREMA.

F. Testing of Elastomer Material

1. The following test shall be performed on each of two pads or on specimens taken from two pads that are identical in all respects to the elastomer proposed for use in special trackwork. All testing shall be at no expense to the Authority.
2. In the event specimens cannot be taken from finished pads, samples certified by the supplier to have been taken from a batch of compound used for making the elastomeric component and having a cure equivalent to the cure of the elastomer component shall be used for the tests.
    a. The elastomer shall be tested in accordance with ASTM D412, to determine the tensile strength and the ultimate elongation. The tensile strength shall be not less than 1500 psi and the ultimate elongation shall be not less than 350 percent.
    b. The elastomer shall be tested for 22 hours at 100C in accordance with ASTM D395, Method B, to determine the percent of compression set. The compression set shall not exceed 30 percent.
    c. The elastomer shall be aged for 336 hours at 70C in accordance with ASTM D573. The change of hardness and the percentage of change from the original tensile strength and original ultimate elongation shall not exceed 40 percent. The change in hardness, measured on the Durometer A scale shall not exceed 10 points.
    d. Test specimens shall be prepared in accordance with Procedure A of ASTM D518. The test specimens shall be tested in accordance with ASTM D1149, at a temperature of 40C, and at an ozone concentration of 50 pphm. The elastomer shall not exhibit any cracking when examined in accordance with ASTM D1149 at the end of a 100 hour exposure.
    e. The elastomer shall be tested at minus 10C for 94 hours in accordance with ASTM D1229, to determine the percent compression set at 30 minutes after release (t30 reading). The compression set shall not exceed 50 percent.
    f. One test for oil absorption shall be conducted with ASTM No. 3 oil at 100C for 70 hours and another test using a different sample shall be conducted with ASTM No. 1 oil at 100C for 70 hours in accordance with ASTM D471, to determine the volume change of the elastomer. The volume change for the No. 1 oil shall not exceed minus 10 or plus 20 percent. The volume change for the No. 3 oil shall not exceed 100 percent all not exceed 100 percent.
    g. Prior to commencing production of elastomer pad sheets, a prototype pad, using the chemical composition intended for production pads, shall be prepared and tested using a one inch by eight inch by one foot nine inch steel plate with two special plate anchorage assemblies two inches from the edges of diagonally opposite corners. The plate and the prototype pad shall be assembled, mounted on a reinforced concrete slab simulating actual field conditions, and subjected to the following tests.
        1) A vertical load increasing in increments of 1000 pounds to a maximum load of 15, 000 pounds shall be applied downward at the center of plate normal to the plate. For each load the vertical deflection of the center of the plate shall be measured to the nearest 0.001 inch and recorded. The load shall be removed and the final position of the plate measured and recorded. The recorded values for vertical load and deflection shall be plotted on a graph as shown on **Exhibit 05658-C**.
        2) The load vs. deflection curve shall lie within the envelope shown on **Exhibit 05658-C** for loads in the range from 4,500 pounds to the load corresponding to a 120,000 pound vehicle.

Throughout that loading range, the spring rate of the fastener, slope of the load-deflection curve, shall not be less than 80,000 pounds per inch or more than 130,000 pounds per inch and shall be of a constant slope within 10 percent. In the event the curve fails to meet the requirements specified above, the chemical formulation of the pad, the coring size, or both shall be modified and the new elastomer pad design retested.

3) An electrical resistance test with one anchor bolt grounded, 100 volts dc shall be applied to the rail head for three minutes. The actual current flow shall be measured to the nearest 0.1 microampere and recorded. Then 1000 volts dc shall be applied to the rail head for two hours, after which 100 volts dc shall be applied again for three minutes and the actual current flow shall be measured, as above, and recorded. A potential of 50 volts rms ac shall be applied to the rail head for three minutes for each increment of measurement for frequencies from 20 Hertz to 10 kilohertz in increments of measurement of 20 Hz up to 100 Hz; 200 Hz up to 1000 Hz; and 2000 Hz up to 10 kHz. The impedance after three minutes shall be determined with an accuracy of plus or minus two percent and recorded for each frequency. The maximum current for 100 volts dc shall be 1.0 microampere. The minimum impedance for any frequency with 50 volts rms ac shall be 10,000 ohms.

1.05 SUBMITTALS:

A. Refer to Section 01300, Submittals.

B. Certificates of Compliance for materials specified in Part 2: Products

C. The Contractor shall submit for approval shop drawings for fabrication of the components and assemblies for all appurtenances listed in this section. No fabrication or manufacturing shall be performed prior to drawing approval. Provide shop drawings on:

1. Bonded insulated and bonded standard joints
2. Standard joints
3. Proprietary bolts and fasteners
4. Hydraulic bumping posts
5. Tie plates
6. Rail clips
7. Screw spike insulators
8. Shims for DF Fasteners
9. Fabrication of the elastomer pads together with a detailed description of the chemical composition and manufacturing processes used in making the elastomer pads.

D. The Contractor, shall in accordance with Specification Section 01300, Submittals, submit shop drawings or detailed catalog cuts of track appurtenances and OTM not fully shown or not in conformance with AREMA Portfolio of Trackwork Plans and Specifications. No fabrication or manufacturing shall be performed prior to drawing approval.

E. Product data on:

1. Bonded insulated joints and adhesives
2. Bonded standard joints and adhesives
3. Proprietary bolts and fasteners
4. Hydraulic bumping posts
5. Tie plates, rail clips, elastomer pads and screw spike insulators

6. Corrosion preventing oil or grease
7. Elastomer pads

F. Four samples of Fox Industries FX-120 Grade Track Crossing (or approved equal): Six inch by six inch sample.

G. Two elastomer pads, or samples taken from pads, for each type of pad specified herein.

H. Certificates and procedure reports:
1. Certificates of product conformance
2. Qualification tests for bonded insulated joints and bonded standard joints
3. Crew qualification tests for bonded joint installation
4. Negative return bonding installation procedure
5. Certified statements showing the results of all elastomer pad tests specified herein.
6. Elastomer pad formulations tested and approved for use on an Authority project within five years prior to opening of bids will be accepted without further testing provided the Contractor submits copies of such certified test reports and verifies the materials furnished are the same as those tested.
7. Certified statements from the supplier of the elastomer shall be submitted stating compliance of the elastomer with the requirements of these specifications.

I. Record of field connections:
1. A record of each bonded standard joint shall be submitted
2. Prior to fabrication, emergency guard rail schedule of string lengths and expansion gap locations

PART 2 - PRODUCTS

2.01 BOLTED JOINTS (INSULATED AND STANDARD)

A. General Requirements: Johnson “Blue” Vulca Bond, or approved equal, with the following requirements:
1. Insulated joints shall be highly resistant to abrading, cracking, cutting, spalling and fatigue failure under impact loads, and shall exhibit deflection characteristics comparable to standard bolted joints.
2. Joint bars shall be quenched and tempered carbon steel in accordance with the AREMA Manual.
3. Joint bars shall be 36 inches in length.
4. Joint bars shall have six, 1 - 1/8 inch diameter bolt holes.
5. Joint bars shall provide full web contact. Inside face of insulated joint bars shall have the insulating material pre-bonded and shall be smooth with no stamping or branding.
6. End posts shall project 1/4 inch, plus or minus 1/16 inch, below the base of rail.
7. All insulated joints shall be furnished complete with bars, end posts, bushings, washer plates, bolts, nuts and washers.
8. Bolts and nuts shall conform to the material requirements of current AREMA Specifications for Heat-Treated Carbon-Steel Track bolts and Carbon-Steel Nuts.
9. Track bolts shall be oval necked and have a nominal diameter of 5 - ½ inches in length in conformance with current AREMA Design for Track Bolts and Nuts.
10. Spring washers shall be single coil, helical spring washers for 1 inch bolts and shall conform to current AREMA Specifications for Spring Washers.
11. Flat washers shall be 2 - 1/4 inches OD, 1 - 3/16 inch ID and 1/8 inch minimum thickness and shall conform to current AREMA Specifications.

2.02 BUMPING POSTS

A. Revenue Vehicle Bumping Post
   1. Requirements: Furnish Hydro-Bumper, Holley Engineering Company, or approved equal, with the following minimum requirements:
   2. Design:
      a. Suitable for installation on ballasted track and direct fixation track.
      b. Permit bolting to web of running rail without anchorage to cross ties or concrete.
      c. Symmetrical about centerline of track.
      d. No part extending more than two inches below base of rail.
      e. Fabricated to dimensions shown.
      f. Equipped with head capable of absorbing 1,000,000 foot-pounds of energy in 30 inches travel.
   3. Provided with one coat of manufacturer's standard shop coat applied to exterior surfaces after complete removal of all foreign matter.
   4. Furnish the product of an established manufacturer regularly engaged in the production of bumping posts.

B. Maintenance Vehicle Bumping Post
   1. Steel bumping post, Type WA, Western-Cullen-Hayes, Inc., or approved equal.
      a. Shock-absorbent head of multiple-spring-and-shockpad design.
      b. Permit installation by bolting to running rails without anchorage to cross-ties or concrete invert.
      c. No part extending more than two inches below base of rail.
   2. Install at the end of M/W tracks in accordance with the manufacturers requirements.
   3. Provided with one coat of manufacturer's standard shop coat applied to exterior surfaces after complete removal of all foreign matter.
   4. Furnish the product of an established manufacturer regularly engaged in the production of bumping posts.

2.03 TIE PLATES

A. Fastener tie plates for Pandrol Spring Clip e2056, 5 - 1/2" rail base, 7" wide and punched for 7/8" screw pikes as manufactured by Pandrol, Inc. Bethlehem Steel, or approved equal.

B. All tie plates shall be canted 40 to 1 inward.

2.04 SPIKES

A. Screw spikes, as manufactured by Pandrol, Inc., Bridgeport, NJ, or approved equal, shall be 7" in length , 7/8" diameter, hot forged, made from medium carbon steel to meet ASTM A66. The head shall be configured for use with a 7/8" socket.

B. Cut track spikes shall be 6 inches by 5/8 inch with reinforced throat, and shall conform to current AREMA "Specifications for Soft-Steel Track Spikes" and "Design for Cut Track Spikes".

2.05 TIE PLUGS

A. Tie plugs shall be treated, five inches in length and conform to current AREMA Specifications for Tie Plugs for 5/8-inch spikes.

2.06 EMERGENCY GUARD RAIL

A. Structural angle, cover plates, and base plates shall be as shown and shall comply with ASTM A36.

B. Structural angle shall be fabricated as specified in the current AISC, Manual of Steel Construction.

C. Holes shall be punched or drilled through the member perpendicular to its face and shall be clean cut, without torn or ragged edges.

D. Structural angles shall be furnished in lengths of not less than 25 feet.

E. Structural angles and plates shall be given a shop coating of rust inhibiting primer, Title Clad II Hi-Bild Primer by Sherwin Williams; 9100 High Performance Epoxy by Rust - Oleum, or approved equal, at the point of fabrication, except that contact areas within three inches of surfaces to be field welded shall not be shop coated. No finish coats of paint are required for emergency guard rail.

F. Washer head drive spike 3/4 inch x 7 inch as manufactured by A&K Railroad Materials, Inc. Lewis Bolt & Nut Company, L. B. Foster Company, or approved equal.

2.07 DERAIL

A. Sliding type, Model HBP, Hayes Track Appliance Company, or approved equal.

B. No part of derail shall extend more than 1 - ½ inches above top of rail when derail is in non-derailing position. Designed for height of 7 - ½ inches from top of rail to bottom of guide box flanges. Stroke: 6- 1/4 inches or less to move from off-rail position to derailing position. Equipped with designated derail blocks.

2.08 SWITCH STAND

A. Switch stand for installation on hand throw switch shall be Foster Parallel-Throw, Low-Type, Design 51A as manufactured by L. B. Foster Company, or approved equal.

2.09 SPRING CLIPS

A. Pandrol type e2056

B. Two per tie plate

2.10 SHIMS FOR DF FASTENERS

A. Shims for DF fasteners shall be galvanized steel in 1/8-inch and 1/16-inch thicknesses and shall provide full bearing of the fastener on the grout pad.

B. Slotted shims will not be permitted.

C. The Contractor shall submit for the Engineer's approval shop drawings of the shims proposed for use.

2.11 ELASTOMER PADS

A. Elastomer pads shall be furnished for use under special plates in special trackwork and shall be fabricated from polychloroprene (neoprene) as specified below

B. Physical Characteristics

1. Elastomer pads shall be 3/4 inch thick and extend 1 inch beyond the plate edges on all sides.
2. All pads shall have a Durometer A hardness of 50 in accordance with ASTM D2240.
3. Elastomer pads furnished for use under all special plates shall be cut from a uniformly cored sheet conforming to the following requirements:
   a. Coring shall consist of cylindrical holes 11/16 inch in depth. A continuous membrane 1/16 inch thick shall close one end of all holes.
   b. Cored holes shall be 1-5/8 inches on center measured between adjacent holes in all directions.
   c. Anchor bolt holes, 1-5/8 inch in diameter, shall be cut at the required locations on the pad.
   d. Tolerances for finished pads shall be as follows:
      1) Length and width: Plus or minus 1/4 inch.
      2) Thickness: Plus or minus 0.03 inch.
      3) Squareness: Plus or minus 1 degree.
      4) Centering of holes: Plus or minus 1/32 inch.
      5) Diameter of holes: Plus or minus 1/32 inch.
      6) Durometer: Plus or minus 5 points.
   e. The diameter of the core holes shall be as follows:
      1) Pads for use under all special plates having a longitudinal dimension greater than 12 inches measured along the rail shall have a diameter of 1 - 1/8 inch.
      2) Pads for use under plates having a longitudinal dimension measured along the rail equal to or less than 12 inches shall have a diameter of 3/4 inch.

2.12 RAIL TROUGH BACKFILL (BUILDING)

A. Fill trenches for tracks within shop buildings with Fox Industries FX-120 Grade Track Crossing, or approved equal.

2.13 ANCHOR ASSEMBLY

A. Threaded Studs

1. Partially - threaded studs shall be as shown, shall be 7/8 - inch diameter for plates in special trackwork and shall conform to ASTM A449 except that chemical requirements shall conform to ASTM A325 for Type 3 bolts, with the chromium, nickel, and copper elements in such combination to achieve maximum corrosion resistance consonant with strength and hardness requirement.
2. They shall be furnished with ASTM A325 nuts, DH Grade and Finish.
3. In addition, nuts shall be a type which provides a positive means of preventing loosening due to in-service vibrations, conforming to Industrial Fastener Institute Standards IFI - 100 and IFI - 101.
4. Studs shall have the embedded portion deformed to resist a nut removal torque of 250 foot - pounds minimum.
5. The studs, nuts and washers shall be galvanized or cadmium plated of such type and thickness as to achieve maximum corrosion protection without causing excessive embrittlement or galling.

B. Insulating Materials
   1. The insulating fiber washer and one piece fiber washer/sleeve shall conform to the requirements shown on the Contract Drawings and as specified herein.
   2. All insulating washers and sleeves shall conform to the requirements specified in the NEMA Standard Publication, LI-1 Grade G-10.

C. Double - Coil Spring Washers
   1. Double - coil spring washers for use in special trackwork shall be galvanized or cadmium - plated parallel coil spring washers as shown and specified.
   2. Using six randomly selected production double - coil spring washers, measure load vs. deflection from 1,000 pounds to 3,000 pounds in 200 - pound increments to determine the deflection or spring compression required to obtain 2,000 - pound bolt tension.

PART 3 - EXECUTION

3.01 PREPARATION

A. Bolted Joints (Bonded joint and standard joint installation):
   1. End-harden rail ends of standard rail as specified in Section 05651, General Track Construction.
   2. Remove rail brands which are located in joint bar rail contact areas. All rail brands shall be removed from the rail by grinding for the entire length of the joint bar.
   3. Rail welds shall be at least eight feet from the center of the joint.
   4. Drill rail holes in conformance with the Contract Drawings and AREMA Specifications or manufacturer's printed instructions using a template as the drilling guide. Debur field drilled holes.
   5. Calibrate bolt-tightening equipment by testing three typical bolts in a device capable of indicating actual bolt tension.

B. Fox Industries FX-120 Grade Track Crossing: Comply with manufacturer's requirements.

3.02 INSTALLATION:

A. Joints:
   1. Bonded insulated joints shall be installed at all insulated joint locations shown. The exact location will be furnished by the Engineer. No insulated joint, except within the limits of special trackwork, shall be installed without the Engineer's approval. All other joints shall be bonded standard joints. Bonded standard joints used to connect CWR strings shall be installed with negative return bonds.
   2. The bonded joint shall be supported by the appropriate direct fixation fastener or plate as shown.
   3. Additional preparation and the installation shall be in accordance with the manufacturer's recommendations. The manufacturer's recommendations will include procedures for sandblasting of rail and heat curing of assembled joints.
   4. All bonded joints shall be installed under the direct supervision of a qualified foreman.
   5. Bolted Standard Joints
      a. Standard joints shall be assembled with a full complement of bolts, nuts and spring washers. Before installing joint bars, rail surfaces to be covered by the bars shall be cleansed and coated with an oil or grease approved by the Engineer to prevent corrosion.
      b. Bolts shall be installed and the nuts threaded finger tight.

c. Bolt tension shall then be increased to 20,000 to 30,000 lbs. by use of a track wrench or power torque wrench. Bolts shall be tightened starting from the center bolts and working to the end bolts.

d. Bolts shall be tightened twice; first, after the track has been bought to approximately true alignment; second, immediately before the completion and final acceptance of the trackwork. Re-tightened track bolts shall be brought to a tension of 15,000 to 25,000 lbs.

e. Bolted standard joints used to connect CWR strings shall be installed with negative return bonds.

1) Negative return bonds shall be as specified in this Section's article for Negative Return Bonding.

6. Bolted Insulated Joints:

a. Installation shall be in accordance with the manufacturer's recommendations and as directed by the Engineer.

b. Rail surfaces within the insulated joint bars shall be clean and free of oil, dirt, rust and metal filings.

c. Joint Resistance Testing will be as specified in this Section's article for Insulated Joint Resistance Test.

7. Insulated Joint Resistance Test: All testing shall be witnessed by the WMATA Engineer.

a. Equipment: The insulated joint resistance test shall be conducted using the following Authority test equipment (See **Exhibit 05658-A**):

b. General Railway Signal (GRS) Track Quality Meter (TQM) 20182-36 GR.1.

c. Standard Resistance Test Fixture.

d. Acceptance Criteria: The insulated joint shall have a minimum resistance of 5,000 ohms.

8. Negative Return Bonding:

a. The Contractor shall furnish and install negative return bonds as specified and shown at all bonded standard joints used to join CWR strings.

b. Negative Return Bonds: Shall include two web type at each location.

c. Web Bond: Manufactured Bond, 500 KCMIL, stranded copper, single conductor, 2000 volt, UL Type RHW, 48 inches long insulated, as manufactured by Erico Products, Inc., fastened to rail wen with 5/8" compression fastener, Huck Manufacturing Co. C50LR-BR20-16 and terminal lug, Bundy Type, YA34-L, each end.

d. The Contractor shall install all negative return bonds in accordance with the manufacturer's instructions.

e. The Contractor shall submit installation procedures for approval.

f. The contact surfaces of the running rail web shall be cleaned on each side of mill scale, oil, grease or other foreign matter to near white finish.

g. Any raised lettering from the steel mill shall be ground flat with the adjacent surface.

h. Each negative return bond shall be installed with sufficient amount of slack to accommodate expansion or contraction.

9. Electrical Testing of Negative Return Bonding

a. The bond resistance of each negative bonded joint shall be tested by the Contractor to verify that it does not exceed 0.000050 ohms.

b. The Null Balance method of testing shall be employed utilizing the four terminal arrangement, two potential and two current terminals. The P1 and P2 leads shall be attached to the rail 46 inches apart and equal distance from the ends of the 500 KCMIL cable. The C1 and C2 current leads shall be attached to the rail approximately six inches outside of the P1 and P2 leads. The meter dials shall then be manipulated to achieve a balanced condition of the meter. This procedure is to be followed for each negative return bonded rail joint.

The resistance of each bonded rail joint shall be recorded and submitted to the WMATA Engineer. Bonds which exceed 0.000050 ohms shall be removed, replaced and retested. Reference Exhibit 05658-A.

10. Record of Field Connections
    a. A record of each bonded standard joint shall be submitted for review and approval by the WMATA Engineer.
    b. This record shall be in the format shown in Exhibit 05658-B.

B. Bumping Posts:
1. Prior to final acceptance, bumping posts shall be cleaned, sand blasted, primed, painted and lubricated as directed by the Engineer. Gauge transitions to provide the required track gauge for bumping posts installations shall be as specified for Section 05651, General Track Construction.
2. Bumping post shall be installed where shown and specified on the Contract Drawings.
3. Insulated joints shall be installed as shown and specified in the field installation drawings.
4. All holes in the running rails for bumping post installation shall be centered 2 - 7/8 inches above the base of the rail and shall be drilled in conformance with AREMA requirements.
5. Flame cutting of holes will not be permitted.
6. Prior to final acceptance, the Contractor shall make all adjustments directed by the WMATA Engineer to ensure that all bumping posts are in proper operating condition and ready for service.

C. Fox Industries FX-120 Grade Track Crossing: Comply with manufacturer's requirements.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

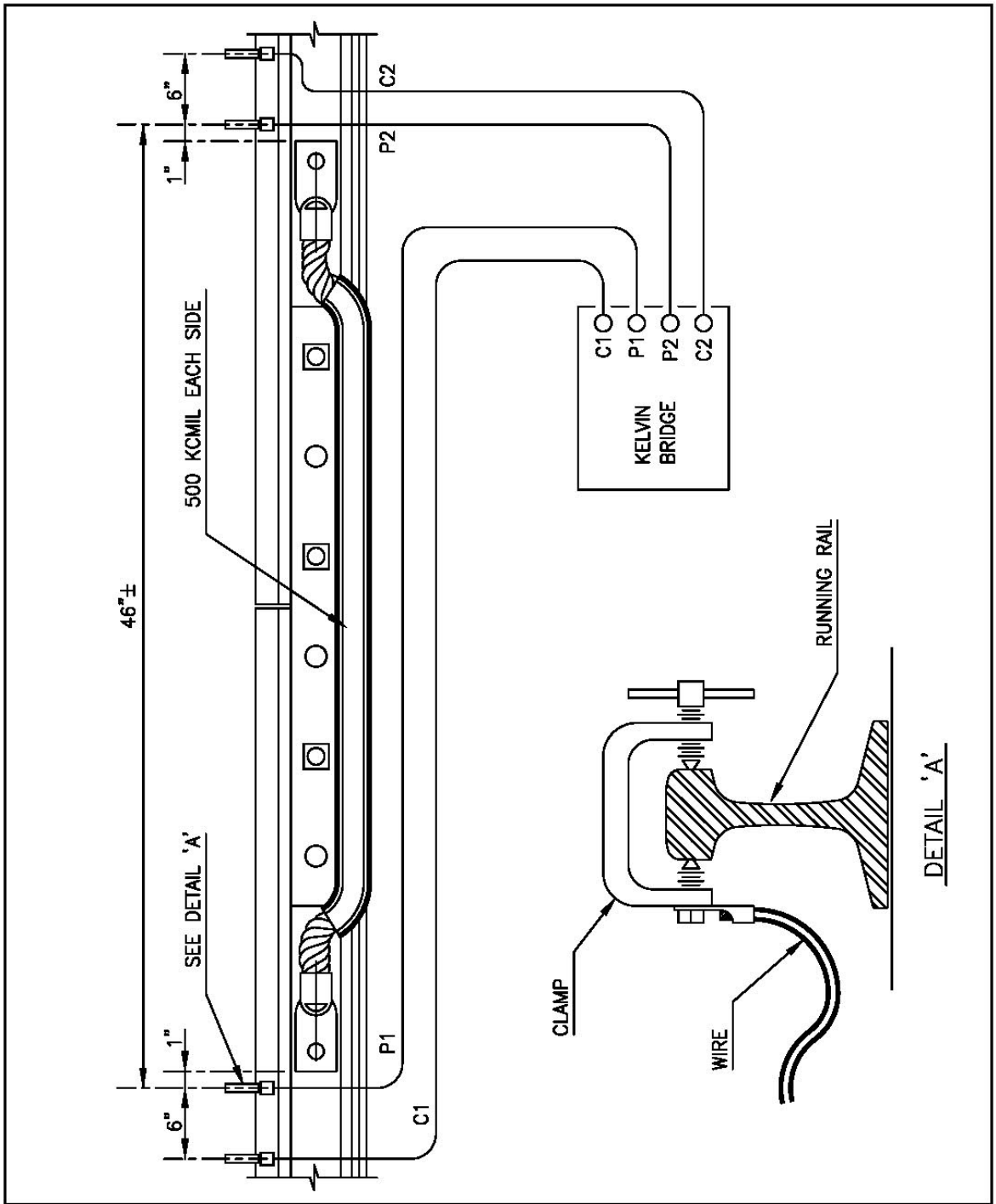
A. Measurement of work specified in this Section will be made in the following manner:

1. No separate measurement.

4.02 PAYMENT:

A. Compensation for work specified in this Section will be made in the following manner:

1. Included in the price of the work of which it is a part.



WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	NEGATIVE RETURN BOND RESISTANCE TEST EXHIBIT 05658–A

RECORD OF FIELD CONNECTIONS

DATE: _____

TIME: _____

TYPE OF CONNECTION: BONDED JOINT ☐

TRACK DESIGNATION: _____

LOCATION: STATION _____

RAIL STRING DESIGNATION: _____ AHEAD _____ BACK

MECHANICAL TEST: _____ PASSED _____ FAILED

BOND RESISTANCE: _____ OHMS

TYPE OF RAIL: HIGH STRENGTH STANDARD (CIRCLE ONE)

MANUFACTURER OF BONDED JOINT _____

AIR TEMPERATURE: _____

RAIL TEMPERATURE: _____

WEATHER CONDITIONS: _____

TRACK ALIGNMENT AND CONSTRUCTION: _____

(CURVE, TANGENT, GRADE, ETC.)

NAME OF ENGINEER OR REPRESENTATIVE PRESENT: _____

NAME OF CONTRACTOR'S FOREMAN PRESENT: _____

NAME OF MANUFACTURER'S REPRESENTATIVE PRESENT: _____

CONTRACTOR'S REPRESENTATIVE: _____

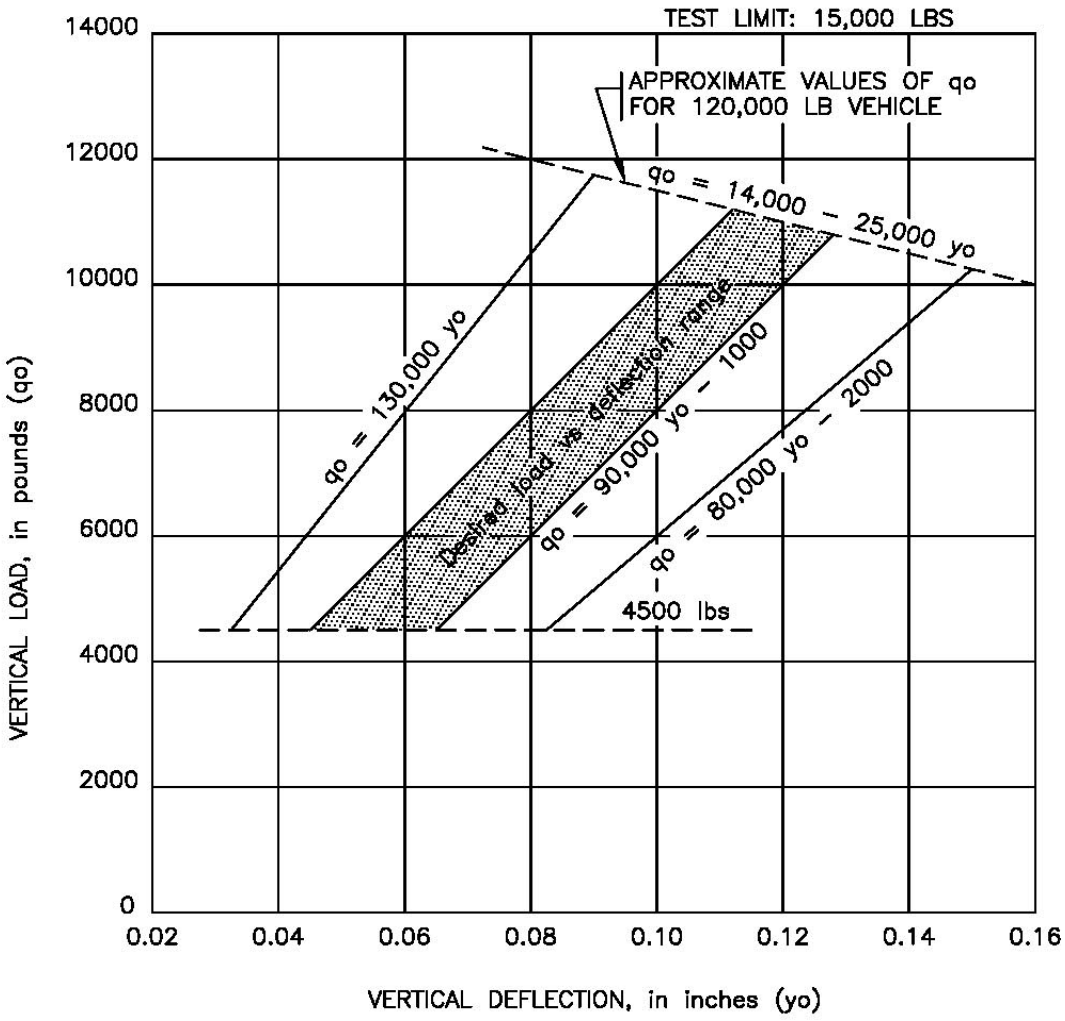
(SIGNATURE)

AUTHORITY REPRESENTATIVE: _____

(SIGNATURE)

WASHINGTON METROPLITAN AREA TRANSIT AUTHORITY

DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	RECORD OF FIELD CONNECTIONS EXHIBIT 05658–B



NOTES:

1. MAXIMUM DEFLECTION AT TEST LIMIT SHALL NOT EXCEED 25% OF THE UNCOMPRESSED THICKNESS OF ELASTOMER PAD.
2. FASTENER SPRING RATE MUST BE BETWEEN 80,000 LBS/IN. AND 130,000 LBS/IN. FOR ALL LOADS BETWEEN 4,500 POUNDS AND THE LINE INDICATING THE APPROXIMATE VALUES OF qo FOR A 120,000 POUND VEHICLE.

WASHINGTON METROPOLITAN AREA TRANSIT AUTHORITY	
DEPARTMENT OF TRANSIT SYSTEM DEVELOPMENT OFFICE OF ENGINEERING & ARCHITECTURE	VERTICAL LOAD TEST ACCEPTANCE CRITERIA EXHIBIT 05658–C

END OF SECTION

SECTION 05659

SPECIAL TRACKWORK

PART 1 - GENERAL

1.01 SECTION INCLUDES

A. This Section specifies manufacture, fabrication, shop assembly, inspection, testing, packaging and shipping special trackwork materials.

B. Special trackwork shall include components for installations in both ballasted and direct fixation track.

C. This Section also specifies fabricating and furnishing guarded turnouts as shown and specified.

1.02 RELATED SECTIONS

A. Section 05651 - General Track Construction

B. Section 05652 - Ballasted Track Construction (BTC)

C. Section 05653 - Direct Fixation Trackwork Construction (DFTC)

D. Section 05654 - Special Trackwork Construction - Ballasted

E. Section 05655 - Special Trackwork Construction - Direct Fixation

F. Section 05656 - Running Rail

G. Section 05657 - Direct Fixation Rail Fasteners

H. Section 05658 - Track Appurtenances and Other Track Material

I. Section 06130 - Timber Ties

J. Section 06131 - Composite (Plastic) Ties

1.02 REFERENCES

A. Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

1. American Railway Engineering and Maintenance-of-Way Association, Manual for Railway Engineering, herein referred to as the AREMA Manual, latest edition.
2. American Railway Engineering and Maintenance-of-Way Association, Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio, latest edition.
3. American Society of Testing and Materials (ASTM)
4. Association of American Railroads (AAR) Signal Manual
5. American Council of Independent Laboratories' Manual of Practice
6. American Welding Society (AWS)
7. Industrial Fastener Institute (IFI)

1.04 QUALITY ASSURANCE/CONTROL

A. Quality Assurance Program - Refer to Section 05651, General Track Construction, and conform to the requirements of the Quality Assurance Program.

B. Quality Assurance Program must be submitted to the Authority and must be consistent with ISO 9001.

C. Tolerances: Conform to the AREMA Portfolio - Plan No. 1010-89, Permissible Variations in Completed Frogs; Plan No. 1011-84, Permissible Variations in Completed Switches; the AREMA Manual, Section 7, and the AREMA Manual, Section 5, in all aspects unless modified by the contract documents.

D. Codes, Regulations, Reference Standards and Specifications:

1. Except as modified in the contract documents, design, manufacture, test, assemble, inspect, ship, unload and stack special trackwork in accordance with the AREMA Portfolio and the AREMA Manual. After approval by the Engineer, match mark all components and package as specified.
2. Contractor's checklist/measurement report shall be provided. The checklist shall be completed and submitted to the Engineer for approval prior to shipping any special trackwork.
3. Except as modified in the contract drawings, use rail in the special trackwork conforming to the requirements of the AREMA Manual, Chapter 4, and Section 05656, Running Rail.\

E. WMATA, or its representatives, reserve the right to visit the producers facility during usual business hours unscheduled to a) observe sampling and testing procedures, b) obtain samples of the prepare material being produced and shipped, and c) review plant inspection methods, quality control procedures, equipment and examine test results of current and previous tests.

1.05 TESTING

A. Notify the Authority in writing not less than 14 days in advance of dates scheduled for any test. The Authority retains the right to witness testing. Do not conduct test until authorized by the Authority.

B. Testing Laboratory:

1. Perform qualification and production quality control tests using either an independent testing laboratory or a qualified manufacturer's laboratory reviewed by the Authority. If an independent testing laboratory is selected, it shall be a member of the American Council of Independent Laboratories. If a manufacturer's laboratory is selected, it shall satisfy the requirements of the American Council of Independent Laboratories' Manual of Practice - Quality Control System - Requirements for A Testing and Inspection Laboratory, and ASTM E329.
2. The selected laboratory shall use the proper equipment and qualified personnel for testing such as described in this Section.

C. Testing Equipment: Provide equipment in good operating condition, of adequate capacity and range, and accurately calibrated. Use testing equipment that is in calibration with standards which are certified and traceable to the National Bureau of Standards within one year immediately preceding the test date. Submit copies of calibration certificates with test reports.

D. Documentation: In conjunction with the specified tests, submit the following documents for review:
   1. Test program plan: In this plan, identify Contractors' approach for accomplishing each of the specified qualification and production quality control tests. Include the projected schedule for test procedure submittals, test executions, and test results report submittals.
   2. Test procedures for each test, describing the objective, equipment, and instrumentation that will be used, procedure to be implemented, and the anticipated results. Include working drawings detailing test equipment and set-up of direct fixation rail fastener that will be tested.
   3. Test report:
      a. A separate report of test results for each test which includes original data calculations, test procedure references, test equipment identification, test personnel, date of test, specified requirements, actual test results, nonconformance if any, and interpretation of the results. Highlight conformance or deviation in a report summary.
      b. Accompany the written test reports with a photographic record of the tests. Include photographs of sufficient clarity to distinguish relevant details as described or referenced in the respective written report.

1.06 PRODUCTION QUALITY CONTROL TESTS OF INSULATION PIECES

A. Test insulated gauge plates and switch rods in accordance with AAR Signal Manual, Part 14.5.3.

1.07 SUBMITTALS

A. Refer to Section 01300, Submittals.

B. Shop drawings for special trackwork components, including the following
   1. Insulated curved split switches, including stock rails.
   2. Insulated switch rods, including clip assemblies.
   3. All insulation materials, parts and assemblies.
   4. Closure rails, turnout rails and connecting rails as provided in the contract documents.
   5. Frog and frog guard rails.
   6. All special plates, including details of components.
   7. Switch panel details.
   8. Rail braces and housing chairs.
   9. Direct fixation rail fasteners, including details of components.
   10. Complete layouts and details for all types of turnouts, single crossovers, double crossovers, and crossing diamonds.
   11. Installation drawings for each type of assembly used during construction.

C. Product data:
   1. Certification of the procedure used in the depth hardening of frog castings.
   2. Test data for the rail used in all fabrication for compliance with AREMA and these specifications.

D. Refer to Section 01322, Certificates and Reports, and submit the following:
   1. Certificates of material compliance required by AREMA and this Specification.
   2. Test reports of chemical analyses, Brinell hardness, electrical insulation, and other tests required by AREMA and this Specification.
   3. Frog depth hardening results

E. Testing laboratory, testing equipment, test program plan, test procedures and test reports for the direct fixation rail fasteners, including the following resting laboratory information for review by the Authority prior to testing:
   1. Name and address of the laboratory
   2. A description of the facilities and testing equipment that will be assigned for this testing.
   3. Names, experience, and qualifications of the personnel that will be laboratory's experience in performing this testing.
   4. For the testing of the direct fixation rail fasteners, a list of the laboratory's experience in testing this type of rail fasteners or fastener - like assemblies

F. A certified copy of reports on the analyses and tests required by referenced ASTM specifications.

G. Contractor's method for locating all special plates, not in the switch panel, which span two or more ties, drilling the ties and holding the plates in place during shop assembly and inspection.

H. Configuration and method of fabrication for switches.

I. Check list or measurement report for all switches and frogs approved by the Engineer. This shall show the design size and allowable tolerance required by AREMA, or as shown and specified in these contract documents, as well as the actual size.

J. Detailed description of the procedure for bonded insert and bonded joint installation approved by the Engineer.

K. Method of packaging and loading each unit approved by the Engineer.

1.08 PREASSEMBLY

A. Completely assemble, prior to shipment, the turnouts, crossing diamonds, and crossovers in Contractor's fabrication shop for inspection by the Contractor's Quality Control (QC) Staff, For mainline turnouts and crossovers, assemble on the specified switch ties and/or the direct fixation fasteners which will be incorporated into the Work.

B. Fully bolt and assemble rail joints for all turnouts. For inspection, use temporary joint bars with "C" clamps for shop assembly. Install 3/16 inch end post shim where insulated joint bars are indicated. Do not apply adhesive during this process.

C. No bracing, wedging, or support blocking will be permitted to hold components to proper gauge and alignment.

D. Variations from the Authority reviewed shop drawings or other contract documents will constitute noncompliance and will not be accepted for shipment unless or until proper modification are made and reviewed by the Authority.

E. Make available to the Authority, without charge, the facilities and assistance to examine the work during its progress, and when the product is finished, to satisfy the Authority that the finished product will comply with the contract documents. Provide templates and one yard straight edge or longer, as necessary, to check flangeways, rail end drilling, switch rail planing, and other features of the Work usually checked by templates.

F. Present material for inspection in a safe area away from excessive noise and manufacturing activities. Provide labor to facilitate inspection of the top, side and bottom of frogs and switches.

G. With minimal bar pressure acting on the switch rail at rod number 1, 25% or more of the switch point contact length, starting from the tip of the point, shall make positive, firm contact with the ball of the stock rail.

H. With no pressure acting on the switch rail, the maximum allowable spring back between the switch point and the ball of the stock rail shall be 3/16 inch, measure six inches back from the tip of the point.

I. For inspection and review, match mark rails in appropriate colors, and sequentially number fasteners or switch ties, in accordance with the Authority reviewed System. Submit the match marking and numbering system on the Contracting Drawings for the Contractor's QC Staff before match marking and numbering commences.

J. Provide the record of the Contractor's completed turnout inspection checklist to WMATA.

PART 2 - PRODUCTS

2.01 GENERAL REQUIREMENTS

A. Special trackwork materials, including oval-neck track bolts of one-inch nominal diameter, nuts and spring washers, and special trackwork assemblies shall be in accordance with AREMA except as modified on the contract drawings and specifications.

B. Rail, switches, frogs and other track material shall be in accordance with AREMA dimensional requirements for 115 RE rail section except as modified on the contract drawings and specifications.

C. Heel ends of switch rails, and ends of stock, closure and connecting rails shall be beveled in accordance with AREMA requirements.

D. Cut all rail ends in accordance with AREMA requirements except that tolerance to be taken up in the rail base.

E. Drill rail ends to receive 36-inch, six-hole joint bars in accordance with AREMA and as shown. Standard joints shall be drilled to allow butting of rail ends. Insulated joints shall be drilled to allow for a 3/8-inch end post. Drill holes in accordance with joint manufacturers instructions, plus or minus 1/32-inch.

F. All rail shall be in accordance with Section 05656, Running Rail.
1. Guard rails: 132 RE section.
2. All other rail: 115 RE section.

G. Drill and ream holes with edges beveled.

H. All joints required for installation shall be new material.

I. Supply all ties in accordance with Section 06130, Timber Ties or Section 06131, Composite (Plastic) Ties.

2.02 STOCK RAILS, CLOSURE RAILS AND CONNECTING RAILS

A. Length: As shown plus or minus 1/8-inch.

B. All ends drilled except ends to be connected to CWR which shall be drilled in the field.

C. Standard Rail and weight shall be new 115 RE rail section, and shall be in conformance with AREMA recommended rail sections, 115 RE rail section and specifications for steel rails, (latest edition).

D. Rail lengths as identified in the contract documents. The standard rail length of rails shall be either 39, 78 or 80 feet.

E. Refer to Section 5656.2.01 for physical characteristics of running rails.

2.03 FROGS

A. Railbound manganese steel construction as shown

B. Frog casting
1. Depress heel of manganese frog casting in accordance with AREMA Plan 617-89.
2. Depth-harden impact areas of manganese frog castings.

C. Frog inserts
1. Cast inserts of carbon steel in accordance with AREMA Specification M3.
2. Provide inserts of one-piece construction.
3. Provide inserts having full-face contact conforming to configuration of 115 RE rail.
4. Provide available bonding area per inch of length equivalent to that available for bonded standard joints where applicable. Adjust dimensions of bonded inserts to allow for glue and fabric.
5. Ensure the inserts are smooth and straight and do not exceed the following permissible variations:
   a. Width between rail webs: Plus or minus 1/32-inch of that shown.
   b. Depth of flangeway groove: Plus or minus 1/16-inch of that shown.
   c. Length of insert: Plus or minus 1/8-inch of that shown.
   d. Straightness of all portions of inserts adjacent to rail using 36-inch straightedge: Plus or minus 1/32-inch.
   e. Finishing height variance of inserts from that required for bonding area: Plus or minus 1/64-inch.

D. Assembly: Prior to delivery, assemble frogs as shown.
1. Bonding adhesive: As manufactured for bonded joint bars by Allegheny Drop Forge Company, Portec, Inc. or equal, applied as directed by the manufacturer to all contact surfaces between inserts and rail.
2. Secure frog, except for insert, with 1-3/8 inch diameter high -strength bolts in accordance with AREMA requirements.
3. Assemble inserts with 1-1/8 inch diameter high-strength bolts, ASTM A490, and lock nuts. Position bolt holes in accordance with AREMA Plans 621-89 and 1010-89 and as shown. Bolt holes 1-3/8 inches in diameter plus or minus 1/32- inch.
4. Flat washers: ASTM F436.
5. Equip bolts as shown with one beveled or flat headlock washer and one flat or beveled washer to provide square bearing and to permit tightening of nuts by wrench.
6. Lock nuts: IFI-100 and IFI-101, ASTM A563, Grade C.
7. Tension bolts to between 75 percent and 85 percent of proof load. Exact value as directed by the Engineer. Ascertain bolt tension by means of torque wrench. Determine desired torque by test similar to that described in IFI-101.

2.04 FROG GUARD RAILS

A. Length: 12'-6"

B. Complete with blocks and bolts as shown.

2.05 SWITCHES

A. Minimum yield strength: 95,000 psi.

B. Switch Rails: As shown.
   1. Switch rails and stock rails: In accordance with Section 05656, Running Rail, and AREMA Plan 221-62, Detail 5100.
      a. Stock rails may be thick web or constructed with reinforcing bars.
      b. Stock rail lengths: as shown or as required for switch panel..
   2. Bolts, rivets, fittings and spring washers in accordance with Appendix A of the AREMA, Portfolio.
      a. Fabricate five bolt heel joint assembly in accordance with AREMA Plan 221-62 and AREMA Manual.
      b. Fabricate forged steel rail stops in accordance with AREMA requirements.
      c. Switch inserts with bolts: As specified for frog inserts.

C. Drill stock rails for ballasted special trackwork as shown. Switch heaters will be furnished and installed by other trades.

D. Floating heel blocks for No. 10 and No. 15 switch as shown.

E. Floating heel block for No. 8 guarded switch as manufactured by Rail Products and Fabricators or equal.

F. The guarded turnouts shall have a modified five bolt hell joint assembly to accommodate the stock rail, switch rail and guard rail in accordance with AREMA Plan 221-62 and AREMA Specifications.

2.06 SWITCH RODS

A. Switch rods and clips of vertical design, Type MJS, modified as shown.
   1. Insulated construction.
   2. Assembled.
   3. Test in accordance with AAR requirements.
   4. Length: As shown.

B. Switch rods must be capable of at least one (1) inch plus/minus adjustment after the initial specified 5 inch throw has been set.

C. Contractor's shop drawings shall provide the required spread measurement for each switch rod which are needed to support the specified throw.

2.07 RAIL BRACES

A. Boltless adjustable brace equal to those formerly manufactured by Bethlehem Steel, modified to permit installation of one inch diameter electric switch heaters on rail web of ballasted turnouts.

B. Shop weld rail brace backing blocks to switch plates.

C. Rail brace backing blocks to permit mounting on 3/4-inch thick flat plates. Allow for modification to fit 1/4-inch recessed gauge plates. Ensure that distance from rail base to horizontal bearing surface of backing block is the same in each case to permit use of standardized wedge.

D. Clearance between backing block and rail base: Determined by design of selected brace.

E. Brace shall use left-hand Pandrol spring clips e2056.

2.08 PLATES

A. Furnish special trackwork units with special plates as shown, fabricated of 3/4-inch thick steel, ASTM A36 in accordance with designs shown or AREMA requirements.

B. Plates complete with specified rail base backing blocks, riser plates, rail stops and rail clamp blocks welded thereon.

C. Riser plates and rail stops fabricated of ASTM A36 steel as shown and as specified.

D. Punch holes in each plate perpendicular to face. Cut clean without torn or ragged edges.

E. Straighten plates cold in press or roller until surface and line requirements are met. The following tolerances are not cumulative.
1. Plate thickness: Plus or minus 1/32-inch.
2. Middle ordinate: Place plate on horizontal support. Place straightedge or wire string from one end of plate to the other on the concave side. Measure distance between plate surface and straightedge or string line. Distance not to exceed 0.001 inch per inch of length with surface upsweep or downsweep uniform.
3. Plate thickness of dual rail stops, single rail stops and riser plates: Plus or minus 1/32-inch.
4. Straightness of edge of dual rail stops, single rail stops and riser plates parallel and adjacent to base of running rail: Plus or minus 1/32-inch.
5. Transverse dimension of dual rail stops: Plus or minus 1/32-inch.
6. Tolerances other than those specified: Plus or minus 1/8-inch.
7. Spike hole locations for ballasted special trackwork: Plus or minus 1/8-inch.

F. Identification of plates:
1. Stamp with suitably sized characters not less than 1/2-inch in height, located on top surface and plainly visible when assembled.
2. Include Contract Number and identification designation as shown.

G. Fillet weld rail braces, rail stops, riser plates and rail clamps to their respective plates as shown in accordance with AWS D1.1.

H. In special trackwork fabricated for ballasted trackwork, seven inch wide elastic fastener tie plates suitable for e2056 Pandrol spring clips shall be used at all support locations not having special frog, switch, gauge or guard plates.

2.09 GAUGE PLATES

A. Switch gauge plates as shown and as specified for plates.

B. Insulation shall be a four hole 7-1/2" x 8" x 3/4" epoxy fiberglass splice block fastened to the plate with Huck type compression fasteners. The insulating material shall have a tensile strength of 70 ksi, compressive strength of 100 ksi and a tensile modulus of 3.4×10^6.

2.10 TURNOUT GUARD RAIL

A. Length: As shown.

B. Complete with blocks and bolts as shown.

C. Type: 132 RE rail.

D. Planned in accordance with AREMA Plan No. 504-89.

2.11 RAIL JOINTS

A. Furnish all standard and insulated joints within the turnout.

B. End post shall be reinforced epoxy fiberglass or approved equal.

2.12 GUARDED TURNOUTS

A. Guard Rail Stop:
   1. Ductile Iron: ASTM A536, Grade 65-45-12 to fit 115 RE rail and as supplied for NYCTA guarded turnouts.
      a. Direct Fixation Turnouts:
         1) Ductile iron rail stops shall be attached to the steel plate with 7/8" square neck carriage bolts, ASTM A325, inserted through a square punched hole from the underside of the plate. A heavy hex nut, Grade 3 ASTM 563 and flat washer, weathering steel ASTM F436 shall complete the assembly; three bolts, nuts and washer per rail stop.
   2. Ballasted Turnouts:
      a. Ductile iron rail stops shall be attached to the tie and plate; three studs with nuts and washers per rail stop. Cast rail stops and house chairs shall be fastened through the ties with 7/8 " diameter double end threaded studs, flat washers and heavy hex nuts. The nuts and washers shall be fastened to the stud on the underside of the tie and on top of the casting similar to NYCTA guarded turnouts.
   3. The rail stop shall be backed with a 6" x 2" x 1/2" steel block welded to the rail plate.

B. Manganese Housing Assembly:
   1. Cast manganese steel: AREMA Manual.
   2. Housing: Similar to that manufactured for the NYCTA.
      a. Direct fixation - 6' - 2 1/2" long.
      b. Ballasted track - 5' - 5" long.
   3. Housing Chairs: Ductile Iron ASTM A536 Grade 65-45-12, as manufactured for NYCTA.
      a. Direct fixation housing chairs shall be fastened to steel plates and gauge plates similar to ductile iron rail stops, except that one hole, as shown, in each chair shall be sized for an anchor assembly instead of the square neck carriage bolt.
      b. Ballasted housing chairs shall be fastened to ties, steel plates and gauge plates similar to ductile iron rail stops.

c. The first housing chair number shall be configured for bolting to a 132 RE guard rail which continues ahead of the point of switch as shown.

4. No part of the housing shall extend more than 1-1/2 inches above the top of rail.

2.13 ELASTOMER PADS

A. Elastomer pads shall be furnished for use under special plates in special trackwork shall be fabricated from polychloroprene (neoprene) as shown and as specified below.

B. Physical Characteristics

1. Elastomer pads shall be 3/4 inch thick and extend 1 inch beyond the plate edges on all sides.
2. All pads shall have a Durometer A hardness of 50 in accordance with ASTM D2240.
3. Elastomer pads furnished for use under all special plates shall be cut from a uniformly cored sheet conforming to the following requirements:
   a. Coring shall consist of cylindrical holes 11/16 inch in depth. A continuous membrane 1/16 inch thick shall close one end of all holes.
   b. Cored holes shall be 1-5/8 inches on center measured between adjacent holes in all directions.
   c. Anchor bolt holes, 1-5/8 inch in diameter, shall be cut at the required locations on the pad.
   d. Tolerances for finished pads shall be as follows:
      1) Length and width: Plus or minus 1/4 inch.
      2) Thickness: Plus or minus 0.03 inch.
      3) Squareness: Plus or minus 1 degree.
      4) Centering of holes: Plus or minus 1/32 inch.
      5) Diameter of holes: Plus or minus 1/32 inch.
      6) Durometer: Plus or minus 5 points.
   e. The diameter of the core holes shall be as follows:
      1) Pads for use under all special plates having a longitudinal dimension greater than 12 inches measured along the rail shall have a diameter of 1 - 1/8 inch.
      2) Pads for use under plates having a longitudinal dimension measured along the rail equal to or less than 12 inches shall have a diameter of 3/4 inch.

C. Testing of Elastomer Material

1. The following test shall be performed on each of two pads or on specimens taken from two pads that are identical in all respects to the elastomer proposed for use in special trackwork. All testing shall be at no expense to the Authority.
2. In the event specimens cannot be taken from finished pads, samples certified by the supplier to have been taken from a batch of compound used for making the elastomeric component and having a cure equivalent to the cure of the elastomer component shall be used for the tests.
   a. The elastomer shall be tested in accordance with ASTM D412, to determine the tensile strength and the ultimate elongation. The tensile strength shall be not less than 1500 psi and the ultimate elongation shall be not less than 350 percent.
   b. The elastomer shall be tested for 22 hours at 100C in accordance with ASTM D395, Method B, to determine the percent of compression set. The compression set shall not exceed 30 percent.
   c. The elastomer shall be aged for 336 hours at 70C in accordance with ASTM D573. The change of hardness and the percentage of change from the original tensile strength and original ultimate elongation shall not exceed 40 percent. The change in hardness, measured on the Durometer A scale shall not exceed 10 points.

d. Test specimens shall be prepared in accordance with Procedure A of ASTM D518. The test specimens shall be tested in accordance with ASTM D1149, at a temperature of 40C, and at an ozone concentration of 50 pphm. The elastomer shall not exhibit any cracking when examined in accordance with ASTM D1149 at the end of a 100 hour exposure.

e. The elastomer shall be tested at minus 10C for 94 hours in accordance with ASTM D1229, to determine the percent compression set at 30 minutes after release (t30 reading). The compression set shall not exceed 50 percent.

f. One test for oil absorption shall be conducted with ASTM No. 3 oil at 100C for 70 hours and another test using a different sample shall be conducted with ASTM No. 1 oil at 100C for 70 hours in accordance with ASTM D471, to determine the volume change of the elastomer. The volume change for the No. 1 oil shall not exceed minus 10 or plus 20 percent. The volume change for the No. 3 oil shall not exceed 100 percent all not exceed 100 percent.

g. Prior to commencing production of elastomer pad sheets, a prototype pad, using the chemical composition intended for production pads, shall be prepared and tested using a one inch by eight inch by one foot nine inch steel plate with two special plate anchorage assemblies two inches from the edges of diagonally opposite corners. The plate and the prototype pad shall be assembled, mounted on a reinforced concrete slab simulating actual field conditions, and subjected to the following tests.

    1. A vertical load increasing in increments of 1000 pounds to a maximum load of 15, 000 pounds shall be applied downward at the center of plate normal to the plate. For each load the vertical deflection of the center of the plate shall be measured to the nearest 0.001 inch and recorded. The load shall be removed and the final position of the plate measured and recorded. The recorded values for vertical load and deflection shall be plotted on a graph as illustrated in Specification Section 05658, **Exhibit 05658-C.**

    2. The load vs. deflection curve shall lie within the envelope illustrated in Specification Section 05658, **Exhibit 05658-C** for loads in the range from 4,500 pounds to the load corresponding to a 120,000 pound vehicle. Throughout that loading range, the spring rate of the fastener, slope of the load-deflection curve, shall not be less than 80,000 pounds per inch or more than 130,000 pounds per inch and shall be of a constant slope within 10 percent. In the event the curve fails to meet the requirements specified above, the chemical formulation of the pad, the coring size, or both shall be modified and the new elastomer pad design retested.

    3. An electrical resistance test with one anchor bolt grounded, 100 volts dc shall be applied to the rail head for three minutes. The actual current flow shall be measured to the nearest 0.1 microampere and recorded. Then 1000 volts dc shall be applied to the rail head for two hours, after which 100 volts dc shall be applied again for three minutes and the actual current flow shall be measured, as above, and recorded. A potential of 50 volts rms ac shall be applied to the rail head for three minutes for each increment of measurement for frequencies from 20 Hertz to 10 kilohertz in increments of measurement of 20 Hz up to 100 Hz; 200 Hz up to 1000 Hz; and 2000 Hz up to 10 kHz. The impedance after three minutes shall be determined with an accuracy of plus or minus two percent and recorded for each frequency.

The maximum current for 100 volts dc shall be 1.0 microampere. The minimum impedance for any frequency with 50 volts rms ac shall be 10,000 ohms.

2.14 SEPARATOR BLOCKS

A. Separator blocks shall be five inches long made of steel or cast iron configured for a 1-7/8 inch flangeway between 115 RE running rail and 132 RE guard rail.

B. Connect separator blocks with a 1-3/8 inch high strength, square head bolt, spring washer and heavy hex nut with one beveled or flat headlock washer and one flat or beveled washer to provide square bearing and to permit tightening of nuts by wrench.

2.15 GUARD RAIL JOINTS

Except for the insulated joint shown in the rail layout diagram, joints in the guard rail shall not be nearer than four (4) feet to a joint in the 115 RE running rail.

2.16 TIMBER TIES

See Specification Section 06130.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Direct Fixation Special Trackwork Fabrication
   1. Fabrication of special trackwork for direct fixation track shall be as specified and shall comply with the applicable related Sections:
      a. General Track Construction (GTC), Section 05651.
      b. Direct Fixation Trackwork Construction (DFTC), Section 05653.
      c. Special Trackwork Construction - Direct Fixation, Section 05655.
      d. Direct Fixation Rail Fasteners, Section 05657.
   2. Tolerances
      a. The final gauge, cross level, superelevation, horizontal alignment and vertical alignment of direct fixation special trackwork shall be as shown and specified. Tolerances shall be as specified for direct fixation track construction for GTC. Switch points in normal position shall be square within 5/8 inch.

B. Ballasted Special Trackwork Fabrication
   1. Fabrication of special trackwork for ballasted track shall be as specified and shall comply with the applicable related Sections:
      a. General Track Construction (GTC), Section 05651.
      b. Ballasted Track Construction (BTC), Section 05652.
      c. Special Trackwork Construction - Ballasted, Section 05654.
      d. Track Appurtenances and Other Track Material, Section 05658
      e. Timber Ties, Section 06130
      f. Composite (Plastic) Ties, Section 06131.
   2. Tolerances
      a. The gauge, cross level, superelevation, and horizontal and vertical alignment of ballasted special trackwork shall be as shown and specified. Tolerances shall be as specified for ballasted track construction for BTC. Switch points in normal position shall be square within 5/8 inch

b. Screw spike holes drilled in ties shall be 11/16 inch diameter and not less than five inches nor more than six inches deep.
c. Tolerance of plus or minus 1/16 inch shall be maintained for the distance between screw spike holes.
d. Tolerance of plus or minus 1/8 inch shall be maintained in the centering of screw spike holes across the width of the tie.

3. Ties shall be bored for screw spikes, and only screw spikes will be permitted in special trackwork.
4. The number and locations of holes shall conform to the location and number of screw spikes shown for each special plate.
5. Elastic fastener tie plates shall have four screw spikes, one at each corner.
6. Boring of holes in excess of those required will not be permitted.
7. Boring in timber ties shall be performed with the heartwood face down. Holes bored in timber ties shall be treated with pentachlorophenol oil immediately after boring.
8. Holes shall be located so that each tie plate will be centered on the tie at a right angle to the rail.
9. Prior to installing tie plates, the surface of the tie shall be swept clean to allow full bearing of the plate on the tie.
10. Boring and spiking will ensure that the outside shoulder of the plates will have full bearing against the rail base when the rails are at proper line and gauge.
11. Spikes shall be started vertically and square, and shall be installed straight. Straightening of spikes will not be permitted. Spikes bent during installation shall be withdrawn and the holes plugged (with treated tie plugs if wood, as per manufacturers instruction if composite). Screw spikes shall be installed firmly to the top surface of the plates.
12. All special plates, not in the switch panel, which span two or more ties shall not be spiked during shop assembly to preclude un-spiking for disassembly and packaging. The Contractor's method for locating these plates, drilling the ties and holding the plates in place during shop assembly and inspection shall be approved by the Engineer.

C. Identification Numbers:
1. As shown on the drawing, each turnout has an identification number. This number shall be stamped on a metal tag and the tag affixed to each panel and separate component bundle.
2. Tags shall be made of corrosive-resistant metal such as anodized aluminum or brass. Fastening nails shall be of the same material as the tags. Numbers shall be stamped in characters ½ inch minimum in height. Tags shall be a minimum of .050 inches thick, 1-1/4 inches wide and two inches long.

D. Package and label parts and replacement materials in moisture-proof containers suitable for shipment and storage.

E. Take special care to package anchor inserts for direct fixation rail fasteners, so as to prevent damage to the epoxy coating.

F. Submit method of packaging to the Contractor's QC Staff for acceptance before shipping the anchor inserts.

G. Attach copies of shipping list in the package and so that the list is readable from the exterior of the package.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

A. Measurement of work specified in this Section will be made in the following manner:
   1. No separate measurement.

4.02 PAYMENT:

A. Compensation for work specified in this Section will be made in the following manner:
   1. Included in the price of the work of which it is a part.

END OF SECTION

SECTION 05660

RESTRAINING RAIL AND LUBRICATORS

PART 1 GENERAL

1.01 SECTION INCLUDES

A. Furnish, fabrication and installation a restraining rail system.

B. Furnish and install the lubricators to include concrete pads, lubrication distribution system, track connections and testing.

C. Furnish and install all required electrical work for the lubrication system.

1.02 RELATED SECTIONS

A. Section 05651- General Track Construction

B. Section 05652 - Ballasted Track Construction

C. Section 05653 - Direct Fixation Track Construction

D. Section 05656 - Running Rail

E. Section 05658 - Track Appurtenances and Other Track Material (OTM)

F. Division 16 - Contact Rail Sections

1.03 REFERENCES

A. Pertinent provisions of the following listed standards and publications shall apply to the Work, except as they may be modified herein, and are hereby made part of these Specifications to the extent required.

1. American Railway Engineering and Maintenance-of-Way Association (AREMA), Manual for Railway Engineering, herein referred to as the AREMA Manual, latest edition.
2. American Railway Engineering and Maintenance-of-Way Association (AREMA), Portfolio of Trackwork Plans, herein referred to as the AREMA Portfolio.
3. American Society for Testing and Materials (ASTM):
4. National Electric Code (NEC) and regulations of the jurisdictional authorities.
5. Insulated Cable Engineers Association (ICEA)
6. National Electrical Manufacturers Association (NEMA)
7. Institute of Electrical and Electronics Engineers (IEEE)
8. Underwriters Laboratories (UL)
9. Military Specifications (MIL or MILSPEC)

1.04 SUBMITTALS

A. Submittals shall be as specified in Section 01300, Submittals.

B. Submit a list of proposed suppliers, of all components within 90 days of notice to proceed. Subsequent changes in proposed suppliers shall be submitted as they occur.

C. Submit the following to the WMATA Engineer for approval at least 120 days before the anticipated rolling dates.

D. Date schedule of 132 RE rail production, inspection, shipment and final delivery.
1. Detailed description of the steel metallurgy
2. Lengths in which the restraining rail section will be provided.
3. Description of the method and verification testing to achieve the required rail hardness.
4. Detailed description of the metallurgy and method of fabrication of the mounting brackets.
5. Detailed description of other components used in the restraining rail and guard rail assemblies including but not limited to shims, bolts, washers, nuts, etc.

E. Provide two sample bracket assemblies (unpainted), each consisting of one bracket with one foot of restraining rail and all necessary hardware.

F. Submit the method of handling and shipping for review and approval at least four (4) weeks before shipping of 132 RE rail and accompanying brackets and hardware.

G. Submit the marking scheme for restraining rail and guard rail identification for installation not less than 30 days before fabrication.

H. Provide processing reports and a list showing the heat and ingot for every piece for informal review during the in-plant inspection and formally submit the same information to the WMATA Engineer.

I. Provide test records, including mechanical properties tests, hardness measurements, ultrasonic test records and all other required test documentation, for informal review during the in-plant inspection and formally submit the same information to the WMATA Engineer.

J. Lubricator Electrical Work:
1. Submit shop drawings and manufacturer's literature.
2. Submit descriptions and all wiring diagrams of equipment.
3. Submit field test procedures for cable.
4. Submit flame retardance and smoke density test reports and data for tests performed not more than 12 months prior to submittal, for cables which are identical to the cable furnished.
5. Provide certified test reports demonstrating that the cable complies in all respects with the requirements of the referenced Standards and Tests, and as modified herein.
6. Provide certificate of conformance to specified wire requirements. Include certificate with submittal of shop drawings and with each cable shipment.

K. Deliverables: Provide the WMATA Engineer one (1) Operation & Maintenance Manual and complete Parts Manual for each rail lubricator.

1.05 QUALITY CONTROL

A. Develop and maintain a quality control program regulating methods, procedures, and process to ensure compliance with standards of quality required by the Contract Documents.

B. Records of all inspection work by the Contractor shall be kept complete and made available to the WMATA Engineer during the performance of the Contract.

B. Inspection and Testing:

1. The products and material incorporated into the work will be subject to inspection by the Engineer at the Contractor's and Subcontractor's facilities, place of manufacture, the shipping point, and at the shipping destination. Inspection and tests by the WMATA Engineer will be performed in such a manner as not to unduly delay the work.
2. WMATA, or its representatives, reserve the right to visit the producers facility during usual business hours unscheduled to a) observe sampling and testing procedures, b) obtain samples of the prepare material being produced and shipped, and c) review plant inspection methods, quality control procedures, equipment and examine test results of current and previous tests. Whether or not the WMATA Engineer inspects or tests any materials, the Contractor will not be relieved from any responsibility regarding defects or other failures to meet the Contract requirements, nor will such inspection or testing be considered as a guarantee of acceptance of any material which may be delivered later.
3. Perform all tests and analyses specified in the AREMA Manual (latest edition) and submit the results to the WMATA Engineer for approval.
4. Make all rail tests and inspections at the mill prior to shipment. Assume full responsibility for all testing indicated. Give the WMATA Engineer sufficient notice when testing in any form is proposed so he may witness the tests.
5. Provide the WMATA Engineer free entry at all times to the manufacturer's mill to inspect processing and testing of rail while work on this Contract is being performed.
6. Performed all tests specified herein at no additional cost to the Authority.
7. Testing must be witnessed and certified by a qualified independent testing firm or individual.

1.06 DELIVERY, HANDLING AND STORAGE

A. Restraining rail shall be stacked and banded for shipment according to normal practice. Brackets shall be palletized.

B. Package small loose parts, i.e. bolts, washers and nuts in secure shipping boxes and kegs.

C. Lift restraining rail at two points, with the rail weight evenly distributed to each lift point. Handle carefully to avoid damage.

D. Load restraining rail with adequate wood strips between the tiers of rail to prevent damage in transit.

PART 2 - PRODUCTS

2.01 RESTRAINING RAIL SYSTEM

A. Rail: 132 RE head hardened or high strength in accordance with AREMA Requirements

1. Hardness: 341 to 388 Brinell
2. Length: 39 feet minimum

B. Separator Block: Cast Ductile Iron.

C. Shims: ASTM A36.

D. Bolts: 1-3/8" diameter, square head, Type 3, ASTM A325.

E. Nut: Hexagonal, Grade C3, ASTM A563.

F. Steel Base Plate and Stop Block: ASTM A36.

G. Spring Washer: AREMA Manual, Section 4.

H. Flat Washer: Hardened weathering ASTM F436 steel.

I. Screw Spike: As specified in Section 05658, Track Appurtenances and OTM.

J. Pandrol Shoulders: As manufactured by Pandrol, Inc. or approved equal.

K. Joints: As shown; and as specified in Section 05658, Track Appurtenances and OTM.

L. Rail Brace: Boltless adjustable brace similar to those formerly manufactured by Bethlehem Steel for use with left-hand Pandrol Spring Clips, e2056.

2.02 LUBRICATORS

A. Portec Protector IV Electric Wayside Lubricator including all hoses, clamps, fittings and lubricant distribution system. (No substitute or "or Equal" lubricator will be approved).
   1. The lubricator housing shall have two mounting brackets on each side to provide for anchoring with ½" expansion anchors into a concrete base pad.
   2. No electrically conductive materials that are a part of the lubricator system shall be installed closer than two feet to any running rail. ~~Non-conducting grease fittings shall be installed on all grease hoses~~.(NOTE: reason for omission: non-conducting grease fittings does not exist per manufacturer).

B. Concrete: ASTM C94, 3500 psi with entrained air.

C. Steel Rebar: ASTM A615, Grade 60.

D. Cast Iron: ASTM A532.

E. Ductile Iron: ASTM A536

F. Malleable Iron: ASTM A47.

G. Stainless Steel 304: ASTM A240, A276.

2.03 LUBRICATOR ELECTRICAL WORK

A. Liquid-tight Flexible Conduit and Fittings: Applicable requirements of UL 360, flexible galvanized steel core, extruded liquid-tight neoprene or PVC jacket overall.
   1. Sizes up to 1-1/4 inch provided with continuous copper bonding conductor, spiral wound between convolutions.
   2. Sizes 1-1/2 inch and above provided with separate grounding conductor.

B. Conduit Connector Fittings:
   1. UL 514B, material and finish similar to that of conduit with which they are to be used.
   2. For enclosures, cabinets, boxes and gutters in electrical rooms: Threaded nylon insulated bushing and locknut.

C. Cable:
   1. UL-labeled as Type RHW-2 or XHHW-2, 600 volts; copper, size as shown; 10AWG and smaller, solid or stranded; 8AWG and larger, Class B stranded.

2. Standards: Except as modified, cable complying in all respects with ICEA S-68-516, NEMA WC8 or ICE S-66-524, NEMA WC7, as appropriate.
3. Nonmetallic Jacket: Chlorosulfonated polyethylene, cross-linked polyolefin or heavy-duty neoprene, as follows:
    a. Chlorosulfonated polyethylene complying with ICEA S-68-518, NEMA WC8.
    b. Cross-linked polyolefin or heavy-duty neoprene with the following requirements when tested in accordance with Part 6 of ICEA S-68-516.
        1) Tensile strength: 1800 psi minimum.
        2) Elongation at rupture: 150 percent minimum.
        3) After air oven aging of 168 hours at 100 deg. C, tensile strength at least 100 percent of unaged value and elongation at least 80 percent of unaged value.
        4) After immersion for 18 hours in ASTM D471 Oil No. 2 at 121 deg. C, tensile strength and elongation at least 80 percent of original values.
    c. Jacket material free of PVC and PVC-based compounds.
4. Flame Retardancy: Cable passing vertical flame test as described in IEEE 383. Cable size for testing: Smaller than #1/0. Comply with UL and ICEA S-68-516.
5. Smoke Generation: Single and multi-conductor cable jacket materials demonstrating low-smoke generation when tested in accordance with ASTM E662.
6. Applied Voltage Testing:
    a. All cable to be given applied voltage dielectric strength test, after six-hour water-immersion test in accordance with the following test procedures:
        1) Polyethylene insulated conductors: In accordance withe paragraphs 6.14.1, 6.14.2, 6.14.5 and 3.5.2 of ICEA S-66-524.
        2) Other conductors: In accordance with paragraphs 3.5.2, 6.27.1, and 6.27.2 of ICEA S-68-516.

D. Connectors and Terminal Lugs: UL 486 with the following additional requirements:
1. For 10 AWG and smaller conductor cable: Pressure type tin-plated copper connectors having nonflammable and self-extinguishing insulation grip with temperature rating equal to that of the conductor insulation.
2. For 8 AWG to 4/0 AWG conductor cable: Compression type tin-plated copper connectors and terminal lugs having nylon insulating sleeve or heat shrinkable insulator for insulation grip.
3. Hardware: High strength silicon, bronze, corrosion resistant, non–magnetic, and electrolytic action free when in contact with copper.

E. Bundling Straps: Self-locking steel barb on one end, with tapered strap of self-extinguishing nylon, temperature rating minus 65 deg. F to plus 250 deg. F.

F. Insulating Tape:
1. Plastic tape: Vinyl plastic with rubber-based pressure-sensitive adhesive, pliable at zero degree F with the following minimum properties when tested in accordance with ASTM D1000
    a. Thickness: 8.5 mils.
    b. Breaking strength: 20 pounds per inch width.
    c. Elongation: 200 percent.
    d. Dielectric breakdown: 10,000volts.
    e. Insulation resistance, indirect method of electrolytic corrosion: 1,000,000 megohms.

G. Grounding and Bonding Equipment: UL 467, IEEE 80, with the following additional requirements:
   1. Grounding conductor: Insulated conductor, size as shown and in accordance with NEC Tables 250-94 and 250-95 as applicable. Insulated conductor complying with the requirements specified for single conductor cable.
   2. Terminal lugs:
      a. For 4/0 AWG and smaller conductors: Copper compression terminal lugs.
   3. Ground connector:
      a. Type as shown or equal.
      b. Copper alloy body and silicon bronze bolt, nut and lock washer with interlocking clamp.
   4. Jumpers: Copper braided or leaf-type flexible jumper, size as necessary.
   5. Equipment ground kits: Insulated/isolated with a minimum up to eight grounded circuits. Install on inside wall of fiberglass enclosure. Secure kits to fiberglass enclosure using bolts and nuts.

H. Sealing compound:
   1. FS TT-S-227, two component, fast-setting, polymeric sealing compound to provide watertight seal between concrete and conduit, between cable and conduit.
   2. Pour-type for horizontal and gun-grade for vertical or overhead application.
   3. When cured, sealant to have rubber-like flexibility allowing minimum movement of conduit and cable in temperature range of minus 40 deg. F to plus 150 deg. F without loss of watertight seal.
   4. Pot life: 15 minutes.
   5. Minimum ambient temperature for application: 35 deg. F.
   6. Initial cure: 15 minutes.
   7. Final cure: Seven days.
   8. Hardness, Durometer A: 20-35.
   9. Seal between conduit and single-conductor cable to withstand water pressure of 70 psi without leakage.
   10. Fox Industries, Type FX-571-G or equal.

I. GFI Circuit Breaker:
   1. NEMA AB1.
   2. Ground fault interrupter (GFI) circuit breaker: As shown and as specified. Overcurrent trip device coordinated to provide selective tripping under overload conditions.

J. Expansion Bolt Anchors: Stainless Steel 304 in accordance with ASTM A276.

K. Grounding stud: Manganese bronze ASTM B138, Alloy No. 675 hard, 3/8 inch high; Evedur GSI, American Brass Company or equal.

L. Cable splice and tap-insulating/sealing kit: Suitable for use on 600-volt, 90C cables, material compatible with cable insulation and jacket, meeting the seal test requirements of ANSI C119.1.
   1. Heat-shrinkable tubing UL-approved, flame-retardant, corrosion-resistant thick-wall tubing with factory-applied sealant for field insulation on in-line splices and taps to provide a watertight seal and insulating encapsulation, with the following additional requirements:
      a. Material: Cross-linked polyolefin.
      b. Shrink ratio: 3 to 1 (min.)
      c. Physical properties:
         1) Ultimate tensile strength: 2,350 psi, ASTM D41
         2) Ultimate elongation: 350% minimum, ASTM D412
         3) Hardness, Shore D: 42, ASTM D2240.

4) Water absorption: 0.02%, ASTM D570, Method 6.1.
5) Specific gravity: 1.2, ASTM D792.

d. Electrical properties:
1) Dielectric strength: 450 volts per mil, ASTM D149.
2) Volume resistivity: 1 x 10^{15} ohm cm, ASTM D257.

e. Thermal properties:
1) Continuous operating temp.: -55 to +135 deg. C.
2) Air oven aging (14 days @ 175 deg. C):
a) Tensile strength: 2,680 psi.
b) Elongation: 375%.
3) Low temperature flexibility (4 hours @ -55 deg. C): No cracking when flexed.
4) Heat shock (4 hours @ 250 deg. C): No cracking, flowing or dripping.

f. Chemical properties:

g. Corrosivity: Non-corrosive, MIL-I-23053/15.

h. Fungus resistance: Non-nutrient, ASTM G21.

PART 3 - EXECUTION

3.01 INSTALLATION

A. Restraining Rail System
1. Shop weld rail brace stop block and Pandrol shoulders to base plate.
2. Install restraining rail system where shown. Install one base plate and bracket on each tie between the end limits of the restraining rail.
3. Fasten base plate and bracket to the ties in accordance with the requirements of Section 05653, Ballasted Track Construction using six screw spikes, or in accordance with the requirements of Section 05653, Direct Fixation Track Construction as appropriate.
4. Field drill the running rail and restraining rail to provide holes as required for the installation of spacer blocks and joints.
5. Holes shall be cylindrical, of the diameter shown and drilled with an approved rail drill.
6. Use an approved template as a guide for drilling holes.
7. All holes drilled in the 115 RE running rail and 132 RE restraining rail for spacer blocks or joints shall be cold worked using the Railroad Cold Expansion process by Fatigue Technology, Inc., Seattle, Washington, or approved equal. The process shall be performed in accordance with the manufacturer's instructions by a crew whose supervisor has been trained by the manufacturer.
8. Cut rail only as necessary to meet the following criteria:
a. The minimum rail length between an insulated joint and a standard joint shall be 15 feet.
b. The minimum rail length adjacent to a 15 foot rail shall be 24 feet.
c. The minimum rail length adjacent to an end section shall be 15 feet.
d. The number of intact 39 foot rail lengths shall be maximized.
e. End sections shall be the maximum length feasible.
9. Rails shall be cut square and clean by means of rail saw or abrasive cutting disks. Rail end beveling shall be performed at all rail cuts and shall be in accordance with current AREMA Manual requirements for Beveling or Slotting of Rail Ends and AREMA Portfolio Plan No. 1005 (latest edition).
10. Locate restraining rail insulated joints between the same fastener plates as the insulated joints in the adjacent running rail. Join rail as illustrated in the contract documents.

11. Assemble all non-insulated joints with thermite welds in accordance with AREMA requirements and the approved weld kit manufacturer's instructions. Four hole strap bars with cast-on fin clearance shall be installed on each side of the rail around the thermite weld.
12. Install bolts and nuts finger tight before tensioning bolts to 20,000 to 25,000 pounds by use of a track wrench or power torque wrench, starting from the center bolts and working to the end bolts. Immediately before the completion and acceptance of work, re-tighten track bolts to a tension of 15,000 to 25,000 pounds.
13. The thermite welded joints shall be centered over a plate. The base of the 132 RE rail shall be ground free of weld fins to fit flush on the plate.
14. Insulated joints shall be assembled with all components shown without rail gaps.
15. Install the restraining rail so that the flangeway is 1-7/8 inches plus or minus 1/8 inch measured 5/8 inch below the top of the running rail. Tighten the restraining rail hold down bolts to 75 percent of the proof load for the size of the bolt used.

B. Lubricators
1. Install lubricator in accordance with the manufacturer's recommendations where shown and as specified herein. If specific mounting locations for the restraining rail lubricators are not specified, mount as per WMATA Trackwork Standard Drawing ST-TW-RR-006 (Lubricator Location At Grade) or as per the WMATA Engineer's direction.
2. Mount lubricator to the concrete using expansion anchors and ½ " diameter bolts.
3. Install track assemblies and grease distribution system to the inbound track and outbound track in accordance with the manufacturer's recommendations. A site visit by the lubricator manufacturer and site diagrams is required to determine the most optimal approach.
4. The train detection system that initiates the release of lubricant shall be configured to release to the appropriate restraining rail when the train is moving in the normal direction of traffic for both directions of train movement.
5. Install grease hoses in accordance with the manufacturer's recommendations. Anchor hoses to ties with appropriate clips at a minimum spacing of 10 feet.
6. Perform electrical work as specified in the technical specification for electrical work.
7. At the completion of installation, the Lubricator Reservoir shall be filled with an appropriate lubricant approved by the WMATA Engineer.
8. Test lubricator system for proper application of lubricant as specified by the manufacturer and approved by the WMATA Engineer.

C. Lubricator Electrical Work:
1. The Contractor shall carefully examine all contract drawings and specifications and be responsible for the proper fitting of materials and equipment at each location as indicated, without substantial alteration. In as much as the drawings are generally diagrammatic and because of the small scale of the drawings, it is not possible to indicate all offsets, fittings and accessories which may be required. Furnishing such fittings and accessories as may be required to meet such conditions shall be at no additional cost to the Authority.
2. The Contractor shall verify exact location , size and extent of all existing utilities, obstructions, and/or other conditions which may affect the proposed work under the project. The Contractor shall take every precaution to prevent damage to existing work and shall repair any damage as a result of this Work.
3. Conduit:
   a. Install conduit and fittings where conduit runs are shown.
   b. Install exposed conduit parallel or perpendicular to the running rails as shown and avoid interference with existing work.

c. Thread and ream the ends of field-cut conduit to remove rough edges. Use locknuts and bushings at conduit entrance to boxes, cabinets and equipment enclosures.
d. Bend conduit so that bends are free from cuts, dents and other damage.
e. Support horizontal conduit with one-hole pipe straps or individual pipe hangers.
f. Apply lead -free conductive anti-seize compound to threaded conduit joints.
g. Use minimum of 18-inch long liquid-tight flexible conduit connection to equipment subject to vibration.
h. Rod and swab conduit after installation, removing water and foreign matter.
i. Waterproof conduit connections.

4. Cable:
   a. Install cable as shown.
   b. Use nylon straps to bundle and secure wire and cable in panelboards.
   c. Use a minimum bending radius 12 times outer diameter of cable. Where shown, use shorter bending radius as permitted by NEC, Appendix H of ICEA S-66-524, NEMA WC7 and cable manufacturer.
   d. To facilitate pulling cable, use UL-listed lubricant recommended by cable manufacturer.
   e. Connect cables to equipment using integral mechanical connectors or compression connectors.
   f. Identify feeder terminations to lubricators using nonmetallic fiberboard tags or plastic labels.
   g. Attach tags to cable with slip-free plastic lacing or nylon bundling straps. Tags shall designate the panelboard name and circuit numbers serving lubricators. Demonstrate that identification tagging of cabling and panelboard has been field verified with the WMATA Engineer present.
   h. Splicing of power cables is not permitted. An exception may be granted by the WMATA Engineer only in extraordinary conditions. Authorization for such an exception must be obtained from the Engineer in advance of making a splice. Any such exception must be fully documented and recorded on as-built drawings. The splice must be made watertight as shown.
5. Wire connection accessories:
   a. Secure connections or terminals lugs to the conductor to engage all strands equally.
   b. Do not rupture insulation nor expose bare conductors.
   c. Install compression connectors and terminal lugs using tools and pressure recommended by the manufacturer. Indent mark connectors and terminal lugs with number of die used for installation.
   d. Apply anti-corrosion joint compound to connectors, terminal lugs and bolting pads before installation.
6. Grounding and bonding:
   a. Ground Connections:
      1) Use terminal lug to connect grounding conductor to equipment enclosure.
      2) Use continuous grounding conductor without splices.
   b. Equipment grounding conductor: Provide equipment grounding conductor for single-phase branch circuits.
   c. Bond metallic ac equipment enclosures to equipment grounding conductor in ac power feeder.
7. Connect branch circuit wires as shown.

8. Make power cable connections to circuit breakers, new molded case circuit breakers and neutral and ground bus bars in panelboards and enclosed circuit breakers by means of integral mechanical connectors as shown. If such items are not furnished with integral mechanical connectors, make connections using compression connectors.
9. On cable splices, taps and terminations cover connectors with electrical putty , wrapped with three layers of plastic tape or final layer or rubber tape and then install watertight encapsulation as follows and under the supervision of kit manufacturer's representative or using a factory-certified installation technician, proficient in field installation of heat-shrinkable sealing kits.
10. Use heat-shrinkable tubing for encapsulation of new splices, taps and terminations.
11. Field Quality Control:
    a. After completion of installation and filling the reservoir with an approved lubricant, demonstrate proper performance of all equipment in the presence of the WMATA Engineer.
    b. Test all metallic equipment enclosures, galvanized rigid steel conduits and liquid-tight flexible conduits for continuity to the grounding system.
    c. Test non-grounded conductors for insulation resistance to ground of 10 megohms. When cable shows unsteady insulation resistance of less than 10,000 ohms, perform high potential test at 80 percent of factory ac test voltage or as recommended by cable manufacturer.
    d. Test continuity of conductors using ohmmeter.
    e. Test circuits for connection in accordance with the wiring diagram.
    f. Check connections to circuit breakers for tightness.
    g. Molded Case Circuit Breakers: Perform pole-to-pole and pole-to- ground insulation resistance tests with 1000 volt d.c. megger. Insulation resistance to be 50 megohms minimum.

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT:

A. Measurement of work specified in this Section will be made in the following manner:
   1. No separate measurement.

4.02 PAYMENT:

A. Compensation for work specified in this Section will be made in the following manner:
   1. Included in the price of the work of which it is a part.

END OF SECTION

SECTION 05661

CONTACT RAIL AND APPURTENANCE FOR TRACTION POWER

PART 1: GENERAL

1.01 SUMMARY

A. This section specifies designing, fabricating, testing and furnishing a composite contact rail system, including the composite contact rail, splice joints, expansion joints, end approaches, terminal lugs, and all appurtenances as ~~shown and~~ specified.

B. Related Sections:
1. Section 16127 - Contact Rail System Installation For Traction Power

~~C. Payment and Measurement:~~
~~1. Compensation for work specified in this section will be made in the following manner:~~
~~a. Work performed by the Contractor pursuant to fabricating and delivering contact rail, splice joints, expansion joints, end approaches, terminal lugs, nuts, bolts and miscellaneous hardware: Lump sum.~~

1.02 REFERENCES

A. Codes, regulations, references standards and specifications:
1. AREA Manual for Railway Engineering for Continuous Cast Rail.
2. ANSI H35.1, Type A6101-T6
3. ASTM B317, Type B.
4. Steel Structure Painting Council, SSPC-SP-10.
5. NEMA CC1.
6. ASTM B117.
7. ASTM A2, Grade 65-35.
8. ASTM A47, Grade 32510
9. ANSI B4.1
10. ASTM A325
11. ASTM B134
12. ANSI B18.8.1
13. ASTM A153
14. ~~ASTM A123~~ B695
15. Steel Structure Painting Council, SSPC-SP-6
16. SAE No. G-18
17. ANSI C37.34

1.03 SYSTEM DESCRIPTION

A. Composite Contact Rail
1. The composite contact rail shall consist of a steel base rail, with one aluminum extrusion fastened to each side of the web area of the base rail, continuous over the finished length.

B. Appurtenances
1. Appurtenances include expansion joints, end approaches, cast parts, terminal lugs, disconnect switch, nuts, bolts, and miscellaneous hardware.

1.04 SUBMITTALS

A. Shop Drawings
   1. The Contractor shall submit for approval shop drawings for fabrication of the components and assemblies of the composite contact rail and appurtenances. No fabrication or manufacture shall be performed prior to drawing approval.

B. Certification:
   1. Certification that composite contact rail and appurtenances furnished meet or exceed specified requirements
   2. Certified test reports.

1.05 QUALITY ASSURANCE

A. Electrical Tests
   1. Splice Joint DC Resistance
      a. Two sections of the composite rail, each 36 inches ~~or more in length~~, shall be joined together. At a constant room temperature the resistance across the joint shall be measured in accordance with NEMA CCI and compared to an equal length of unjointed composite rail at the same temperature.
      b. If the resistance across the jointed rail exceeds by more than five percent the resistance of the unjointed rail the joint design will be rejected.
   2. Composite Rail and Splice Joint Thermal Cycle
      a. Using the same jointed and unjointed sections used in the dc-resistance test, the specimens shall be cycled thermally for a minimum of ten cycles. Each thermal cycle shall consist of lowering the rail temperature to minus 5C and measuring the resistance of the specimens, then raising the temperature of the specimens to plus 117C and measuring the resistance again for a minimum of ten cycles.
      b. If at any time the resistance of the jointed or unjointed sections exceeds the requirements of these specifications, the design will be rejected.
   3. Composite Rail and Splice Joint Assembly Salt-spray Test
      a. Using the same jointed and unjointed sections used in the dc resistance test, perform a 500-hour salt-spray test in accordance with the requirements of ASTM B117.
      b. If, at the end of the test, the resistance of either specimen increases by more than five percent, the design will be rejected.
   4. Electrical Characteristics
      a. The assembled composite contact rail shall have an electrical resistance not greater than 0.002 ohms per 1,000 feet at 20C. The manufacturer shall provide certificates of product conformance.
      b. The composite rail shall be capable of conducting 5,000 amperes dc continuous with a temperature rise not to exceed 40C above 30C ambient in still air.
      c. The rail shall be capable of withstanding a fault current of 135,000 amperes dc, or equivalent ac, for 100 milliseconds without mechanical or thermal damage.
      d. The Contractor shall submit certification of all the listed electrical characteristics of the composite contact rail.

B. Testing of Terminal Lugs
   1. Two assemblies from each lot of terminal lugs shall be tested. Failure of any assembly to pass the following tests will cause rejection of the entire lot.
   2. A completed compression connection shall provide electrical resistance not greater than an equivalent length of uncut cable when measured between the distant end of the cable and the connector tongue.
   3. Bare conductors shall be used for performing tests.

4. Resistance measurement shall be taken before and after the tests specified below.
5. The test connections shall then be subjected to a sustained tension of 5,000 psi of the nominal conductor cross sectional area for a period of three hours. At the end of three hours, there shall be no increase in electrical resistance of the connection beyond that specified. There shall be no slipping of the conductor in the connector nor deformity or loosening of the connection.
6. Provide certificates of product performance.

C. For codes, regulation, references, standards and specifications, refer to Article 1.02 above.

PART 2: PRODUCTS

2.01 MATERIALS

A. Composite Contact Rail
1. Steel Base Rail
   a. The steel base rail shall be new No. 1 or No. 2 rail conforming to the current requirements of the AREA Manual for Railway Engineering for continuous cast rail. No. 2 rails will be accepted for not more than 15 percent, by weight, of the total base rail furnished.
   b. The standard length of the steel base rail shall be 39 feet at a temperature of 60F. Shorter lengths, varying in increments of one foot from 39 to 25 feet, will be accepted for a maximum of 11 percent, by weight.
   c. A maximum variation of plus-or-minus ½ inch of the stated length for each rail will be permitted.
2. Aluminum Extrusions
   a. The aluminum extrusions shall be of a uniform cross section and shall conform to the alloy and temper requirements of ANSI H35.1, Type A6101-T6 and shall also conform to the requirements of ASTM B317, Type B.
   b. The extrusions shall be formed to permit maximum clamping force with the steel base rail and the cable terminal lugs to create the maximum electrical contact area. In addition, they shall permit rail tongs to grasp the head of the steel base rail for lifting the composite rail without damage to the aluminum extrusions.
   c. Sufficient clearance at the base shall be provided to permit mounting of the contact rail protection cover assembly, clearing insulator ears and other appurtenances. Sufficient clearance shall be provided at the rail head to mount the specified contact rail heater supplied in other contract.
3. Splice Joint
   a. The splice joint assembly shall consist of two aluminum alloy extrusions of the same material specified for composite rail aluminum extrusion, except that the internal contour of the splice joint extrusion shall conform to the external contour of the composite rail aluminum extrusion to ensure proper vertical and horizontal alignment of the composite rail sections.
   b. The splice joint assembly shall provide ample contact surface for the transfer of electrical current across the joint and the joint shall have a resistance no greater than that of an equal length of composite rail.
   c. The splice joint extrusions shall be pre-drilled as required to accept four 7/8-inch diameter steel compression fasteners, as manufactured by the Huck Manufacturing Company, or equal.
   d. The assembled splice joint shall be capable of withstanding a 25,000-pound longitudinal tension force across the joint without exceeding the yield point of its components.

B. Appurtenances
1. Expansion Joints
   a. The expansion joint assembly shall consist of the following;

1) Two bars of medium carbon steel, ASTM A27, Grade 65-35 or malleable iron, ASTM A47, Grade 32510.
2) Two sections of steel base rail as required.
3) Aluminum extrusions.
4) Accessories as required.

b. The aluminum extrusions shall be bolted to each base rail to allow the attachment of a splice joint assembly on each section.

c. The internal contour of the expansion joint bars shall conform to the external contour of the modified steel base rail sections to ensure proper alignment horizontally and vertically and to create a smooth passage across the joint for the collector shoe. The assembled modified steel base rail sections shall be pre-drilled as required.

d. The expansion joint assembly shall be designed to accommodate 12 inches of movement for each 1,000 feet of composite contact rail.

2. End Approaches

a. The end approaches shall consist of sections of steel base rail as specified, cut and welded to provide a smooth transition for the collector shoe onto the composite contact rail.

b. The end approaches shall be supplied in lengths of 11 feet and five-feet six-inches as shown. The mating end of each end approach shall contain sufficient length of aluminum extrusion bolted to the web to allow the attachment of a splice joint assembly.

c. The end approaches shall be pre-drilled.

3. Cast Parts

a. Cast parts for the composite rail assembly, including expansion joints, shall be manufactured as specified.

b. Castings shall be free of cracks, flaws, blemishes, scale, or any other defect that would be detrimental to the service for which they are intended. The finish surface shall be smooth and shall fit all adjoining parts accurately. Grinding will be permitted to ensure the specified fit.

c. Medium Steel Castings

1) Steel for casting shall be medium steel made by the open-hearth, basic oxygen or electric-furnace process, ASTM A27, Grade 65-35.
2) All castings shall be fully annealed by heating to a temperature above the transformation range and, after being held for a proper time at this temperature, cooled slowly and uniformly in the furnace.
3) Steel castings shall be free from defects such as cracks, machining flows, porosity or excessive shrinkage and shall be finished to a true and homogenous surface.

d. Malleable-iron castings

1) Parts cast from malleable iron shall conform to ASTM A47, Grade 32510.

4. Terminal Lugs

a. Terminal lugs shall be compression-type lugs compatible with 1,000-KCMIL, 427-strand cable. Terminal lugs shall be 98 percent pure copper. The entire lug shall be hot-dip, tin-coated, 0.3 mils minimum thickness. Tongues shall not be less than two inches square by ½ inch thick and drilled for a 5/8-inch diameter fastener.

5. Disconnect Switch

a. Outdoor, moisture-resistant, single-pole, single-throw, bolted pressure type/no-lead-break, manually operated mechanism for operation on 750 volts dc.

b. In accordance with ANSI C37.34.

c. Continuous current rating: 4000 ~~1200~~ amperes dc ~~minimum~~ as shown with temperature rise not exceeding 50C over 30C ambient.

d. Dielectric withstand voltage from switch and mounting base across open contacts: 3000 volts dc minimum for one minute.

e. Momentary fault current rating: 160,000 amperes dc with rate of rise of 10 amperes per micro-second.

f. Terminals equipped with lugs for connection of four (4) ~~two~~ 1000 KCMIL, 427 strand, copper cables on each side as shown.

g. Designed to prevent opening or closing by gravity or vibration or of its own accord.

h. Insulating operating-handle mechanism with mechanical latch to prevent accidental opening or closing and capable of being padlocked in open or closed position.

i. Enclosure:

1) NEMA Type 3R in accordance with ICS 6.

2) Capable of withstanding 200-pounds force without damage to switch or enclosure.

3) Minimum three-inch clearance to exposed terminals of switch in open and closed positions.

4) Material: Fiberglass, 1/8-inch minimum thickness.

5) Size: To fit within limits shown on drawing.

6) Cover: Designed to provide easy access to switch. Equipped with stainless steel piano hinge and hasp.

7) Cable openings: Compatible with switch terminals; furnished with Type GRE sealing bushings suitable for 1000 KCMIL cable, O.Z. Electrical Manufacturing Co., Inc., or equal.

8) Flanges and mounting hardware: Furnished as necessary to mount enclosure on concrete base and to mount switch in enclosure.

6. Nuts, Bolts, and Miscellaneous Hardware

a. All nuts, bolts, and flat washers shall be manufactured in accordance with ASTM A325.

b. The dimensional data and type hardware for all nuts, bolts and miscellaneous parts shall be as shown on the manufacturing drawings. Steel bolts, nuts, and washers shall be galvanized as specified below.

c. Cotter pins shall conform to ASTM B134, and ANSI B18.8.1

7. Galvanizing

a. Bolts and miscellaneous hardware to be mechanical zinc coated in accordance with ASTM A695.

c. Before galvanizing, the finished parts shall be pickled or sandblasted and the scale and adhering impurities thoroughly removed. The pickling shall be done in properly diluted sulfuric acid, after which the parts shall be thoroughly cleaned in cold, running water.

d. Sand-blasting shall meet or exceed Steel Structure Painting Council SSPC-SP-6, except that the maximum grit size shall be SAE No. G-18.

e. The parts shall then be immersed in a solution of either zinc chloride or hydrochloric acid. Immediately following thorough drying, the parts shall be dipped into the zinc bath before corrosion starts again.

8. Tolerances for Fits.

a. Tolerances for fits shall be in accordance with ANSI B4.1.

2.02 FABRICATION

A. Composite Contact Rail

1. Method of Assembly

a. Prior to final assembly of the aluminum extrusions to the steel base rail, the contact surfaces of the steel base rail shall be sandblasted to near white finish in accordance with Steel Structures Painting Council SSPC-SP-10.

b. After sandblasting, the surfaces of both the steel base rail and the aluminum extrusions shall be cleaned of all oil, grease and other foreign matter.

c. The aluminum extrusions shall be free of aluminum oxide at the time of application of the oxide-inhibiting paste.

d. Following the cleaning process, all mating surfaces shall receive a liberal and evenly distributed coating of oxide-inhibiting paste, Dearborn Chemical Product NO-OX-1D or equal. Oxide-inhibiting paste shall also be applied to all interface surfaces of the fasteners.

e. After application of the oxide-inhibiting paste, the aluminum extrusions shall be permanently attached to the steel base rail on maximum 19-inch centers with 5/8-inch diameter steel compression fasteners, as manufactured by the Huck Manufacturing Company or equal.

f. The installed fastener shall provide a minimum 19,000-pound clamping force. The fastening system shall maintain the aluminum extrusions in stable, intimate electrical contact with the steel base rail under all conditions of thermal expansion and contraction from zero degree to 150F.

g. The assembled composite rail sections shall be pre-drilled on each end to accept a splice joint assembly as required. After assembly all excess oxide-inhibiting paste shall be removed from each rail.

PART 3: EXECUTION - Not Used

PART 4 - MEASUREMENT AND PAYMENT

4.01 MEASUREMENT AND PAYMENT

A. Compensation for work specified in this section will be made in the following manner:

1. Work performed by the Contractor pursuant to fabricating and delivering contact rail, splice joints, expansion joints, end approaches, terminal lugs, nuts, bolts and miscellaneous hardware: Lump sum.

END OF SECTION

SECTION 05700

ORNAMENTAL METAL

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing ornamental (architectural) metalwork.

B. Related Work Specified Elsewhere:
   1. Not used.
   2. Hydraulic elevator: Section 14200.

1.02 PERFORMANCE REQUIREMENTS FOR HANDRAILS AND RAILINGS:

A. Structural Performance of Handrails and Railings: Provide handrails and railings complying with requirements of ASTM E 985 for structural performance, based on testing performed according to ASTM E 894 and ASTM E 935.

B. Thermal Movements: Provide handrails and railings that allow for thermal movements resulting from the following maximum change (range) in ambient and surface temperatures by preventing buckling, opening of joints, overstressing of components, failure of connections, and other detrimental effects. Base engineering calculation on surface temperatures of materials due to both solar heat gain and nighttime-sky heat loss.
   1. Temperature Change (Range): 120 deg F, ambient; 180 deg F, material surfaces.

C. Control of Corrosion: Prevent galvanic action and other forms of corrosion by insulating metals and other materials from direct contact with incompatible materials.

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

   1. Shop Drawings: Show fabrication and installation of ornamental metal. Include plans, elevations, component details, and attachments to other Work. Indicate materials and profiles of each ornamental metal member, fittings, joinery, finishes, fasteners, anchorages, and accessory items.
      a. Include setting drawings, templates, and directions for installing anchor bolts and other anchorages.
      b. Obtain approval for minor variations in detail for the purpose of improving fabrication and installation procedures, but not affecting general design for structural stability.

   2. Samples for Verification: Three of each of the following in each finish to be used in the work. For each profile and pattern of fabricated metal and for each type of metal finish required, prepared on metal of same thickness and alloy indicated for the Work.
      a. Include 6-inch long samples of linear shapes, tubing and extrusions
      b. Include 4-inch square samples of plates and sheet metal.
      c. Welded joints: For color matching.
      d. Brazed joints: Typical for work involved.

   3. Certification:
      a. Welding Certificates: Copies of certificates for welding procedures and

personnel.

b. Qualification Data: For firms and persons specified in "Quality Assurance" Article to demonstrate their capabilities and experience. Include lists of completed projects with project names and addresses, names and addresses of architects and owners, and other information specified.

c. Certified test reports: Certified test reports verifying that epoxy grout conforms to specified requirements.

d. Certification that adhesive is appropriate for the long-term intended use.

1.04 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. AWS: A5.7, A5.8, D1.1, D1.3.
3. PEI: S-100.
4. MS: MIL-C-18480.
5. ASTM: A36, A48, A153, A276, A312, A366, A413, A424, A500, A501, A536, A554, A653, A666, A743, B43, B135, B455, B584, C307, C413, C552, C579, C580, D1187, D3656, E527.
6. ANSI: A156.18.
7. FS TT-P-664.
8. SSPS-Paint 5, Paint 12.
9. NAAMM.

B. Installer Qualifications: Arrange for installation of ornamental metal specified in this Section by the same firm that fabricated it.

C. Fabricator Qualifications: A firm experienced in producing ornamental metal similar to that indicated for this Project and with a record of successful in-service performance, as well as sufficient production capacity to produce required units.

D. Welding Standards: Qualify procedures and personnel according to the following:
1. AWS D1.1, "Structural Welding Code--Steel."
2. AWS D1.3, "Structural Welding Code--Sheet Steel."

1.05 DELIVERY, STORAGE, AND HANDLING:

A. Store ornamental metal inside a well-ventilated area, away from uncured concrete and masonry, and protected from weather, moisture, soiling, abrasion, extreme temperatures, and humidity.

B. Deliver and store cast-metal products in wooden crates surrounded by sufficient excelsior to ensure that products will not be cracked or otherwise damaged.

1.06 PROJECT CONDITIONS:

A. Field Measurements: Where ornamental metal is indicated to fit to other construction, verify dimensions of other construction by field measurements before fabrication and indicate measurements on Shop Drawings. Coordinate fabrication schedule with construction progress to avoid delaying the Work.
1. Established Dimensions: Where field measurements cannot be made without delaying the Work, establish dimensions and proceed with fabricating ornamental metal without field measurements. Coordinate other construction to ensure that actual dimensions correspond to established dimensions.

1.07 COORDINATION

A. Coordinate installation of anchorages for ornamental metal items. Furnish Setting Drawings, templates, and directions for installing anchorages, including sleeves, concrete inserts, anchor bolts, and items with integral anchors, that are to be embedded in concrete or masonry. Deliver such items to Project site in time for installation.

PART 2 - PRODUCTS

2.01 MATERIALS, GENERAL:

A. Insofar as practicable, furnish products of a single manufacturer.

2.02 METALS:

A. General: Provide metals free from surface blemishes where exposed to view in finished unit. Exposed-to-view surfaces exhibiting pitting, seam marks, roller marks, stains, discolorations, or other imperfections on finished units are not acceptable.

B. Bronze: Provide copper alloy of type and form indicated to comply with the following requirements:
   1. Extruded Shapes: ASTM B455, Alloy UNS No. C38500 (extruded architectural bronze).
   2. Plate, Sheet, Strip, and Bars: ASTM B36, Alloy UNS No. C28000 (muntz metal, 60 percent copper).
   3. Seamless Pipe: ASTM B43, Alloy UNS No. C23000.
   4. Seamless Tubes: ASTM B135, Alloy UNS No. C23000 (red brass, 85 percent copper).
   5. Delete subparagraph above or below. Verify availability and color match with other copper-alloy forms. See Evaluations.
   6. Sand Castings: ASTM B584, Alloy UNS No. C86500 (No. 1 manganese bronze).
   7. Stainless Steel: Grade and type designated below for each form required:
   8. Pipe: ASTM A312, Grade TP 304.
   9. Castings: ASTM A743, Grade CF 8 or Grade CF 20.
   10. Sheet, Strip, Plate, and Flat Bar: ASTM A666, Type 304.
   11. Bars and Shapes: ASTM A276, Type 304.Select subparagraph above or below.

C. Steel: Provide steel in form indicated to comply with the following requirements:
   1. Tubing: Cold formed, ASTM A500.
   2. Steel Plate, Shapes, and Bars: ASTM A36.
   3. Steel Sheet:
      a. Commercial-quality, cold-rolled, stretcher-leveled, carbon-steel sheet complying with ASTM A 366, Class I, matte finish.
      b. ASTM A653, mild-annealed, leveled, cold-rolled, galvanized, 16-gauge.

D. Base Metal for Porcelain Enamel: ASTM A424, vitreous enameling steel of low metalloid and copper content, manufactured and processed for the production of architectural porcelain enamel units, 16-gauge.

E. Porcelain Enamel Panel Liners: ASTM A653, hot dipped galvanized steel sheet, G90 zinc coating, 20-gauge.

2.03 MISCELLANEOUS MATERIALS:

A. Welding Electrodes and Filler Metal: Type and alloy of filler metal and electrodes as

recommended by producer of metal to be welded, complying with applicable AWS specifications, and as required for color match, strength, and compatibility in fabricated items.

B. Fasteners: Use fasteners of same basic metal as fastened metal, unless otherwise indicated. Do not use metals that are corrosive or incompatible with materials joined.
1. Provide concealed fasteners for interconnecting ornamental metal components and for attaching them to other work, unless otherwise indicated.
2. Provide concealed fasteners for interconnecting ornamental metal components and for attaching them to other work, unless exposed fasteners are unavoidable or are the standard fastening method.
3. Provide Phillips flat-head machine screws for exposed fasteners, unless otherwise indicated.

C. Cast-in-Place and Postinstalled Anchors: Anchors of type indicated below, fabricated from corrosion-resistant materials with capability to sustain, without failure, a load equal to six times the load imposed when installed in unit masonry and equal to four times the load imposed when installed in concrete as determined by testing per ASTM E 488 conducted by a qualified independent testing agency.
1. Cast-in-place anchors
2. Chemical anchors.
3. Expansion anchors.

D. Insect Screen: ASTM D3656, with aluminum or galvanized steel frame as shown.

E. Epoxy Grout: Nonshrink, nonstaining, 100-percent solids, two-component or three-component epoxy-resin system, that has been in successful use for an equivalent application for a minimum of five years.
1. On horizontal applications: Self-leveling type.
2. On vertical and overhead surface application: Non-sag type.
3. Physical properties:

Property	Requirement	ASTM Test Method
Tensile strength	1,800-psi minimum in seven days	C307
Compressive strength	13,500-psi minimum in 28 days	C579
Modulus of rupture	13,500 psi	C580
Water absorption	One-percent maximum, two hours at 212F	C413

F. Panel Core: Cellular glass, ASTM C552, Type IV, one-inch thick.

G. Shop Primer for Ferrous Metal: Fast-curing, lead- and chromate-free, universal modified-alkyd primer complying with performance requirements of FS TT-P-664; selected for good resistance to normal atmospheric corrosion, compatibility with finish paint systems indicated, and capability to provide a sound foundation for field-applied topcoats despite prolonged exposure.

H. Shop Primer for Galvanized Steel: Zinc-dust, zinc-oxide primer formulated for priming zinc-coated steel and for compatibility with finish paint systems indicated, and complying with SSPC-Paint 5.

I. Bituminous Paint: Cold-applied asphalt mastic complying with SSPC-Paint 12, except containing no asbestos fibers, or cold-applied asphalt emulsion complying with ASTM D1187

J. Adhesive: Hot spray contact cement, certified by fabricator as appropriate for the long-term intended use

2.04 FABRICATION, GENERAL:

A. Form ornamental metal to required shapes and sizes, with true curves, lines, and angles. Provide components in sizes and profiles indicated, but not less than that needed to comply with requirements indicated for structural performance.

B. Provide necessary rebates, lugs, and brackets to assemble units and to attach to other work. Drill and tap for required fasteners, unless otherwise indicated. Use concealed fasteners where possible.

C. Comply with AWS for recommended practices in shop welding and brazing. Provide welds and brazes behind finished surfaces without distorting or discoloring exposed side. Clean exposed welded and brazed joints of all flux, and dress all exposed and contact surfaces.
1. Type, size and spacing of welds: As shown on approved shop drawings.
2. Remove weld spatter and welding oxides from finished surfaces by descaling and grinding.
3. Use oxyacetylene method for welding joints of extruded architectural bronze, 16-B&S gauge or heavier.
4. To ensure color match at exposed joints, insert pieces of the base metal or low-fuming bronze, conforming to AWS A5.7, Classification R Cu Zn C as filler material. Adjust oxidizing flame to minimize porosity of joint.
5. Grind and polish welded beads on exposed polished surfaces to match and blend with finish on adjacent parent metal.

D. Mill joints to a tight, hairline fit. Cope or miter corner joints. Form joints exposed to weather to exclude water penetration.

E. Provide castings that are sound and free of warp, cracks, blowholes, or other defects that impair strength or appearance. Grind, wire brush, sandblast, and buff castings to remove seams, gate marks, casting flash, and other casting marks.

F. Finish exposed surfaces to smooth, sharp, well-defined lines and arris.

G. Assemble items in the shop to greatest extent possible to minimize field splicing and assembly. Disassemble units only as necessary for shipping and handling limitations. Clearly mark units for reassembly and coordinated installation. Use connections that maintain structural value of joined pieces.

H. Cleaning metal surfaces:
1. After grinding and polishing or where subject to severe forming operations, remove extraneous material from metal surfaces, thoroughly rinse with clear water and dry.
2. Remove lubricants used in fabrication before work leaves shop.
3. Match-mark materials for field assembly as necessary. Arrange sequence of shipments to expedite erection and to minimize field handling of material.

2.05 FABRICATING HANDRAILS AND RAILINGS:

A. Nonwelded Connections: Fabricate handrails and railings to interconnect members with concealed mechanical fasteners and fittings, unless otherwise indicated. Fabricate members

and fittings to produce flush, smooth, rigid, hairline joints.

1. Fabricate splice joints for field connection using an epoxy structural adhesive where this is fabricator's standard splicing method.

B. Welded Connections: Fabricate handrails and railings for connecting members by welding. Cope components at perpendicular and skew connections to provide close fit, or use fittings designed for this purpose. Weld connections continuously to comply with the following:

1. Use materials and methods that minimize distortion and develop strength and corrosion resistance of base metals.
2. Obtain fusion without undercut or overlap.
3. Remove flux immediately.
4. At exposed connections, finish exposed surfaces smooth and blended so no roughness shows after finishing and welded surface matches contours of adjoining surfaces
5. Provide welded connections for stainless-steel handrails and railings.
6. Provide welded connections for ferrous handrails and railings.

C. Retain paragraph and subparagraphs below if required for brazing copper-alloy railings. See Evaluations.Brazed Connections: Fabricate bronze handrails and railings for connecting members by brazing. For connections made during fabrication, braze corners and seams continuously to comply with the following:

1. Use materials and methods that match color of base metal, minimize distortion, and develop maximum strength and corrosion resistance.
2. Remove flux immediately.
3. Where exposed field connections are necessary, insert inside sleeves and secure at bottom with flush screws to provide hairline joint. Finish exposed surfaces smooth and blended so no roughness shows after finishing and brazed surface matches contours of adjoining surfaces.

D. Form changes in direction of railing members as follows shown on approved shop drawings.Retain one of seven subparagraphs below; if retaining more than one, also retain last subparagraph. If there is a need to limit specific methods to selected locations or to railings of different metals, select method that predominates as default by adding phrase ", unless otherwise indicated," and qualify other methods retained by adding phrase "where indicated."

E. Form simple and compound curves by bending members in jigs to produce uniform curvature for each repetitive configuration required; maintain profile of member throughout entire bend without buckling, twisting, or otherwise deforming exposed surfaces of handrail and railing components

F. For handrails and railings with nonwelded connections that are exposed to exterior or to moisture from condensation or other sources, provide weep holes or another means to drain water entrapped in hollow sections of railing members.

G. Provide wall returns at ends of wall-mounted handrails, unless otherwise indicated; close ends of returns.

H. Close exposed ends of handrail and railing members with manufacturer's standard prefabricated end fittings.

I. Brackets, Flanges, Fittings, and Anchors: Provide wall brackets, flanges, miscellaneous fittings, and anchors to interconnect handrail and railing members to other work, unless otherwise indicated.

1. Furnish inserts and other anchorage devices for connecting handrails and railings to concrete or masonry work. Fabricate anchorage devices capable of withstanding loads imposed by handrails and railings. Coordinate anchorage devices with

supporting structure.

2. For railing posts set in concrete, provide preset sleeves of steel, not less than 6 inches long and inside dimensions not less than 1/2 inch greater than outside dimensions of post, with steel plate forming bottom closure.

2.06 FABRICATING BRONZE CLADDING:

A. Brake-formed as shown on approved shop drawings. Laminate to backup material to achieve permanent bond and as recommended by bronze manufacturer.

B. Fit and braze exposed joints in cladding with copper-phosphorous alloy or silver alloy, conforming to AWS A5.8, Classification B Cu P-5 and B Ag 1, respectively. Clean joints and apply flux properly before brazing. After brazing, remove excess brazing metal from face of work.

2.07 FABRICATING STEEL CLADDING:

A. Formed of steel sheet ASTM 366, with baked-enamel finish.

B. Weld and fill seams and joints before finishing.

2.08 INSULATED PANELS FOR ELEVATOR HOISTWAYS:

A. Consisting of exposed face of bronze or stainless steel sheet, back face of steel sheet, panel core and adhesive.

B. Fabricated as specified for bronze or stainless steel cladding.

2.09 PORCELAIN ENAMEL PANELS:

A. Laminated type in sizes and shapes shown conforming with PEI standards specified.

2.10 FINISHES, GENERAL:

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.11 BRONZE FINISHES:

A. Base-metal finish: Medium satin wheel-polished or belt-polished with aluminum oxide or silicon carbide abrasives of 80-120 grit, using a peripheral wheel speed of 6,000 fpm to a smooth dull finish with a directional pattern.

B. Applied finish: ANSI A156.18 finish number 613, dark oxidized satin bronze, oil rubbed; oxide or sulfide chemical process using immersion or brushed on application as recommended by the manufacturer.

1. Color of finish: Match sample on file with the Authority’s Representative.

2.12 STAINLESS-STEEL FINISHES:

A. Remove or blend tool and die marks and stretch lines into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Satin, Directional Polish: ANSI A156.18 finish number 654, satin stainless steel.

D. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.13 STEEL FINISHES:

A. Galvanizing: Hot-dip galvanize products made from rolled, pressed, and forged steel shapes, castings, plates, bars, and strips indicated to be galvanized to comply with ASTM A 123.
   1. Hot-dip galvanize iron and steel hardware indicated to be galvanized to comply with ASTM A 153.

B. Fill vent and drain holes that will be exposed in finished Work, unless indicated to remain as weep holes, by plugging with zinc solder and filing off smooth.

C. Preparation for Shop Priming: After galvanizing, thoroughly clean ornamental metal of grease, dirt, oil, flux, and other foreign matter, and treat with metallic-phosphate process.

D. Preparation for Shop Priming: Prepare uncoated ferrous-metal surfaces to comply with minimum requirements indicated below for SSPC surface-preparation specifications and environmental exposure conditions of installed ornamental metal:
   1. Exteriors (SSPC Zone 1B): SSPC-SP 6, "Commercial Blast Cleaning."
   2. Interiors (SSPC Zone 1A): SSPC-SP 7, "Brush-off Blast Cleaning."

E. Factory-Primed Finish: Apply air-dried primer immediately after cleaning and pretreatment, to provide a minimum dry film thickness of 2 mils per applied coat, to surfaces that will be exposed after assembly and installation, and to concealed, nongalvanized surfaces.

F. Baked-Enamel Finish:
   1. Primer: Kem Hi-Temp Heat-Flex II 450 Primer by Sherwin-Williams, or equal.
   2. Finish coat: Kem Hi-Temp Heat-Flex 450 Finish by Sherwin-Williams, or equal.
   3. Porcelain Enamel Finish: PEI S-100, Specification for Architectural Porcelain Enamel on Steel for Exterior Use: Class AA or Class A.

PART 3 - EXECUTION

3.01 PREPARATION:

A. Remove foreign substances and irregularities from surfaces against which metalwork is to be placed.

3.02 INSTALLATION, GENERAL:

A. Coordinate installation of ornamental metalwork with work of other trades. Provide anchorage devices and fasteners where necessary for securing ornamental metal to in-place construction.

B. Perform cutting, drilling, and fitting required to install ornamental metal. Set products accurately in location, alignment, and elevation; measured from established lines and levels. Provide temporary bracing or anchors in formwork for items to be built into concrete, masonry, or similar construction.

C. Fit exposed connections accurately together to form tight, hairline joints or, where indicated, with uniform reveals and spaces for sealants and joint fillers. Where cutting, welding, and grinding are required for proper shop fitting and jointing of ornamental metal, restore finishes to eliminate any evidence of such corrective work.

D. Do not cut or abrade finishes that cannot be completely restored in the field. Return items with such finishes to the shop for required alterations, followed by complete refinishing, or provide new units as required.

E. Fasten metalwork in place so that items will not be distorted, finish will not be impaired, nor fasteners over stressed from expansion and contraction of metal.

F. Protect exposed metalwork throughout work to prevent scratches, stains, discoloration and other damage. Restore protective coverings that have been damaged during shipment or installation. Remove protective coverings only when there is no possibility of damage from other work yet to be performed at same location.
   1. Retain protective coverings intact; remove coverings simultaneously from similarly finished items to preclude nonuniform oxidation and discoloration.

G. Field Welding: Comply with applicable AWS specification for procedures of manual shielded metal arc welding, for appearance and quality of welds, and for methods used in correcting welding work. Weld connections that are not to be left as exposed joints but cannot be shop welded because of shipping size limitations. Grind exposed welded joints smooth and restore finish to match finish of adjacent surfaces.

H. Provide protection against galvanic action between dissimilar metals by completely covering contact surfaces with heavy brush-coat of bituminous paint or by separating contact surfaces with preformed tape.

I. Apply heavy brush-coat of bituminous paint to contact surfaces of ornamental metals, except stainless steel, which come into contact with concrete, mortar or other masonry. Do not apply paint onto concrete or masonry surfaces. Apply to metal, let cure, then apply metal fabrication to concrete or masonry.

3.03 INSTALLING HANDRAILS AND RAILINGS:

A. Adjust handrails and railings before anchoring to ensure alignment at abutting joints.

B. Concrete-Anchored Posts in Sleeves: Insert posts in preset sleeves, cast into concrete, and fill annular space between posts and sleeve with epoxy grout.
   1. Remove contaminants from surfaces receiving and coming into contact with the grout. Remove surface contaminants such as curing compounds from holes that receive grout. Ensure that surfaces to receive grout are dry at the time of grouting.
   2. Prime surfaces in accordance with grout manufacturer's recommendations.
   3. Mix and place epoxy grout for locations shown or specified as recommended by grout manufacturer. Level exposed surfaces of grout joints with adjacent surfaces. Grind rough or raised projections smooth and flush with adjacent surfaces. Retain paragraph above or below or delete both if no posts in concrete.

C. Anchor posts to metal surfaces with fittings designed for this purpose.

D. Non-welded Connections: Use mechanical or adhesive joints for permanently connecting railing components. Use wood blocks and padding to prevent damage to railing members and fittings. Seal recessed holes of exposed locking screws using plastic cement filler colored to match finish of handrails and railing

E. Welded Connections: Use fully welded joints for permanently connecting railing components by welding. Cope or butt components to provide 100 percent contact or use fittings designed for this purpose.

F. Anchor railing ends into concrete or masonry with fittings designed for this purpose.

G. Anchor railing ends to metal surfaces with fittings using concealed fasteners.

H. Anchor railing ends to metal surfaces by welding.

I. Expansion Joints: Provide expansion joints at locations indicated or, if not indicated, at intervals not to exceed 40 feet. Provide slip-joint internal sleeve extending 2 inches beyond joint on either side, fasten internal sleeve securely to one side, and locate joint within 6 inches of post.

3.04 CLEANING:

A. Upon completion of installation, clean surfaces of metalwork by procedure recommended by metalwork manufacturer.

B. Clean up rubbish and debris caused by this work and remove from the site.

3.05 PROTECTION:

A. Protect finishes of ornamental metal from damage during construction period with temporary protective coverings approved by ornamental metal fabricator. Remove protective covering at the time of Substantial Completion.

B. Restore finishes damaged during installation and construction period so no evidence remains of correction work. Return items that cannot be refinished in the field to the shop; make required alterations and refinish entire unit, or provide new units.

END OF SECTION

SECTION 05810

EXPANSION JOINT COVER ASSEMBLIES

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing expansion joint cover assemblies.

B. Related Work Specified Elsewhere:
1. Cast-In-Place Structural Concrete: Section 03300.
2. Expansion Joint Systems: Section 05811.
3. Flashing and Sheet Metal: Section 07600.
4. Seals and Sealants: Section 07900.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements specified for each:
1. Product data for each type of expansion joint cover assembly specified, including manufacturer's product specifications, installation instructions, details of construction relative to materials, dimensions of individual components, profiles, and finishes.
2. Shop drawings showing fabrication and installation of expansion joint cover assembly including plans, elevations, sections, details of components, joints, splices, and attachments to other units of Work.
3. Samples for initial selection purposes in the form of manufacturer's color charts, actual units, or sections of units showing full range of colors, textures, and patterns available for each exposed metal and elastomeric material of expansion joint cover assembly indicated.
4. Samples for verification purposes in full-size units of each type of expansion joint cover assembly indicated; in sets for each finish, color, texture, and pattern specified, showing full range of variations expected in these characteristics.
   a. Install elastomeric material for joints samples to verify color selected.

1.03 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
1. Comply with codes and regulations of the jurisdictional authorities.
2. ADA: Americans with Disabilities Act.
3. AAMA: 603.8, 605.2, 606.1, 607.1, 608.1
4. ANSI/UL: 263.
5. ASTM: A167, B209, B221, B455, C920, D2000, E119, E1399.
6. NAAMM: Metal Finishes Manual.
7. NFPA: 251.
8. UBC: 43-1.

B. Single-Source Responsibility: Where practical, obtain expansion joint cover assemblies specified in this Section from one source from a single manufacturer. Coordinate compatibility with expansion joint cover assemblies specified in other sections.

C. Fire-Test-Response Characteristics: Where indicated, provide expansion joint cover assemblies identical to those assemblies whose fire resistance has been determined per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E119, including hose stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.
1. Fire-Resistance Ratings: Not less than the rating of adjacent construction.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Aluminum: ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 6061-T6, sheet and plate.
   1. Protect aluminum surfaces to be placed in contact with cementitious materials with a protective coating.

B. Bronze: ASTM B455, alloy C38500 for extrusions; alloy C28000 Muntz Metal for plates.

C. Brass: UNS alloy C26000 for half hard sheet and coil.

D. Stainless Steel: ASTM A167, Type 304 with 2B finish, unless indicated otherwise, for plates, sheet, and strips.

E. Extruded Preformed Seals: Single or multicellular elastomeric profiles as classified under ASTM D2000, designed with or without continuous, longitudinal, internal baffles. Formed to fit compatible frames, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.

F. Preformed Sealant: Manufacturer's standard elastomeric sealant complying with ASTM C920, Use T, factory-formed and -bonded to metal frames or anchor members; in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.
   1. Joints 2 Inches Wide and Less: Withstand plus or minus 35 percent movement of the joint width without failure.
   2. Joints Greater Than 2 Inches to 4 Inches Wide: Withstand plus or minus 50 percent movement of the joint width without failure.

G. Seismic Seals: Typically for exterior application, two single-layered elastomeric profiles, one interior and one exterior, as classified under ASTM D2000; retained in a set of compatible frames, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors. At manufacturer's option, omit interior profile for interior application.

H. Fire Barriers: Designed for indicated or required dynamic structural movement without material degradation or fatigue when tested according to ASTM E1399. Tested in maximum joint width condition with a field splice as a component of an expansion joint cover per ANSI/UL 263, NFPA 251, U.B.C. 43-1, or ASTM E119, including hose stream test of vertical wall assemblies by a nationally recognized testing and inspecting agency acceptable to authorities having jurisdiction.

I. Accessories: Manufacturer's standard anchors, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesive, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.02 EXPANSION JOINT COVER ASSEMBLIES:

A. General: Provide expansion joint cover assemblies of design, basic profile, materials, and operation indicated on approved shop drawings. Provide units comparable to those indicated or required to accommodate joint size, variations in adjacent surfaces, and dynamic structural movement without material degradation or fatigue when tested according to ASTM E1399. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline mitered corners where joint changes directions or abuts other materials. Include closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint cover assemblies.

B. Moisture Barrier: Provide manufacturer's continuous, standard, flexible vinyl moisture barrier under covers at locations indicated on approved shop drawings.

C. Fire-Rated Joint Covers: Provide expansion joint cover assemblies with manufacturer's continuous, standard, flexible fire barrier seals under covers at locations indicated on approved shop drawings to provide fire-resistive rating not less than the rating of adjacent construction.

D. Coverless Fire Barrier: Provide manufacturer's continuous standard flexible fire barrier seals at locations indicated on approved shop drawings to provide fire-resistive rating not less than the rating of adjacent construction.

E. Metal Floor-to-Floor Joint Cover Assemblies: Provide continuous extruded metal frames of profile indicated with seating surface and raised floor rim or exposed trim strip to accommodate flooring and concealed bolt and anchors embedded in concrete. Provide assemblies formed to receive cover plates of design indicated and to receive filler materials (if any) between raised rim of frame and edge of plate. Furnish depth and configuration to suit type of construction and to produce a continuous flush wearing surface with adjoining finish floor surface.
   1. Partially Concealed Cover: Provide one frame on each side of joint, designed to accommodate manufacturer's floor cover plate and filler.
   2. Exposed Cover: Provide one frame on each side of joint, designed to support floor plate and filler
   3. Flat Cover Plates: Provide cover plates of profile and wearing surface indicated. Extend flat plates to lap each side of joint.
      a. Filler Insert: Furnish abrasive-resistant flexible gasket filler between edge of cover plate and raised rim of frame to accommodate required movement
   4. Fixed Cover Plates: Attach one side of the cover plate to a frame or finished wearing surface, with other side resting on other frame or finished wearing surface to allow free movement.
   5. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames as to have free movement on both sides.
   6. Floor Cover Plate Wearing Surfaces: Provide cover plates with the following type of wearing surfaces.
      a. Plain.
      b. Fluted.
      c. Recessed to receive full thickness of flooring material.
      d. Abrasive plate.
      e. Adhesive filled plate.
      f. Adhesive strip plate.

F. Floor-to-Wall Joints: Provide one frame on floor side of joint only. Provide wall side frame where required by manufacturer's design.
   1. Angle Cover Plates: Attach angle cover plates for floor-to-wall joints to wall with countersunk, flat-head exposed fasteners secured to drilled-in-place anchor shields, unless otherwise indicated, at spacing recommended by joint cover manufacturer.

G. Wall, Ceiling, and Soffit Joint Cover Assemblies: Provide interior wall and ceiling expansion joint cover assemblies of same design and appearance. Provide exterior wall and soffit expansion joint cover assemblies of same design and appearance. Provide wall expansion joint cover assemblies compatible with floor expansion joint cover assemblies design and appearance.
   1. Fixed Metal Cover Plates: Provide a concealed, continuously anchored frame fastened to wall, ceiling, or soffit only on one side of joint. Extend cover to lap each side of joint and to permit free movement on one side. Attach cover to frame with cover in close contact with adjacent finish surfaces.

2. Floating Metal Cover Plates: Cover plate secured in or on top of frames to permit free movement on both sides.
3. Self-Centering Cover Plates: Concealed centering device with the cover plate secured in or on top of frames to permit free movement on both sides.
4. Flexible Filler: Secure the approved flexible filler between frames to compress and expand with movement.

H. Joint Cover Assemblies with Preformed Seals: Provide joint cover assemblies consisting of continuously anchored aluminum extrusions and continuous extruded preformed seals of profile indicated or required to suit types of installation conditions shown. Furnish extrusions designed to be embedded in or attached to concrete with lugs. Vulcanize or heat-weld splices (if any) to ensure hermetic joint condition.
1. Cover Plate: Include extruded aluminum cover plate fastened to one side of joint and extend plate to lap each side of joint to permit free movement with cover in close contact with adjacent contact surfaces.

I. Joint Cover Assemblies with Elastomeric Sealant: Provide continuous cover joint assemblies consisting of elastomeric sealant factory-bonded to extruded aluminum frames of profile indicated or required to suit types of installation conditions shown. Provide frames for floor joints with means for embedding in or anchoring to concrete without using exposed fasteners and that will result in exposed surfaces of sealant and aluminum frames finishing flush with adjacent finished floor surface without exposing anchors.

J. Compression Seals: Preformed, elastomeric extrusions having internal baffle system in sizes and profiles shown or as recommended by the manufacturer. Provide lubricant and adhesive for installation recommended by the manufacturer.

K. Foam Seal: Nonextruded, low-density, cross-linked, nitrogen-blown ethylene vinyl acetate polyethylene copolymer foam. Provide adhesive for installation recommended by the manufacturer.

2.03 METAL FINISHES:

A. General: Comply with NAAMM "Metal Finishes Manual" for finish designations and application recommendations, except as otherwise indicated. Apply finishes to products in factory after fabrication. Protect finishes on exposed surfaces before shipment.

B. Aluminum Finishes: Finish designations prefixed by AA conform to the system established by the Aluminum Association for designating aluminum finishes.
1. Mill Finish: AA-M10 (unspecified mill finish).
2. Class II, Clear-Anodized Finish: AA-M12C22A31 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, clear film thicker than 0.4 mil].
3. Class I, Clear-Anodized Finish: AA-M12C22A41 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, clear film thicker than 0.7 mil[complying with AAMA 607.1.
4. Class II, Color-Anodized Finish: AA-M12C22A32/A34 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class II Architectural, film thicker than 0.4 mil with integral color or electrolytically deposited color].
5. Class I, Color-Anodized Finish: AA-M12C22A42/A44 [Mechanical Finish: as fabricated, nonspecular; Chemical Finish: etched, medium matte; Anodic Coating: Class I Architectural, film thicker than 0.7 mil with integral color or electrolytically deposited color] complying with AAMA 606.1 or AAMA 608.1.
   a. Color: As selected by the Engineer from within standard industry colors and color density range.
6. Baked Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited

chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.

a. Organic Coating: Thermosetting modified acrylic enamel primer/topcoat system complying with AAMA 603.8 except with minimum dry film thickness of 1.5 mils, medium gloss

b. Color: As selected by the Engineer from manufacturer's standard colors.

7. High-Performance Organic Coating: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: chemical conversion coating, acid chromate-fluoride-phosphate pretreatment; Organic Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturer's instructions.

a. Fluoropolymer Two-Coat Coating System: Manufacturer's standard two-coat thermocured system, composed of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.

b. Fluoropolymer Three-Coat Coating System: Manufacturer's standard three-coat thermocured system composed of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluorocarbon topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 605.2.

1) Resin Manufacturers: Subject to compliance with requirements, provide fluoropolymer coating systems containing resins produced by one of the following manufacturers:

a) Ausimont USA, Inc. (Hylar 5000).

b) Elf Atochem North America, Inc. (Kynar 500).

c) Or equal.

2) Color and Gloss: As selected by the Engineer from manufacturer's standard choices for color and gloss.Retain below for covers in contact with masonry or concrete.

8. Factory-Primed Concealed Surfaces: Protect concealed metal surfaces to be placed in contact with concrete or masonry with a shop coat of manufacturer's standard primer on the contact surfaces.

C. Bronze Finish: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

1. Natural Satin Finish: CDA Designation M32, mechanical finish, directional textured, medium satin.

D. Stainless Steel Finishes: Comply with NAAMM "Metal Finishes Manual" for recommendations relative to application and designations of finishes.

1. Bright, Cold-Rolled Unpolished Finish: AISI No. 2B finish.
2. Bright, Directional Polish: AISI No. 3 finish.

E. Factory Finish: Manufacturer's standard factory finish.

PART3 - EXECUTION

3.01 PREPARATION:

A. Manufacturer's Instructions: In addition to requirements of these specifications, comply with manufacturer's instructions and recommendations for phases of Work, including preparing substrate, applying materials, and protecting installed units.

B. Coordinate and furnish anchorages, setting drawings, templates, and instructions for installation of expansion joint cover assemblies to be embedded in or anchored to concrete

or to have recesses formed into edges of concrete slab for later placement and grouting-in of frames.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure expansion joint cover assemblies to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and provide for secure attachment of expansion joint cover assemblies.

3.02 INSTALLATION:

A. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required to install expansion joint covers. Install joint cover assemblies in true alignment and proper relationship to expansion joints and adjoining finished surfaces measured from established lines and levels. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling. Set floor covers at elevations to be flush with adjacent finished floor materials. Locate wall, ceiling, roof, and soffit covers in continuous contact with adjacent surfaces. Securely attach in place with required accessories. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches on center.

B. Continuity: Maintain continuity of expansion joint cover assemblies with a minimum number of end joints and align metal members mechanically using splice joints. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials (if any) to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

C. Extruded Preformed Seals: Install seals complying with manufacturer's instructions and with minimum number of end joints. For straight sections provide preformed seals in continual lengths. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer. Apply adhesive, epoxy, or lubricant-adhesive approved by manufacturer to both frame interfaces before installing preformed seal. Seal transitions according to manufacturer's instructions.

D. Elastomeric Sealant Joint Assemblies: Seal end joints within continuous runs and joints at transitions according to manufacturer's directions to provide a watertight installation.

E. Seismic Seals: Install interior seals in continual lengths; vulcanize or heat-weld field splice joints in interior seal material to provide watertight joints using manufacturer's recommended procedures. Install exterior seal in standard lengths. Seal transitions and end joints according to manufacturer's instructions.

F. Fire Barriers: Install fire barriers, including transitions and end joints, according to manufacturer's instructions so that fire-rated construction is continuous.

3.03 CLEANING AND PROTECTION:

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's instructions.

END OF SECTION

SECTION 05811

EXPANSION JOINT SYSTEMS

PART 1 - GENERAL

1.01 DESCRIPTION:

A. This section specifies providing exterior (pedestrian and vehicular) traffic joints, exterior (wall and ceiling) joints, exterior soffit joints, interior (pedestrian and vehicular) traffic joints, interior (wall anc ceiling) joints and interior soffit joints.

B. Related Work Specified Elsewhere:
   1. Cast-In-Place Structural Concrete: Section 03300.
   2. Expansion Joint Cover Assemblies: Section 05810.
   3. Flashing and Sheet Metal: Section 07600.
   4. Seals and Sealants: Section 07900.

1.02 DEFINITIONS:

A. Architectural Joint System: Any filler or cover used to span, fill, cover, or seal a joint, except expanding foam seals and poured or foamed in-place sealants.

B. Cyclic Movement: Periodic change between widest and narrowest joint widths in an automatically mechanically controlled system.

C. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist passage of flame and hot gases through a movement joint.

D. Maximum Joint Width: Widest linear gap a joint system tolerates and performs its designed function without damaging its functional capabilities.

E. Minimum Joint Width: Narrowest linear gap a joint system tolerates and performs its designed function without damaging its functional capabilities.

F. Movement Capability: Value obtained from the difference between widest and narrowest widths of a joint opening typically expressed in numerical values (inches) or a percentage of nominal value of joint width.

G. Nominal Joint Width: Width of linear gap indicated as representing the conditions existing when architectural joint systems will be installed or, if no nominal joint width is indicated, a width equal to the sum of maximum and minimum joint widths divided by two

1.03 PERFORMANCE REQUIREMENTS:

A. General: Provide factory-fabricated architectural joint systems capable of withstanding the types of loads and of accommodating the kinds of movement, and the other functions for which they are designed including those specified below, without failure. Types of failure include those listed in Appendix X3 of ASTM E1399.
   1. Vehicular Traffic Joints: Support vehicular traffic across joint.
   2. Pedestrian Traffic Joints: Support pedestrian traffic across joint.
   3. Exterior Joints: Maintain continuity of weather enclosure.
   4. Joints in Fire-Resistance-Rated Assemblies: Maintain fire-resistance ratings of assemblies.
   5. Joints in Smoke Barriers: Maintain integrity of smoke barrier.

6. Joints in Acoustically Rated Assemblies: Inhibit passage of airborne noise.
7. Other Joints: Where indicated, provide joint systems that prevent penetration of water, moisture, and other substances deleterious to building components or content.
8. Seismic Joints: Remain in place on exposure to seismic activity (movement).
9. Joints in Surfaces with Architectural Finishes: Serve as finished architectural joint closures.

1.02 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:
   1. Product Data: Include manufacturer's product specifications, construction details, material and finish descriptions, and dimensions of individual components and seals.
   2. Shop Drawings: For each joint system specified, provide the following:
      a. Placement Drawings: Include line diagrams showing entire route of each joint system, plans, elevations, sections, details, joints, splices, locations of joints and splices, and attachments to other Work. Where joint systems change planes, provide Isometric Drawings depicting how components interconnect to achieve continuity of joint covers and fillers.
   3. Samples for Initial Selection: Manufacturer's color charts consisting of units or sections of units showing the full range of colors, textures, and patterns available for each exposed metal and elastomeric material of joint system indicated.
      a. Include similar Samples of material for joints and accessories involving color selection.
   4. Samples for Verification: Full-size units 6 inches long of each type of joint system indicated; in sets for each finish, color, texture, and pattern specified, showing the full range of variations expected in these characteristics.
   5. Product Test Reports: From a qualified testing agency indicating architectural joint systems comply with requirements, based on comprehensive testing of current products.

1.05 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Comply with codes and regulations of the jurisdictional authorities.
   2. AAMA: 606.1, 607.1, 608.1, 2603, 2604, 2605.
   3. ADA: Americans with Disabilities Act.
   4. ASTM: A666, B36, B209, B221, B455, E119, E814, E1399, E1612, E1783.
   5. NAAMM: Metal Finishes Manual for Architectural and Metal Products.
   6. UL: 2079.

B. Source Limitations: Where practical, obtain architectural joint systems through one source from a single manufacturer. Coordinate compatibility with adjoining joint systems specified in other Sections.

C. Fire-Test-Response Characteristics: Where indicated, provide joint systems incorporating fire barriers that are identical to those of assemblies tested for fire resistance per **[ASTM E 119] [and] [ASTM E 814] [UL 2079]**, including hose-stream test of vertical wall assemblies, by a testing and inspecting agency acceptable to authorities having jurisdiction.

PART 2 - PRODUCTS

2.01 MATERIALS:

A. Aluminum: ASTM B221, alloy 6063-T5 for extrusions; ASTM B209, alloy 6061-T6 for sheet and plate.
   1. Apply manufacturer's standard protective coating on aluminum surfaces to be placed in contact with cementitious materials.

B. Bronze: ASTM B455, alloy C38500 for extrusions; alloy C23000 Red Brass for plates.

C. Brass: ASTM B36/B36M, UNS alloy C26000 for half hard sheet and coil.

D. Stainless Steel: ASTM A666, Type 304 with No. 2B finish, unless otherwise indicated, for plates, sheet, and strips.

E. Preformed Seals: Single or multicellular extruded elastomeric seals designed with or without continuous, longitudinal, internal baffles. Formed to be installed in frames or with anchored flanges, in color indicated or, if not indicated, as selected by the Engineer from manufacturer's standard colors.

F. Preformed Silicon-Foam Sealant System: Section 07900.

G. Strip Seals: Elastomeric membrane or tubular extrusions with a continuous longitudinal internal baffle system throughout complying with ASTM E 1783; used with compatible frames, flanges, and molded-rubber anchor blocks.

H. Compression Seals: Preformed, elastomeric extrusions having internal baffle system complying with ASTM E1612 in sizes and profiles indicated or as recommended by manufacturer.

I. Preformed Cellular Foams: [Nonextruded, low-density, crosslinked, nitrogen-blown ethylene-vinyl-acetate copolymer] [Neoprene] [or] [polyurethane] extruded, compressible foam.

J. Fire Barriers: Any material or material combination, when fire tested after cycling, designated to resist the passage of flame and hot gases through a movement joint.

K. Accessories: Manufacturer's standard anchors, clips, fasteners, set screws, spacers, flexible moisture barrier and filler materials, drain tubes, lubricants, adhesives, and other accessories compatible with material in contact, as indicated or required for complete installations.

2.02 EXPANSION JOINT SYSTEMS:

A. General: Provide joint systems of design, basic profile, materials, and operation indicated on approved shop drawings. Provide units with the capability to accommodate joint widths indicated and variations in adjacent surfaces.
   1. Furnish units in longest practicable lengths to minimize number of end joints. Provide hairline mitered corners where joint changes directions or abuts other materials.
   2. Include closure materials and transition pieces, tee-joints, corners, curbs, cross-connections, and other accessories as required to provide continuous joint systems.
   3. Frames for Strip Seals: Designed with semiclosed cavity that provides a mechanical lock for seals of type indicated.
   4. Public Arena Seals: Non-slip seals designed for installation on treads and risers and to lie flat with adjacent surfaces, and complying with ADA guidelines for public areas.

5. Cyclic-Movement-Test-Response Characteristics: No evidence of visual fatigue, inability to cycle between designated joint widths, or other types of failure as determined by testing products identical to those indicated per ASTM E1399 including Appendix X3.
6. Fire-Resistance Ratings: Provide manufacturer's standard fire barrier with a rating not less than that of adjacent construction.
7. Moisture Barrier: Provide manufacturer's standard unit.

2.03 FINISHES, GENERAL:

A. Comply with NAAMM's "Metal Finishes Manual for Architectural and Metal Products" for recommendations for applying and designating finishes.

B. Protect mechanical finishes on exposed surfaces from damage by applying a strippable, temporary protective covering before shipping.

2.04 ALUMINUM FINISHES:

A. Finish designations prefixed by AA comply with the system established by the Aluminum Association for designating aluminum finishes.

B. Mill Finish: AA-M10 (Mechanical Finish: as fabricated; no other applied finish unless buffing is required to remove scratches, welding, or grinding produced in fabrication process.

C. Class II, Clear Anodic Finish: AA-M12C22A31 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, clear coating 0.010 mm or thicker) complying with AAMA 607.1.

D. Class I, Clear Anodic Finish: AA-M12C22A41 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, clear coating 0.018 mm or thicker) complying with AAMA 607.1.

E. Class II, Color Anodic Finish: AA-M12C22A32/A34 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class II, integrally colored or electrolytically deposited color coating 0.010 mm or thicker).

F. Class I, Color Anodic Finish: AA-M12C22A42/A44 (Mechanical Finish: nonspecular as fabricated; Chemical Finish: etched, medium matte; Anodic Coating: Architectural Class I, integrally colored or electrolytically deposited color coating 0.018 mm or thicker) complying with AAMA 606.1 or AAMA 608.1.
1. Color: As selected by the Engineer from the full range of industry colors and color densities.

G. Baked-Enamel Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic Coating: as specified below). Apply baked enamel complying with paint manufacturer's specifications for cleaning, conversion coating, and painting.
1. Organic Coating: Thermosetting, modified-acrylic enamel primer/topcoat system complying with AAMA 2603 except with a minimum dry film thickness of 1.5 mils, medium gloss.
2. Color: As selected by the Engineer from manufacturer's full range.

H. High-Performance Organic Finish: AA-C12C42R1x (Chemical Finish: cleaned with inhibited chemicals; Chemical Finish: acid-chromate-fluoride-phosphate conversion coating; Organic

Coating: as specified below). Prepare, pretreat, and apply coating to exposed metal surfaces to comply with coating and resin manufacturers' written instructions.

1. Fluoropolymer Two-Coat System: Manufacturer's standard two-coat, thermocured system consisting of specially formulated inhibitive primer and fluoropolymer color topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2604.
2. Fluoropolymer Three-Coat System: Manufacturer's standard three-coat, thermocured system consisting of specially formulated inhibitive primer, fluoropolymer color coat, and clear fluoropolymer topcoat, with both color coat and clear topcoat containing not less than 70 percent polyvinylidene fluoride resin by weight; complying with AAMA 2605.
    a. Color and Gloss: As selected by the Engineer from manufacturer's full range.

2.05 STAINLESS STEEL FINISHES:

A. Remove tool and die marks and stretch lines or blend into finish.

B. Grind and polish surfaces to produce uniform, directionally textured, polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

C. Bright, Cold-Rolled, Unpolished Finish: No. 2B finish.

D. Bright, Directional Polish: No. 4 finish.

E. Satin, Directional Polish: No. 6 finish.

F. Mirrorlike Reflective, Nondirectional Polish: No. 8 finish.

G. When polishing is completed, passivate and rinse surfaces. Remove embedded foreign matter and leave surfaces chemically clean.

2.06 COPPER ALLOY FINISHES:

A. Finish designations prefixed by CDA comply with the system established by the Copper Development Association for designating copper-alloy finish systems, as defined in NAAMM's "Metal Finishes Manual for Architectural and Metal Products."
    1. Remove tool and die marks and stretch lines or blend into finish.
    2. Grind and polish surfaces to produce uniform, directionally textured polished finish indicated, free of cross scratches. Run grain with long dimension of each piece.

B. Standard Finish Designation: CDA M32 (Mechanical Finish: directionally textured, medium satin).

PART 3 - EXECUTION

3.01 PREPARATION:

A. Prepare substrates according to architectural joint system manufacturer's written instructions.

B. Coordinate and furnish anchorages, Placement Drawings, and instructions for installing joint systems to be embedded in or anchored to concrete or to have recesses formed into edges of concrete slab for later placement and grouting-in of frames.

C. Fastening to In-Place Construction: Provide anchorage devices and fasteners where necessary to secure joint systems to in-place construction, including threaded fasteners with drilled-in expansion shields for masonry and concrete where anchoring members are not embedded in concrete. Provide fasteners of metal, type, and size to suit type of construction indicated and to provide for secure attachment of joint systems.

3.02 INSTALLATION:

A. Comply with manufacturer's written instructions for handling and installing architectural joint assemblies and materials, unless more stringent requirements are indicated.

B. Coordinate installation of architectural joint assembly materials and associated work so complete assemblies comply with assembly performance requirements.

C. Terminate exposed ends of exterior architectural joint assemblies with factory-fabricated termination devices to maintain waterproof system.

D. Install factory-fabricated transitions between building expansion joint cover assemblies and roof expansion joint assemblies to provide continuous, uninterrupted, watertight construction.

E. Coordinate the size of joint opening at the time joint segments are set in position (distance between joint segments) with the temperature of the structure and the designed joint movement.

F. Cutting, Fitting, and Placement: Perform cutting, drilling, and fitting required to install joint systems.
1. Install joint cover assemblies in true alignment and proper relationship to joints and adjoining finished surfaces measured from established lines and levels.
2. Allow adequate free movement for thermal expansion and contraction of metal to avoid buckling.
3. Set covers in horizontal surfaces at elevations that place exposed surfaces flush with adjoining finishes.
4. Locate covers in continuous contact with adjacent surfaces.
5. Securely attach in place with required accessories.
6. Locate anchors at interval recommended by manufacturer, but not less than 3 inches from each end and not more than 24 inches o.c.

G. Continuity: Maintain continuity of joint systems with a minimum number of end joints and align metal members. Cut and fit ends to produce joints that will accommodate thermal expansion and contraction of metal to avoid buckling of frames. Adhere flexible filler materials, if any, to frames with adhesive or pressure-sensitive tape as recommended by manufacturer.

H. Extruded Preformed Seals: Install seals to comply with manufacturer's written instructions and with minimum number of end joints.
1. For straight sections, provide preformed seals in continuous lengths.
2. Vulcanize or heat-weld field splice joints in preformed seal material to provide watertight joints using procedures recommended by manufacturer.
3. Apply adhesive, epoxy, or lubricant adhesive approved by manufacturer to both frame interfaces before installing preformed seals.
4. Seal transitions according to manufacturer's written instructions.
5. Install foam seals with adhesive recommended by manufacturer and heat seal all splices.

I. Joint Systems with Seals: Seal end joints within continuous runs and joints at transitions according to manufacturer's written instructions to provide a watertight installation.

J. Seismic Seals: Install interior seals in continuous lengths. Install exterior seal in standard lengths and vulcanize or heat-weld field splice joints to provide watertight joints using manufacturer's recommended procedures. Seal transitions and end joints according to manufacturer's written instructions.

K. Fire Barriers: Install fire barriers to provide continuous, uninterrupted fire resistance throughout length of joint, including transitions and end joints.

3.03 CLEANING AND PROTECTION:

A. Do not remove protective covering until finish work in adjacent areas is complete. When protective covering is removed, clean exposed metal surfaces to comply with manufacturer's written instructions.

END OF SECTION

SECTION 05840

BEARINGS

PART 1 - GENERAL

1.02 DESCRIPTION:

A. This section specifies spherical and elastomeric bearings, fixed and sliding types, as shown. Pot Bearings shall not be used.

B. Related Work Specified Elsewhere:
   1. Structural Steel: Section 05120.

1.02 QUALITY ASSURANCE:

A. Codes, Regulations, Reference Standards and Specifications:
   1. Codes and regulations of the jurisdictional authorities.
   2. AWS: C-2.2, D 1.1.
   3. AASHTO: Standard Specifications for Highway Bridges, including supplement and M235. Where conflict occurs between AWS and AASHTO, AASHTO governs.
   4. AISC:
      a. Specification for the Design, Fabrication and Erection of Structural Steel for Buildings.
      b. Code of Standard Practice for Steel Buildings and Bridges.
      c. Specifications for Structural Joints using ASTM A325 and A490 Bolts.
   5. AISI: C1018, C1020.
   6. ANSI: B18.2, B27.2.
   7. ASTM: A167, A240, A 709, C287, D621, D1777, D2256.
   8. ASNT: Recommended Practice SNT-TC-1A.
   9. MS: MIL P23236

B. Source Quality Control:
   1. Testing and inspection:
      a. Nondestructive-test requirements for welded members:
         1) Perform the following:
         2) For all fillet-weld connections: 10 percent of welds inspected by magnetic particle inspection.
         3) The Engineer may designate additional items to be inspected by radiography.
      b. Bolts: The Engineer will randomly select at least five bolts for test purposes from each bin of bolts furnished.

C. Qualification of Welding Personnel and Procedures:
   1. Prior to qualifying welding personnel and welding procedures, confirm an agreement with the Engineer as to procedural details, sequence of welding, handling of materials to be inspected, and approval of electrodes, wire, flux and other welding materials and equipment.
   2. Employ welding personnel whose qualification is certified in accordance with AWS Standard D1.1. Such certification is to remain in force for the duration of the welding operations under this Contract.
   3. Do not start fabrication until qualification has been successfully completed.

D. Qualification of Nondestructive-Testing Personnel:

1. Nondestructive testing of fracture-critical members to be conducted by personnel qualified as NDT Level II or Level III in accordance with ASNT SNT-TC-1A.
2. Level-II technicians to be supervised by Level III-personnel.

E. Stock Material:
1. For qualification of welding personnel and procedures and for quality-assurance testing, use only stock materials which can be identified as having been rolled from a given heat and for which certified mill tests can be produced.
2. When stock material is proposed, inform the Engineer of such intention at least 10 days in advance of commencing fabrication to permit sampling and testing. Select identified material from as few heats as possible.

F. Welder's Identification Mark:
1. Assign each welder and welding operator an identification mark to stamp on pieces he has welded.
2. Have welder or welding operator place his identification mark by metal-die stamp in letters 3/8-inch high in position that identification of welder or operator will appear adjacent to each of his welds in finally assembled members for ready reference to radiographic films and for identification by the Engineer.

G. Bearing Manufacturer:
1. Qualification of Bearing Manufacturer: The Contractor shall demonstrate that the selected bearing manufacturer has a successful performance record for at least ten (10) years in the design and fabrication of spherical bearings in structures similar to the Work herein. The manufacturer shall also be capable of ensuring a close control over the materials, workmanship and quality within his facilities.
2. Certification of Bearing Quality: The Contractor shall submit the following certification for approval by the Engineer:
   a. Bearing certificate of conformance.
   b. Test reports and certification of all materials included in the construction of all the bearings.
3. Inspection Facilities: The manufacturer shall be required to furnish facilities for the testing and inspection of the complete bearings and/or representative samples in his plant or at an independent test facility.

H. Testing of Bearings:
1. Sampling:
   a. Select at random at least one sample from each "lot" of completed bearings at the manufacturer's plant.
   b. One "lot" consists of one of the following:
      1) No more than 24 fixed or modified fixed bearings of one "load category".
      2) No more than 25 expansion bearings of one "load category".
   c. One "load category" may consist of bearings of differing vertical load capacity but not to exceed a range of capacity differing by more than 300 kips.
2. Friction Test:
   a. Specially made bearings are not to be used; only actual bearings to be used in the project are to be tested. Test in accordance with the requirements of Section 18.8.3 of the current addition of AASHTO "Standard Specifications for Highway Bridges". A sample from each lot of expansion bearing is to be tested.
3. Proof Load Test:
   a. Test one bearing from each production "lot" of fixed and expansion bearings.

b. Apply a load to the test bearings equal to 150% of the rated design capacity of the bearing simultaneously rotated 0.02 radians or the design rotation, which is greater, for one hour.
c. During the test or subsequently upon disassembly, the bearing shall show no sign of deformation or extrusion of the PTFE.

4. Material Tests:
5. One sample of PTFE is to be taken from each "lot".

1.03 SUBMITTALS:

A. Submit the following for approval in accordance with the General Requirements and with the additional requirements as specified for each:

1. Shop Drawings:
   a. Structural details: Include the following:
      1) Bills of materials giving complete information for fabrication and erection of component parts of structures including material and finish information.
      2) Details of location, type, sizes of bolts and welds and for welded structures details of welding as specified.
      3) Structural computations for Contractor-designed work certified by a professional engineer registered in the area where the work is to be performed.
   b. Match marks:
      1) Provide diagram showing match marks for connecting structural parts assembled in shop for purpose of drilling or reaming holes in field connections.
   c. Welding:
      1) Complete shop details of qualification test specimens.
      2) Include information on specimen identification, number of pieces and welding procedure specification, type of material, sizes of pieces and welds and other variables affecting detail or tests.
   d. Manufacturer's test procedures for bolts.
   e. Bearings:
      1) The manufacturer is to submit detailed assembly drawings and any attachments in sufficient detail for proper review of the contract and this specification.
      2) Shop drawings are to include but not be limited to the following information:
         a) Plan view and section elevation including all relative dimensions.
         b) Details of all components and sections showing all materials incorporated into the bearing.
         c) All ASTM, AASHTO and other material designations.
         d) Vertical, horizontal, rotation and movement capacity.
         e) A schedule of all bearing offsets if required by the project.
         f) Paint or coating requirements.
         g) Complete design calculations verifying conformance with the provisions of this specification and certified by a professional engineer registered in the jurisdiction where the work is performed. Do not proceed until approval has been received

B. Certification:

1. Certified mill test reports of structural steel at least 10 days prior to start of fabrication.

2. Certified quality-assurance testing and inspection reports.
3. Certification verifying that welding personnel have been qualified in accordance with AWS D1.1.
4. Manufacturer's certification that bolts meet approved testing.
5. Spherical-type bearings:
    a. The certification package is to contain the following:
        1) Materials test reports for all steels used except AISI C1018 and C1020 for which a mill conformance certificate is acceptable.
        2) Certificate of Compliance for all non-ferrous metals.
        3) Certificate of Compliance for PTFE and any adhesives used.A certificate of compliance for the bearings executed by an officer of the manufacturer's company.
        4) Certificate of Compliance for any dowels or bolts supplied
        5) Test reports for the performance tests.

1.04 PRODUCT DELIVERY, STORAGE AND HANDLING:

A. General:
1. Load, transport, unload and store structural materials so as to keep them clean and free from damage

B. Steelwork: See section 05120.

C. Bolts and Nuts: See section 05120.

D. Paint: See section 05120.

E. Bearings:
1. Bearings are to be securely banded together as units so that they may be shipped to the jobsite and stored without relative movement of the bearing parts or disassembly at any time. Bearings are to be wrapped in moisture resistance and dust resistant material to protect against shipping and jobsite conditions.
2. Take care to ensure that bearings at the jobsite are stored in a dry sheltered area free from dirt or dust until installation.
3. When bearings are to be inspected on site, they are to be inspected within one week of arrival and may not be disassembled except under the supervision of the manufacturer or his representative or with the written approval of the manufacturer. Following inspection, the wrapping is to be reapplied and the bearings kept clean until installation.
4. Removal of sole and top plates of bearings for separate attachment to the structure is not permitted except under the direct supervision of the manufacturer.

1.05 JOB CONDITIONS:

A. Environmental Requirements:
1. Welding: See section 05120.
2. Painting: See section 05120.

PART 2- PRODUCTS

2.01 MATERIALS:

A. PTFE sliding surfaces conforming to the material requirements of AASHTO Section 18.8. Reprocessed material shall not be used.

B. Stainless Steel sliding surfaces conforming to ASTM A167 or A240 Type 304 with a surface finish 20 micro-inches rms. or less. Welded stainless steel overlay produced using Type 309L electrodes.

C. Solid Stainless Steel stock for spherical bearings core conforming to ASTM A 240, Type 318 or Type 304 or to ASTM A167, Type 304, with a minimum yield strength of Fy equal 30,000 psi.

D. Steel in Bearings:
   1. Bearings for Aerial Line Sections
   2. Bearing assemblies used in the line sections of the aerial structure with span lengths of 80 feet or more, shall be self lubricating bearing assemblies to provide rotation and longitudinal movement as needed for expansion joints. The bearing assembly shall be an integral unit composed of:
      a. Spherical bearings plates - A convex solid stainless steel plate with surface of woven PTFE fabric mechanically interlocked to the substrate plate, and a mating concave solid stainless steel plate with finished bearing surface. The spherical interface shall provide rotational movement in any direction.
      b. Flat bearing plates - A flat plate with the PTFE material similarly fixed on the sliding surface, and a solid stainless steel concave mating plate, as described in [1] above, with a flat finished sliding surface, to provide longitudinal translation movement. The relative movement between these two flat surfaces is to be restricted to the longitudinal direction.
         1) The PTFE fabric shall have a minimum thickness of 1/16" and is to meet the following requirements:
            a) Hardness at 78˚F per ASTM D676 - 50-65 Durometer D
            b) Tensile strength per ASTM D638 - 2800 psi (Min. Avg.)
            c) Elongation per ASTM D1708 - 200% (Min. Avg.)
            d) The coefficient of friction between the steel plate and the PTFE surface shall be no greater than .06 at 800 psi compressive loading.
         2) The stainless steel surfaces shall have a finish of 20 RMS.
   3. Elastomeric bearings for Aerial Stations:
      a. Criteria for the design shall be governed by AASHTO Section 14 "Elastomeric bearings". Method A or B is to be used as applicable. The compressive strain should not exceed 7%.
      b. Bearing assemblies to be used in aerial stations shall be the sliding plate type bearing which allows translation by sliding of a self lubricating surface across a smooth hard solid stainless steel mating surface. The assembly is to have solid stainless steel bearing plate on the upper unit with sole plate and a preformed fabric pad with a rigidly confined PTFE bearing surface in the lower unit with masonry plate.
      c. The preformed fabric pad shall meet AASHTO Specifications 10.3.12 “Preformed Fabric Pads” and capable of withstanding loads of 10 ksi perpendicular to the plane of lamination.
      d. The metal bearing plate shall be fabricated from minimum of 13 gage stainless steel, and have a mirror finish with a minimum 20 micro inches RMS on the PTFE bearing side.
      e. The coefficient of friction between the steel plate and the PTFE surface shall be no greater than .06 at 800 psi compressive loading.
   4. Expansion bearings shall be sized and set at the time of construction to allow for the following:
      a. The maximum temperature movement based on the mean 48 hour prior temperature.

b. The anticipated rotation and movement due to creep, shrinkage and elastic shortening from time of setting through day 400. These computed rotation and movements shall be increased by a factor of 1.3.

5. Materials and fabrication for all type bearings, shall be in accordance with AASHTO, Section 18, Division II, and with the contract specifications.

E. All steel, except stainless steel, used in fabrication of structural bearings, including masonry, sole plates, hold-down bolts and plates, etc., to be in accordance with ASTM A709, Grade 50W, unless otherwise shown in the Contract Drawings.

1. All steel surfaces exposed to the atmosphere (except stainless) may at the manufacturer's option, be either shop painted with a coat of epoxy coal-tar protective coating system or zinc metalized.
   a. Epoxy coal-tar coating in accordance with the requirement of Military Specification MIL-P23236, Class 2, and be applied at a minimum wet-film thickness of 10 mils.
   b. Apply the metalized coatings in accordance with industry standards and AWS C-2.2.
2. Prior to application of the protective coating, the surfaces to be coated or metalized are to be cleaned in accordance with the recommendations of the manufacturer of the system.

F. Bolts and Nuts: ANSI B18.2.1 and B18.2.2.

G. Round Washers Other Than Those In Contact With High-Strength Bolt Heads And Nuts: ANSI B27.2, Type B.

H. Beveled Washers:
1. Square, smooth and sloped to make contact surfaces of bolt head and nut parallel.
2. Diameter of hole in square beveled washers as follows:
   a. For bolts less than one-inch diameter: 1/16-inch larger than bolt size.
   b. For bolts larger than one-inch diameter: 1/8-inch larger than bolt size.

I. For all other materials, see section 05120.

2.02 DESIGN OF BEARINGS:

A. General:
1. Multi-Rotational bearings are to be designed to accommodate the loads, forces and movements specified in the bearing schedule.
2. Maximum design stresses for all bearing components are not to exceed the allowable design stresses of the applicable issue of the AASHTO "Standard Specifications for Highway Bridges" and the applicable sections of this specification.
3. Minimum "Design Rotation" capacity is .015 radians or as specified in the contract plans.
4. Minimum horizontal capacity is 10% of the vertical capacity.
5. Bearings are to be designed for 1 inch additional total movement capacity in each direction specified under "Design Movement" in the "Bearing Schedule". Spacing between the guides of the bearing do not require this additional movement capacity.
6. Bearings are to be designed so that all rotational and sliding elements can be replaced with a minimum of jacking.
7. All dimensions in this specification are in the customary units of the United States.

B. Design of Rotational Elements:
1. Spherical Element-Concave Surface-PTFE/Woven Teflon Fabric Pad:

a. The spherical radius shall be determined such that the resulting geometry of the bearing is capable of withstanding the greatest ratio of horizontal force to vertical load under all loading conditions to prevent unseating the concave element.
b. If required during construction, mechanical safety restraints shall be incorporated to prevent overturning.
c. Maximum design rotation of the structure itself plus 0.03 radians shall be considered in the bearing design to prevent overturning or uplift.
d. Calculations showing the determination of the radius shall be submitted for approval.The projected area of sheet PTFE shall be designed for a maximum working stress of 3500 psi at the full load of the structure.
e. The projected area of woven fiber PTFE shall be designed for a maximum working stress of 6000 psi at the full load of the structure.
f. The concave surface shall face down whenever possible.
g. The minimum edge and center thickness shall be 3/4".
h. For sheet PTFE the minimum thickness shall be 1/8" and recessed for 1/16" in the spherical element.
i. PTFE fabric shall be a minimum of 1/16" thick when measured in accordance with ASTM D1777.
j. PTFE woven fabric shall be mechanically interlocked with the stainless steel substrate in accordance with the requirements of Section 18.8.2.1.3 of AASHTO.

2. Rotational Elements-Spherical Convex Surfaces
a. The convex element shall be designed for the following service rotation in radians:
1) Service rotation = "Design Rotation" + 0.03: where Design Rotation refers to the rotation of the structure itself.
b. When convex elements are connected to masonry or distribution plates it shall be by means of a fillet weld around the entire perimeter or set into a cavity and sealed by welding or other acceptable means.
c. The minimum edge thickness shall be 3/4".
d. For PTFE/Stainless and sliding surfaces, the stainless surface shall be one of the following:
1) ASTM A240 Type 304,13 gage thick with a 20 micro-inch rms finish.
2) Solid stainless steel ASTM A240 Type 304 or 304L shall be equal to or less than a 20 micro-inch rms finish.
3) Stainless steel weld overlay a minimum of 3/32" thick with a 20 micro-inch rms finish.
e. If sheet PTFE is used for guided surfaces, it shall be pigmented.

C. Design of Non-Rotational Elements:
1. PTFE Sliding Surfaces:
a. Sheet PTFE sliding surfaces, filled or unfilled, are to be designed for 3500 psi average maximum working stress at the fully factored dead and live load of the structure.
b. Sheet PTFE is to be minimum of 1/8 inch thick, epoxy-bonded into a square-edge recess 1/16 inch deep.
c. Fabric PTFE sliding surfaces are to be designed for 6000 psi average maximum working stress at the fully factored dead and live load of structure.
d. Fabric PTFE is to have a minimum thickness of 1/16 inch and be epoxy-bonded to the substrate using a system that prevents migration of epoxy through the fabric. Any edges, other than the selvedge are to be oversown or recessed so that no cut fabric edges are exposed.
e. PTFE used on guide bars shall be pigmented
2. Stainless Steel Sliding Surfaces:

a. The stainless steel surface is to cover the mating surface in all operating positions plus one inch in each direction of movement. This is to conform with the requirements of Article 2.2.A.5.
b. Sheet stainless steel is to be minimum of 13 gage thick and connected to the substrate by a continuous weld around the entire perimeter. The sheet is to be in full contact with the substrate.
c. Stainless steel sliding surfaces are to be, preferably, face down.
d. Stainless steel welded overlay is to be a minimum of 3/32 inches thick after welding, grinding and polishing and be produced using Type 309L electrodes.

3. Guide Bars:
a. May be integral by machining from the solid, welded or connected with high strength fasteners. High strength fasteners are to be designed using .25 X Ultimate Strength in shear.
b. Guide bars are to be designed for the specified horizontal forces, but not for less than 10 percent of the vertical capacity of the bearing.
c. The total space between the guide bars and guided members (both sides) is to be, preferably, 1/16 inch or as specified.
d. Guided members must have their contact area within the guide bars in all operating positions.
e. Guiding off the fixed base or any extensions of it where transverse rotation is anticipated is to be avoided.

2.03 FABRICATION:

A. Rotational Elements:
1. Spherical bearing machined diameters shall be + or - 0.015". Convex radius dimensions shall be + 0.000" - 0.010". Concave radius dimensions shall be + 0.010" - 0.000"
2. Mating surfaces shall be as in Design section, external edges may be "as cast" or flame-cut.
a. Lower surface of convex element shall be Class "C" tolerance.

B. Non-Rational Elements:
1. Masonry and distribution plate tolerances:
a. Plan dimensions under 30 inches, minus 0-inch plus 3/16 inch.
b. Plan dimensions over 30 inches, minus 0-inch plus 1/4 inch.
c. Thickness tolerance shall be minus 0.030-inch plus 0.060-inch.Masonry plates used with Spherical Bearings, Class "C" for the underside and Class "A" for the upperside.
2. PTFE sliding surface tolerance:
a. Plan dimensions "total design area" plus 5 percent minus 0 percent.
b. Substrate flatness Class "B" Spherical Bearings.
3. Stainless steel sheet is to be seal-weld around the entire perimeter using techniques which ensure it remains in contact with the backing plate. Finish, 20 micro-inches rms or better. Flatness to Class "A" tolerance
4. Sole plates conforming to:
a. Plan dimensions under 30 inches minus 0-inch plus 3/16-inch.
b. Plan dimensions over 30 inches minus 0-inch plus 1/4-inch.
c. Center line Thickness, minus 1/32-inch plus 1/8-inch.
d. Flatness of surface in contact with poured in place concrete, none, in contact with stainless steel sliding surface, Class "A", in contact with another steel plate, Class "B".
e. No edge shall be thinner than 3/4-inch.

f. Bevels shall be machined to an angular tolerance of plus-or-minus 0.002 radians.
g. Flatness of beveled surfaces shall be Class "A".

5. Guide bar tolerances:
   a. Length, unless integral with plate plus-or-minus 1/8-inch.
   b. Section dimensions, plus-or-minus 1/16-inch.
   c. Flatness where it bears on another plate Class "A".
   d. Bar-to-bar, nominal dimensions plus-or-minus 1/32-inch.
   e. Not more than 1/32-inch out of parallel.
6. Overall bearing height is to be not more than 3/16-inch or less than 1/16-inch under nominal dimension. All edges shall be broken and not sharp.

C. Determination of Flatness and Tolerances:
1. Flatness of bearings is determined by the following method:
   a. A precision straightedge, longer than the nominal dimension to be measured, shall be placed in contact with the surface to be measured or as parallel to it as possible.
   b. Select a feeler gage having a tolerance of plus or minus 0.001 inch and attempt to insert it under the straightedge. Since layering of feeler gages tends to degrade accuracy, the least number of blades shall be used.
   c. Flatness is acceptable if the feeler does not pass under the straightedge.
   d. Flatness tolerances are arranged in the following classes:
      1) Class "A" 0.0005 inch X "Nominal Dimension".
      2) Class "B" 0.001 inch X "Nominal Dimension".
      3) Class "C" 0.002 inch X "Nominal Dimension".
   e. "Nominal Dimension" will be interpreted as a actual dimension of the plate, in inches, under the straightedge.
   f. In determining flatness, the straightedge may be located in any position on the surface to be evaluated and not necessarily at 90 degrees to the edges.
   g. A 1-inch border around the plate is to be ignored in determining flatness.

PART 3 - EXECUTION

3.01 FABRICATION: See Section 05120.

A. Bearings:
1. The manufacturer of the bearing is also to furnish all details pertaining to the bearing assemblies including the following:
   a. Masonry and sole plates.
   b. Anchor studs and pins.
   c. Guide bars or shear blocks.
   d. High-Strength bolts.
   e. Stainless steel sheets and PTFE sheets.
   f. Shipping straps or retaining clamps.Miscellaneous details.
2. Sizes, dimensions and details pertaining to the spherical bearing core that are not shown on the Drawings are to be designed and determined by the bearing manufacture for the loading and movements shown on the Drawings and in the Contract Specification.
3. Details shown on the Drawings for the bearings, outside of the actual spherical-bearing core, may have to be adjusted to suit actual dimensions and requirements of the spherical-bearing furnished by the manufacturer. See Bearing Notes on the Drawings.
4. Bolts in guide bars or shear blocks, and sole and masonry plates are to be capable of being removed in the field for bearing replacement.Studs on masonry and sole

plates are to be positioned as shown and to clear reinforcement in pier columns, abutment beamseats and box girders.

3.02 WELDING: See Section 05120.

3.03 BOLTING: See Section 05120.

3.04 ERECTION:

A. Set bearing assemblies to lines and grades shown and adjust to horizontal position shown.

B. Bearings Installation:

1. Bearings are to be evenly supported over their upper and lower surfaces under all erection and service conditions.
2. Bearings are to be lifted by their undersides only or by specially designed lifting lugs.
3. When installing bearings, care is to be taken to avoid damage to and contamination of bearings surfaces.
4. Align the centerlines of the bearing assembly with those of the substructure and superstructure. On guided bearings, special care must be taken to properly align the guiding mechanism with the designated expansion direction of the structure.
5. Bearings straps or retaining clamps are to be left in place as long as possible to ensure parts of bearings are not inadvertently displaced relative to each other. Care must be taken to remove straps or clamps before any normal structural movement takes place, such as post-tensioning, etc.
6. Set offsets of upper and lower bearing parts as required by Contract Drawings.
7. Provide blockouts in concrete for placement of the bearings. Do not cut any reinforcement in pier columns or abutment beam seats. Studs on masonry and sole plates may be shifted slightly from dimensions shown on the bearings to clear reinforcement in substructures and the box girders. Set bearings on a level plane and fill blockout in accordance with the following:
   a. Clean entire blockout surfaces, concrete and reinforcement of rust, misplaced mortar and other foreign materials.
   b. Immediately following the cleaning operation, dry the entire surfaces, concrete and reinforcement, and uniformly coat both with an epoxy bonding compound conforming to AASHTO Specification M235, Class III, in accordance with the manufacturer's recommendations.
   c. Set and level the bearings to the correct elevations.
   d. Fill the blockout with cement grout of a type which exhibits zero shrinkage when tested in accordance with ASTM C287. Grout to contain no aluminum powder, iron particles, chlorides, sulphites, fluorides or nitrates.

END OF SECTION