

SECTION 05 05 23

WELDING-QUALITY ASSURANCE

PART 1 GENERAL

1.1 REFERENCES

- A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
1. Canadian Standard Association CSA:
 - a. W47.1, Certification of Companies for Fusion Welding of Steel.
 - b. W47.2, Certification of Companies for Fusion Welding of Aluminum.
 - c. W55.3, Certification of Companies for Resistance Welding of Steel and Aluminum
 - d. W59, Welded Steel Construction (Metal Arc Welding).
 - e. W59.2, Welded Aluminum Construction.
 - f. W178.2, Certification of Welding Inspectors.
 - g. W186, Welding of Reinforcing Bar in Reinforced Concrete Construction.
 2. American Welding Society (AWS):
 - a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.
 - b. A3.0, Standard Welding Terms and Definitions Including Terms for Adhesive Bonding, Brazing, Soldering, Thermal Cutting and Thermal Spraying.
 - c. D1.1, Structural Welding Code – Steel.
 - d. D1.6, Structural Welding Code – Stainless Steel.
 - e. QC1, Specification for AWS Certification of Welding Inspectors.
 3. American Society of Mechanical Engineers (ASME):
 - a. BPVC SECTION IX, Qualification Standard for Welding and Brazing Procedures, Welders, Brazers, and Welding and Brazing Operators Welding and Brazing Qualifications.

1.2 DEFINITIONS

- A. Class W47.1 welding positions flat (F) horizontal (H); vertical (V) overhead (O).
- B. CJP: Complete Joint Penetration.
- C. CWB: Canadian Welding Bureau.
- D. CWI: Certified Welding Inspector.
- E. GTSM: Gauge to Sound Metal.
- F. MT: Magnetic Particle Testing.
- G. NDE: Nondestructive Examination.

- H. NDT: Nondestructive Testing.
- I. PJP: Partial Joint Penetration.
- J. PQR: Procedure Qualification Record.
- K. PT: Liquid Penetrant Testing.
- L. RT: Radiographic Testing.
- M. UT: Ultrasonic Testing.
- N. VT: Visual Testing.
- O. WPQ: Welding Personnel Performance Qualification.
- P. WPS: Welding Procedure Specification.
- Q. WPDS: Welding Procedure Data Sheets.
- R. WQR: Welder Qualification Record.
- S. Contractor's inspection:
- T. Verification Inspection:

1.3 SUBMITTALS

- A. Shop and Field Drawings:
 - 1. Welding Data (Shop and Field):
 - a. Show on a weld map complete information regarding base metal specification designation, location, type, size, and extent of welds with reference called out for WPS and NDE numbers in tail of welding symbol.
 - b. Distinguish between shop and field welds.
 - c. Indicate, by welding symbols or sketches, details of welded joints and preparation of base metal. Provide complete joint welding details showing bevels, groove angles, and root openings for welds.
 - d. Fillet weld symbols shall show fillet size and length.
 - e. Groove weld symbols shall indicate CJP or PJP or GTSM in the tail of the symbol, as applicable.
 - f. For pipe fittings, provide a joint weld beveling diagram.
 - g. Welding and NDE symbols shall be in accordance with AWS A2.4.
 - h. Welding terms and definitions shall be in accordance with AWS A3.0.
 - i. Submit welding data together with shop drawings as a complete package.
- B. Informational Submittals:
 - 1. When CAN/CSA applies, WPS's and related WPDS's shall be submitted for all joints prequalified in accordance with W59. Similar documentation is required

- for non prequalified joints accompanied by PQR's for the non-prequalified joints. All such documentation shall be affixed with the CWB acceptance stamp.
2. When AWS applies, WPS's standard formats shall be submitted for all prequalified and non prequalified joints. In addition, PQR's shall be submitted for non-prequalified joints.
 3. When the BPVC applies, WPS's and PQR's shall be submitted in accordance with ASME SECT. IX approved by the authority having jurisdiction.
 4. When CAN/CSA W55.3 applies, documentation of resistance welded joint qualification accepted by the CWB shall be submitted.

1.4 QUALIFICATIONS

- A. Structural fabricators and erectors shall be certified in accordance with CAN/CSA W47.1-03 and/or W47.2.
- B. BPVC fabricators shall be qualified in accordance with ASME Section IX.
- C. Welding personnel shall be qualified in accordance with the appropriate codes – CAN/CSA W47.1 or W47.2; AWS D1.1; D1.2; D1.6; ASME Section IX.
- D. CWI shall be qualified in accordance with CAN/CSA W178.2 or AWS QC1 and shall have prior experience with the welding codes specified.
- E. Non-destructive inspection personnel shall be qualified in accordance with the appropriate CAN/CGSB requirements or NDT Level II certified in accordance with ASNT SNT-TC-1A.

1.5 SEQUENCING AND SCHEDULING

- A. Unless otherwise specified, all Submittals required in this Section shall be submitted and approved prior to commencement of welding operations.

PART 2 PRODUCTS (Not Used)

PART 3 EXECUTION

3.1 GENERAL

- A. Welding and Fabrication by Welding: Conform to governing welding codes referenced in attached Welding and Nondestructive Testing Table.

3.2 NONDESTRUCTIVE WELD TESTING REQUIREMENTS

- A. Contractor's Inspection Criteria:
 1. Selection of Welds to be Tested: Unless 100 percent NDT is specified herein, as agreed upon between Contract Administrator and Contractor.

2. Unless otherwise specified, perform NDT of welds at a frequency as shown in the attached NDT table in accordance with the referenced welding codes. Perform UT on CJP groove welds that cannot be readily radiographed. In case there is a conflict the higher frequency level of NDT shall apply.
- B. Weld Acceptance criteria for Contractor's inspection shall be based on the acceptance criteria as per the governing welding codes listed in the NDT table.

3.3 SOURCE AND FIELD QUALITY CONTROL

- A. Contractor Inspection:
1. The W178.2 (or QC1-96) CWI, employed by the Contractor, shall be present whenever shop or field welding is to be performed. The CWI shall perform inspection prior to assembly, during assembly, during welding, and after welding. CWI shall perform inspections as required in referenced welding codes and as follows:
 - a. Verifying conformance of specified job material and proper storage.
 - b. Monitoring conformance with approved WPS.
 - c. Monitoring conformance of WPQ.
 - d. Inspecting weld joint fit-up and in-process inspection.
 - e. Providing 100 percent visual inspection of all welds.
 - f. Supervising nondestructive testing personnel and evaluating test results.
 - g. Maintaining records and preparing report confirming results of inspection and testing comply with the Work.
- B. Verification Inspection:
1. An independent testing agency will be retained by The City to perform verification inspection and testing of welds.

3.4 WELD DEFECT REPAIR

- A. Repair and retest rejectable weld defects until sound weld metal has been deposited in accordance with appropriate welding codes.
- B. Repair and retest rejected weld defects to meet the design, plans and specifications.
- C. Retesting shall be performed with the same NDT method used for initial tests and to the same frequency of testing.

3.5 SUPPLEMENTS

- A. The supplements listed below, following "End of Section," are a part of this Specification.
1. Welding and Nondestructive Testing Table.

END OF SECTION

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WELDING AND NONDESTRUCTIVE TESTING						
Specification Section	Governing Welding Codes or Standards	Submit WPS	Submit WPQ	Onsite CWI Req'd	Submit Written NDT Procedure Specifications	NDT Requirements
03 21 00 Reinforcing Steel	CAN/CSA W186, Welding of Reinforced Bar in Reinforced Concrete Construction	Yes	Yes	Yes	No	100% MT of all rebar splices; see Section 03 21 00
03 40 00 Precast Concrete	CAN/CSA W59, Welded Steel Construction (Metal Arc Welding) and CAN/CSA W186, Welding of Reinforced Bar in Reinforced Concrete Construction	Yes	Yes	Yes	Yes	100% VT; see Section 03 40 00
05 12 00 Structural Steel Framing	CAN/CSA W59, Welded Steel Construction (Metal Arc Welding)	Yes	Yes	Yes	Yes	10% UT or RT of all groove-and-butt joint welds; 10% MT of all fillet welds; see Section 05 12 00
05 50 00 Metal Fabrications (Basic)	CAN/CSA W59, Welded Steel Construction (Metal Arc Welding) or CAN/CSA W59.2, Welded Aluminum Construction	No	No	Yes	No	100% VT; see Section 05 50 00
05 52 00 Aluminum Guards and Handrails	CAN/CSA W59, Welded Steel Construction (Metal Arc Welding) or CAN/CSA W59.2, Welded Aluminum Construction	No	No	No	No	100% VT; see Section 05 52 00

SECTION 05 12 00

STRUCTURAL STEEL FRAMING

PART 1 GENERAL

1.1 REFERENCES

- A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
1. Canadian Standard Association (CSA):
 - a. CAN/CSA-G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - b. CAN/CSA-S16 Design of Steel Structures.
 2. Canadian Institute of Steel Construction (CISC):
 - a. Code of Standard Practice for Structural Steel.
 - b. Handbook of Steel Construction
 - c. Standardized Shear Connections.
 3. ASTM International (ASTM):
 - a. A6, Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Steel Piling.
 - b. A53, Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless.
 - c. A325, Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 - d. A490, Standard Specification for High Structural Bolts, Classes 10.9 and 10.9.3, for Structural Steel Joints (Metric).
 - e. A563, Standard Specification for Carbon and Alloy Steel Nuts.
 - f. A653, Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
 - g. A1011, Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High-Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
 - h. F436, Standard Specification for Hardened Steel Washers.
 - i. F959, Standard Specification for Compressible-Washer-Type Direct Tension Indicators for Use with Structural Fasteners.
 - j. F1852, Standard Specification for "Twist Off" Type Tension Control Structural Bolt/Nut/Washer Assemblies, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
 4. American Welding Society (AWS):
 - a. A2.4, Standard Symbols for Welding, Brazing, and Nondestructive Examination.

1.2 DESIGN REQUIREMENTS

A. Framing Design:

1. Structural Steel Framing System has been designed on the basis of steel sections shown. It is the intent of Contract that indicated steel sizes, shapes, thicknesses, arrangements and grades of material be used.
2. If for any reasons sections shown are not available, substitute sections may be proposed for the use and must be accepted in writing by the Contract Administrator prior to use. Contract Administrator may consider such substitutions only if proposed members provide equal or greater strength with deflection compatible with adjacent construction, and do not interfere in any way with the architectural construction or the installation of mechanical and electrical utilities. No increase in payment will be made because of substitutions.

B. Connections – General:

1. Design in accordance with CAN/CSA-S16, Clause 21. - Connections.
2. Connections may be bolted or welded.
3. Design connections for end reactions from torsion, bending moment, shear, and axial load where indicated.
4. Where no end reaction is indicated, design connection on the basis of simple construction for the end reaction of a laterally supported beam of a given span under a uniformly distributed factored load that has attained its maximum moment capacity in accordance with Standardized Shear Connections published by Canadian Institute of Steel Construction (CISC).
5. For beams with intersecting bracing members, design connections for beam reaction plus reaction from the bracing members.

C. Bolted Connections:

1. Unless noted otherwise, use bearing-type connections with snug-tightened bolts.
2. Use pre-tension bearing type bolts in accordance with CAN/CSA-S16 for:
Bracing connections, moment connections.
3. Where indicated, use slip-critical connections.
4. Use high-strength bolts in accordance with CAN/CSA-S16, Clause 22. – Design and Detailing of Bolted Connections.
5. Use pre-tensioned bolts in accordance with CAN/CSA-S16, Clause 22.2.2 - Use of Pretensioned High-Strength Bolts for:
 - a. Slip-critical connections.
 - b. Connections of members resisting crane loads.
 - c. Connections supporting running machines or other live loads that produce impact or cyclic loads.
 - d. Connections where bolts are subject to tensile axial loads or stress reversal.
 - e. Connections using oversize or slotted holes, unless designed to accommodate movement.
6. Use clipped double connections where beams of similar size are bolted to both sides of a column at a common location.

- D. For bracing and other tension and compression members, design connections, if not finished to bear, to develop the force due to full factored loads where indicated. Otherwise, design for minimum of 50 percent of strength of the member in tension or 100 percent of strength of the member in compression, whichever governs.
- E. Design splices for the full strength of the member in torsion, bending, shear, and axial load unless noted otherwise.
- F. Provide welded stiffener plates on both sides of the web of beams or girders at points of concentrated loads including beams supporting columns, hangers or running over tops of columns, monorails, other beams and equipment supports. Minimum stiffener plates thickness shall be 10 mm or flange thickness of columns (hangers)/(beam webs) above or below. Minimum size of weld shall be 5 mm double fillet weld, or shall be sufficient to develop the full strength of the stiffener, whichever is greater.

1.3 SUBMITTALS

- A. Action Submittals:
 - 1. Provide Shop Drawing details showing:
 - a. Submit fabrication and erection documents. Include connection design details, shop details, erection diagrams and erection procedures.
 - b. Submit connection design details and calculations bearing seal and signature of a professional engineer registered in the Province of Manitoba for review and approval prior to submitting shop details.
 - c. Indicate fabrication details including cuts, copes, connections, bolt tension, holes, bearing plates, threaded fasteners, shop coatings, galvanizing, or other surface treatments, and welds on shop details. Indicate welds using American Welding Society (AWS) welding symbols in accordance with AWS A2.4.
 - d. On erection diagrams, mark each member with a number corresponding to the drawing containing the shop details of the member.
 - e. Submit shop details and erection diagrams together for each structure or part of structure.
 - f. Shop drawings will be reviewed for general arrangement and material specifications.
 - g. Shop drawings bearing seal and signature of a professional engineer will not be reviewed for structural adequacy.
 - h. Dimension shop drawings in units same as Contract Drawings.
- B. Informational Submittals:
 - 1. Mill Certificates of tests made in accordance with ASTM A6.
 - 2. High-Strength Bolts (Plain Non coated and Hot-Dip Galvanized):
 - a. Certificates of Compliance that products meet chemical and mechanical requirements of standards specified.
 - b. Manufacturer's inspection test report results for production lot(s) furnished, to include:
 - 1) Tensile strength.
 - 2) Yield strength.

- 3) Reduction of area.
- 4) Elongation and hardness.
- c. Certified Mill Test Reports for Bolts and Nuts:
 - 1) Name and address of manufacturer.
 - 2) Bolts correctly marked.
 - 3) Marked bolts and nuts used in required mill tests and manufacturer's inspection tests.
3. Direct Tension Indicators (DTIs): Furnish manufacturer's test report meeting requirements of ASTM F959.
4. Tension Control (TC) Bolts: Furnish manufacturer's test report meeting requirements of ASTM A325 and ASTM F1852.
5. Welding Procedures, Qualifications, and Inspection Report: As specified in Section 05 05 23, Welding-Quality Assurance.
6. Diagrams/Templates: Anchor bolt diagrams and/or templates for anchor bolt locations, in accordance with installing trade's schedule requirements.

1.4 QUALITY ASSURANCE

A. Identification:

1. Marking:

- a. Heat number, producer's name or brand mark materials to comply with CAN/CSA-G40.20-M.
- b. For member identification do not use die stamping.
- c. Shop mark all members for fit and match.
- d. If steel is to be left in unpainted condition, place marking at locations not visible from exterior after erection.
- e. Mark galvanized materials with a stamp or wire-on tag indicating the name of the galvanizer, the applicable code, and the weight of zinc coating.

B. Welding Qualifications: As specified in Section 05 05 23, Welding-Quality Assurance.

1.5 DELIVERY, STORAGE, AND HANDLING

A. Delivery:

1. Load structural members in such a manner that they will be transported and unloaded without damage to coatings and without being excessively stressed, deformed, or otherwise damaged.
2. Deliver structural members to project site in protective manner that snow, road salt, dirt, etc. will not cause discoloring or damage to steel protective coating.

B. Storage:

1. Protect structural steel members and packed materials from corrosion and deterioration.
2. Store in dry area and not in direct contact with ground.
3. Protect fasteners from dirt and moisture. Do not remove lubricant from bolts and nuts.

- C. Handle materials to avoid distortion or damage to members or supporting structures.

PART 2 PRODUCTS

2.1 MATERIALS

- A. All material shall be new and shall conform to the following:
1. W and H-Shapes:
 - a. CAN/CSA-G40.20/G40.21 Grade 350W.
 2. Shapes Except W and H-Shapes, Rolled plates and Bars:
 - a. CAN/CSA-G40.20/G40.21 Grade 300W.
 3. Steel Pipe: ASTM A53, Type E or S, Grade B.
 4. Hollow Structural Sections (HSS): CAN/CSA-G40.20/G40.21 Grade 350W Class C.
 5. Cold Formed Sections:
 - a. ASTM A653 Grade 340 (Grade 50), $F_y = 345$ MPa for coated sections.
 - b. ASTM A1011 Grade 340 (Grade 50), $F_y = 345$ MPa for uncoated sections.

2.2 FASTENERS

- A. Anchor Bolts: As specified in Section 05 50 00, Metal Fabrications (Basic).
- B. High-Strength Bolts: ASTM A325 or ASTM A490, bolt type 1, plain uncoated .
- C. Direct Tension Indicators (DTIs) or Load Indicator Washers:
 1. ASTM F959, coating type to match bolt finish.
 2. Type A325 or A490, to match bolt type.
 3. Manufacturers and Products:
 - a. TurnaSure LLC, Langhorne, PA; DTI's.
 - b. Applied Bolting Technology Products, Ludlow, VT; DTI's, regular or Squirter type.
- D. Tension Control (TC) Bolts:
 1. High-strength, ASTM A325 and F1852.
- E. Nuts: ASTM A563, type to match bolt type and finish.
- F. Hardened Steel Flat and Beveled Washers: ASTM F436, type to match bolt finish.
- G. Welding Electrodes: See Section 05 05 23, Welding-Quality Assurance.

2.3 ANCILLARY MATERIALS

- A. Grout: As specified in Section 03 60 00, Grouting.

2.4 FABRICATION

- A. General:
1. Fabricate as shown and in accordance with CAN/CSA-S16 and CISC Code of Standard Practice for Structural Steel.
 2. Columns shall be full length members without splices, unless shown otherwise.
 3. Mark and match mark materials for field assembly.
 4. Complete assembly, including bolting and welding of units, before start of finishing operations.
 5. Field measure before fabrication.
 6. Provide camber as indicated on Drawings. Shop camber to produce parabolic profile. Field camber is not allowed.
- B. Connections:
1. Shop Connections: Weld or bolt.
 2. Meet requirements of CAN/CSA-S16.
 3. Meet OSHA requirements for one independent bolt at beams framing in to column web connections.
- C. Welded Construction:
1. As specified in Section 05 05 23, Welding-Quality Assurance.
 2. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.
- D. Interface With Other Work:
1. Holes:
 - a. As necessary or as indicated for securing other Work to structural steel framing, and for passage of other Work through steel framing members.
 - b. Cut holes and reinforce openings only where shown.
 - c. No flame-cut holes will be permitted without prior approval of Contract Administrator. Cutting of holes in structural members in the field will not be permitted except with written approval of Contract Administrator.
 - d. Prevent accumulation of water in tubular members or enclosed sections by providing drainage holes.
 2. Weld threaded nuts to framing, and other specialty items where shown or required to receive other Work.
- E. Shop Paint Primer:
1. Do not shop prime the following surfaces, unless indicated otherwise:
 - a. Faying surfaces of slip critical bolted connections.
 - b. Within 50 mm of field-welded connections.
 - c. Steel members to be completely encased in reinforced concrete or coated with cementitious fireproofing.
 2. Apply shop primer to top flange surfaces of composite steel beams unless indicated otherwise.

- F. Slip Critical Bolted Connections:
 - 1. Mask faying surfaces of slip critical (SC) bolted connections to be shop painted.
- G. Beams:
 - 1. Rolled sections and/or welded wide flange sections to be straight without camber, except where beams exceed 12 m in length, in which case, camber beams 3 mm per 3 m of length, unless noted on drawings.

2.5 SOURCE QUALITY CONTROL

- A. Welding:
 - 1. Visually inspect fabrication welds as specified in Section 05 05 23, Welding-Quality Assurance.
 - 2. An independent testing agency will be retained by The City to perform the following inspection and testing of fabrication welds as specified in Section 05 05 23, Welding-Quality Assurance.
 - a. Groove welds:
 - 1) Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.
 - 2) Use RT only for butt joint groove welds.
 - b. Fillet welds larger than 8 mm: Liquid penetrate (PT) or magnetic particle (MT) for 10 percent of randomly selected welds, unless otherwise indicated.
 - c. All Welds: 100 percent visually inspected (VT).
 - 3. Repair and retest defective welds as specified in Section 05 05 23, Welding-Quality Assurance.

PART 3 EXECUTION

3.1 ERECTION

- A. Meet requirements of CAN/CSA S16 and CISC Code of Standard Practice for Structural Steel.
- B. Install Contractor-designed temporary construction bracing to provide necessary support until components are in place and construction is complete.
- C. High-Strength Bolted Connections:
 - 1. Tighten in accordance with CAN/CSA S16 Clause 23 Installation and Inspection of Bolted Joints.
 - 2. Hardened Washers:
 - a. Provide at locations required by use of washers section of CAN/CSA S16, to include slip critical connections using slotted or oversized holes or ASTM A490 bolts.
 - b. Use beveled style and extra thickness where required by CISC Handbook of Steel Construction.
 - c. Use square or rectangular beveled washers at inner flange surfaces of Canadian Standard beams and channels.

- d. Do not substitute DTIs for hardened flat washers required at slotted and oversize holes.
 3. For bearing-type connections not fully tensioned (N, X), tighten to snug tight condition. Use hardened washer over slotted or oversize holes in outer plies.
- D. Fully Tensioned Bolted Connections:
1. Use DTIs or TC bolts at slip critical (SC) and fully tensioned (FT) bearing-type connections.
 2. DTIs:
 - a. Position within bolted assembly in accordance with ASTM F959.
 - b. Install bolts, with DTIs plus hardened washers as required, in all holes of an assembly and tighten until plies are in firm contact and fasteners are uniformly snug tight.
 3. Final tighten bolts, beginning at most rigid part of bolted connection and progressing toward free edges, until final twist-off of TC bolts or until DTIs have been compressed to an average gap equal to or less than shown in Table 2, ASTM F959.
- E. Welded Connections:
1. As specified in Section 05 05 23, Welding-Quality Assurance.
 2. Groove and Butt Joint Welds: Complete penetration, unless otherwise indicated.

3.2 FIELD ASSEMBLY

- A. Set structural frames accurately to lines and elevations shown.
- B. Clean bearing surfaces and other surfaces that will be in permanent contact before assembly.
- C. Align and adjust various members forming a part of a complete frame or structure before permanently fastening.
- D. Level and plumb individual members of structure within tolerances shown in CAN/CSA S16 Clause 29.3 Erection Tolerances.
- E. Establish required leveling and plumbing measurements on mean operating temperature of structure. Make allowances for difference between temperature at time of erection and mean temperature at which structure will be completed and in service.
- F. Perform necessary adjustments to compensate for minor discrepancies in elevations and alignment.
- G. Splice members only where indicated and accepted on shop drawings.

3.3 MISFITS AT BOLTED CONNECTIONS

- A. Where misfits in erection bolting are encountered, immediately notify Contract Administrator for approval of one of the following methods of correction:
 1. Ream holes that must be enlarged to admit bolts and use oversized bolts.

2. Plug weld misaligned holes and redrill holes to admit standard size bolts.
 3. Drill additional holes in connection, conforming with CSA Standards for bolt spacing and end and edge distances, and add additional bolts.
 4. Reject member containing misfit, incorrect sized, or misaligned holes and fabricate new member to ensure proper fit.
 5. Field weld connections to provide equivalent strength of bolts with the approval of Contract Administrator.
- B. Do not enlarge incorrectly sized or misaligned holes in members by burning or by use of drift pins.

3.4 GAS CUTTING

- A. Do not use gas cutting torches in field for correcting fabrication errors in structural framing.
- B. Secondary members not under stress and concealed in finished structure may be corrected by gas cutting torches, if approved by Contract Administrator.
- C. Finish flame-cut sections equivalent to sheared and punched appearance.

3.5 REPAIR AND CLEANING

- A. Immediately after erection, clean field welds, bolted connections, and abraded areas of shop primer.
- B. Remove and grind smooth tack welds, fit-up-lugs, and weld runoff tabs.
- C. Remove weld back-up bars and grind smooth.
- D. Apply touchup paint primer by brush or spray of same thickness and material as that used in shop application.

3.6 FIELD QUALITY CONTROL

- A. High-Strength Bolted Connections:
1. An independent testing agency will be retained by The City to perform the following inspection and testing in accordance with CAN/CSA S16:
 - a. Marking identification and conformance to ASTM standards.
 - b. Alignment of bolt holes.
 - c. Placement, type, and thickness of hardened washers.
 - d. Tightening of bolts.
 2. Bearing-Type Connections Not Fully Tensioned (N, X): Snug tight condition with plies of joint in firm contact.
 3. Fully Tensioned (FT) Bearing and Slip Critical (SC) Connections:
 - a. Conduct preinstallation test.
 - b. Monitor installation and tightening of DTIs or TC bolts.
 - c. Monitor condition of faying surfaces for slip critical connections.
 4. Preinstallation Test:

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- a. Conduct jobsite test prior to start of work using a bolt tension measuring device.
 - b. Select representative sample of not less than three bolts of each diameter, length, and grade.
 - c. Include DTIs and flat hardened washers as required to match actual connection assembly.
 - d. Conduct test in accordance with Specification for Structural Joints Using ASTM A325 or A490 Bolts.
5. Nondestructive Testing (NDT) Report: Prepare and submit a written NDT report identifying location of inspected bolted connections and summary of corrections as required to meet code acceptance criteria.
6. Defective Connections: Correct and reinspect defective and improperly tightened high-strength bolted connections. Retest fully tensioned bolts as necessary to demonstrate compliance of completed work.
- B. Welded Connections:
1. Visually inspect field welds in accordance with Section 05 05 23, Welding-Quality Assurance.
 2. An independent testing agency will be retained by The City to perform the following inspection and testing of field welds as specified in Section 05 05 23, Welding-Quality Assurance.
 - a. Groove Welds:
 - 1) Radiographic (RT) or ultrasonic (UT) testing for 10 percent of randomly selected welds, unless otherwise indicated.
 - 2) Use RT only for butt joint groove welds.
 - b. Fillet Welds Larger Than 8 mm: Liquid penetrant (PT) or magnetic particle (MT) for 10 percent of randomly selected welds, unless otherwise indicated.
 - c. All Welds: 100 percent visually inspected (VT).
 3. Repair and retest defective welds as specified in Section 05 05 23, Welding-Quality Assurance.

END OF SECTION

SECTION 05 50 00

METAL FABRICATIONS (BASIC)

PART 1 GENERAL

1.1 SUMMARY

- A. Comply with Division 1, General Requirements.
- B. Metal Fabrications (Structural): Refer to Section 05 50 02, Metal Fabrications (Structural).
- C. Welding (Quality Assurance) Refer to Section 05 05 23, Welding-Quality Assurance.

1.2 REFERENCES

- A. Comply with the latest edition of the following statutes codes and standards and all amendments thereto.
 - 1. CAN/CSA-S16 Design of Steel Structures.
 - 2. CAN/CSA G40.20/G40.21 General Requirements for Rolled or Welded Structural Quality Steel/Structural Quality Steel.
 - 3. CSA S157/S157.1 Strength Design in Aluminum/Commentary on CSA S157-05, Strength Design in Aluminum.
 - 4. CSA W47.1 Certification of Companies for Fusion Welding of Steel.
 - 5. CSA W47.2-M Certification of Companies for Fusion Welding of Aluminum.
 - 6. CSA W55.3 Certification of Companies for Resistance Welding of Steel and Aluminum.
 - 7. CSA W59 Welded Steel Construction (Metal Arc Welding).
 - 8. CSA W59.2-M Welded Aluminum Construction.
 - 9. ASTM A36 Standard Specification for Carbon Structural Steel.
 - 10. ASTM A48 Standard Specification for Gray Iron Castings.
 - 11. ASTM A53 Standard Specification for Pipe, Steel, Black and Hot-Dipped, Zinc Coated, Welded and Seamless.
 - 12. ASTM A108 Standard Specification for Steel Bar, Carbon and Alloy, Cold-Finished.
 - 13. ASTM A123 Standard Specification for Zinc (Hot-Dip Galvanized) Coatings on Iron and Steel Products.
 - 14. ASTM A153 Standard Specification for Zinc Coating (Hot-Dip) on Iron and Steel Hardware.
 - 15. ASTM A193 Standard Specification for Alloy-Steel and Stainless Steel Bolting for High-Temperature or High Pressure Service and Other Special Purpose Applications.
 - 16. ASTM A194 Standard Specification for Carbon and Alloy Steel Nuts for Bolts for High-Pressure or High-Temperature Service, or Both.
 - 17. ASTM A240 Standard Specification for Chromium and Chromium-Nickel Stainless Steel Plate, Sheet, and Strip for Pressure Vessels and for General Applications.

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18. ASTM A276 Standard Specification for Stainless Steel Bars and Shapes.
19. ASTM A307 Standard Specification for Carbon Steel Bolts, Studs, and Threaded Rod 60000 psi Tensile Strength.
20. ASTM A312 Standard Specification for Seamless, Welded and Heavily Cold Worked Austenitic Stainless Steel Pipes.
21. ASTM A325 Standard Specification for Structural Bolts, Steel, Heat Treated, 120/105 ksi Minimum Tensile Strength.
22. ASTM A511 Standard Specification for Seamless Stainless Steel Mechanical Tubing.
23. ASTM A563 Standard Specification for Carbon and Alloy Steel Nuts.
24. ASTM A653 Standard Specification for Steel Sheet, Zinc-Coated (Galvanized) or Zinc-Iron Alloy-Coated (Galvannealed) by the Hot-Dip Process.
25. ASTM A666 Standard Specification for Annealed or Cold-Worked Austenitic Stainless Steel Sheet, Strip, Plate, and Flat Bar.
26. ASTM A743 Standard Specification for Castings, Iron-Chromium, Iron-Chromium - Nickel, Corrosion-Resistant, for General Application.
27. ASTM A780 Standard Practice for Repair of Damaged and Uncoated Areas of Hot-Dip Galvanized Coatings.
28. ASTM A786 Standard Specification for Hot-Rolled Carbon, Low-Alloy, High-Strength Low-Alloy, and Alloy Steel Floor Plates.
29. ASTM A793 Standard Specification for Rolled Floor Plate, Stainless Steel.
30. ASTM A1008 Standard Specification for Steel, Sheet, Cold-Rolled, Carbon, Structural, High-Strength Low Alloy, High-Strength Low-Alloy with Improved Formability, Solution Hardened, and Bake Hardenable.
31. ASTM A1011 Standard Specification for Steel, Sheet and Strip, Hot-Rolled, Carbon, Structural, High Strength Low-Alloy, High-Strength Low-Alloy with Improved Formability, and Ultra-High Strength.
32. ASTM B26 Standard Specification for Aluminum-Alloy Sand Castings.
33. ASTM B209 Standard Specification for Aluminum and Aluminum-Alloy Sheet and Plate.
34. ASTM B221 Standard Specification for Aluminum-Alloy Extruded Bars, Rods, Wire, Profiles, and Tubes.
35. ASTM B241 Standard Specification for Aluminum and Aluminum-Alloy Seamless Pipe and Seamless Extruded Tube.
36. ASTM B308 Standard Specification for Aluminum-Alloy 6061-T6 Standard Structural Profiles.
37. ASTM B316 Standard Specification for Aluminum and Aluminum-Alloy Rivet and Cold-Heading Wire and Rods.
38. ASTM B468 Standard Specification for Welded UNS N08020 Alloy Tubes.
39. ASTM B632 Standard Specification for Aluminum-Alloy Rolled Tread Plate.
40. ASTM B766 Standard Specification for Electrodeposited Coatings of Cadmium.
41. ASTM F436 Standard Specification for Hardened Steel Washers.
42. ASTM F467 Standard Specification for Nonferrous Nuts for General Use.
43. ASTM F468 Standard Specification for Nonferrous Bolts, Hex Cap Screws, Socket Head Cap Screws, and Studs for General Use.
44. ASTM F1136 Standard Specification for Zinc/Aluminum Corrosion Protective Coatings for Fasteners.

45. ASTM F1554 Standard Specification for Anchor Bolts, Steel, 36, 55, and 105-ksi Yield Strength.
46. ANSI B36.10 Pipe, Steel.
47. ANSI/NAAMM MBG 531-88/NAAMM Metal Bar Grating Material.
48. CISC/CPMA 2-75a A Quick-Drying Primer for use on Structural Steel.
49. National Building Code 2010 with 2011 Manitoba Amendments (NBC).
50. SSPC SP1 Solvent Cleaning.

1.3 SYSTEM DESCRIPTION

- A. Design Requirements
1. Design miscellaneous metal items in accordance with applicable standards.
 2. Design work of this Section, which will support other items or will be required to support structural loads of any nature, by a professional structural engineer licensed in the Province of Manitoba. Affix professional seal and signature to shop drawings for such items.
 3. Design connections and splices using high-strength bolts or welds. Use bearing type bolts for bolted connections.
 4. Design structural steel connections for moments, shears and axial loads in accordance with CAN/CSA S16 requirements for Simple Construction. Design connection for greater than half the shear capacity of the member unless indicated otherwise.
 5. Design splices for the full strength of the member in bending, shear and axial load.
 6. Design end connections and/or splices in bracing members for the full axial strength of the member.
 7. Where overlapping or contacting surfaces cannot be avoided, completely seal weld these surfaces. Where there is any evidence of rusting or deterioration of finish in such areas, carry out remedial seal welding and refinishing.
 8. Design aluminum work to CSA S157/S157.1 and CSA W59.2-M.
 9. Design equipment, anchorage, and support systems for vertical and lateral loading in accordance with NBC.

1.4 SUBMITTALS

- A. Shop Drawings: Submit shop drawings before fabrication commences of each metal fabrication item, showing in large scale fabrication details, thickness, anchors, location, dimensions, erection details, connections and jointing details, and finishes.
- B. Submit welding procedure specification for each type of material.
- C. Submit sample of aluminum railing including a welded joint to the Contract Administrator for acceptance. Commence fabrication only after acceptance has been obtained.
- D. Samples: Submit two samples of each finish.

- E. Submit written certification from professional engineer licensed in the Province of Manitoba stating that support systems, anchorage, and equipment have been designed according to requirements of the NBC for post-disaster structures.

1.5 QUALITY ASSURANCE

- A. Ensure workmanship of the highest quality throughout by employing only metal workers that have demonstrated the highest skills in this type of work and qualified welders certified to weld the materials used in fabrication of the miscellaneous metals. Comply with Section 05 05 23, Welding-Quality Assurance.
- B. Welding Procedure for Steel, aluminum and Stainless Steel:
 - 1. Comply with Section 05 05 23, Welding-Quality Assurance.

1.6 DELIVERY, STORAGE AND HANDLING

- A. Provide protective coating on stainless steel and aluminum items.
- B. Coordinate deliveries with construction schedule and arrange ahead for off-the-ground, covered storage locations.
- C. Handle and store metal materials at job site to prevent damage to other materials, existing buildings, structure, finishes or property.
- D. Handle components with care, and provide protection for surfaces against marring or other damage. Ship and store members with cardboard or other resilient spacers between surfaces.
- E. Use removable coatings or wrappings to protect exposed surfaces of prefabricated metal work which does not receive site finishing. Use materials recommended by finishers or manufacturers to ensure that method is sufficiently protective, easily removed, and harmless to the finish.
- F. Prevent the formation of wet storage stain on galvanized members with the following measures:
 - 1. Stack members or bundle to allow air between the galvanized surfaces during transport from supplier. Load materials in position that continuous drainage could occur.
 - 2. Raise members from the ground and separate with strip spacers to provide free access of air to most parts of the surface. Incline in a manner which will allow continuous drainage. Do not lay galvanized steel on cinders, clinkers, wet soil or decaying vegetation.
 - 3. Handle galvanized members in such a manner as to avoid any mechanical damage and to prevent distortion.

1.7 COORDINATION

- A. Supply to concrete, masonry and/or other Sections, materials requiring setting and/or building-in in concrete, masonry or other trades. This includes inserts, anchors, frames, sleeves, etc. Verify locations of these materials on site before fabrication and erection.

1.8 WARRANTY

- A. Submit a 5-year warranty for prefinished aluminum work against defects in materials and workmanship including but not limited to fading or non-uniformity of color, cracking, peeling or other corrosion.

PART 2 PRODUCTS

2.1 MATERIALS

- A. Where anchors, lifting hooks, screws, bolts, nuts, washers, hangers and other fasteners are not specifically shown or specified, provide such items with at least the strength and corrosion resistance properties of the metal fabrication for which they are required.
- B. Structural Steel:
 - 1. W and H-Shapes:
 - a. CAN/CSA-G40.20/G40.21 Grade 350W
 - 2. Shapes Except W and H-Shapes, Rolled plates and Bars:
 - a. CAN/CSA-G40.20/G40.21 Grade 300W.
 - 3. Steel Pipe: ASTM A53, Type E or S, Grade B.
 - 4. Hollow Structural Sections (HSS): CAN/CSA-G40.20/G40.21 Grade 350W Class C.
 - 5. Cold Formed Sections:
 - a. ASTM A653 Grade 340 (Grade 50), $F_y = 345$ MPa for coated sections.
 - b. ASTM A1011 Grade 340 (Grade 50), $F_y = 345$ MPa for uncoated sections.
- C. Welding Electrode: Comply with requirements of applicable welding codes. Refer to Section 05 05 23, Welding-Quality Assurance for applicable codes.
- D. Structural Steel Connections:
 - 1. High strength Bolts:
 - a. For structural connections at platforms, support frames and similar items; use ASTM A325 carbon steel high strength bolts with nuts and washers.
 - b. Where such structural connections will be normally exposed to atmospheric conditions use ASTM A325 carbon steel bolts hot-dip galvanized to ASTM A153.
 - 2. Nuts: ASTM A563 and the recommended nut grade and style listed in Appendix X1, Table X1 thereof. Where connections will be normally exposed to atmospheric conditions use Grade C3 or DH3.
 - 3. Washers: Bolted connections - hardened steel washers conforming to ASTM F436. Hot-dip galvanized washers with galvanized bolts.

- E. Cast In Place Anchor Bolts and Anchor Bolt Sleeves:
1. Cast-In-Place Anchor Bolts:
 - a. Carbon Steel: ASTM F1554, Grade 55 with weldability supplement S1.
 - b. Stainless Steel: ASTM F593, AISI Type 316, Condition CW.
 - c. Headed type, unless otherwise shown on Drawings.
 - d. Material type and protective coating as shown in Fastener Schedule at end of this Section.
 2. Anchor Bolt Sleeves:
 - a. Plastic:
 - 1) Single unit construction with corrugated sleeve.
 - 2) Top of sleeve shall be self-threading to provide adjustment of threaded anchor bolt projection.
 - 3) Material: High density polyethylene.
 - b. Fabricated Steel: ASTM A36/A36M.
- F. Concrete and Masonry Drilled Anchors:
1. General:
 - a. Material and Protective coating as shown in Fastener Schedule at end of this section.
 2. Wedge Anchors:
 - a. Hilti Kwik-Bolt-3 (KB-3) Anchor.
 - b. ITW Construction Products; Ramset/Red Head; Trubolt Wedge Anchor.
 3. Drop in Expansion Anchors:
 - a. Hilti HDI Drop-In Anchor.
 - b. ITW Construction Products; Ramset/Red Head; Multi-Set II Drop-In and Self Drill Anchor.
 4. Undercut Anchors:
 - a. Hilti HDA Undercut Anchor.
 - b. USP Structural Connectors; DUC Undercut Anchor.
 5. Heavy Duty Sleeve Anchors:
 - a. Hilti HSL-3 Heavy Duty Sleeve Anchor.
 - b. ITW Construction Products; Ramset/Red Head; Dynabolt Hex Nut Sleeve Anchor.
 6. Adhesive Anchors:
 - a. Threaded Rod:
 - 1) ASTM F593 stainless steel threaded rod, diameter as shown on Drawings.
 - 2) Length as required, to provide minimum depth of embedment.
 - 3) Clean and free of grease, oil, or other deleterious material.
 - 4) For hollow-unit masonry, provide galvanized or stainless steel wire cloth screen tube to fit threaded rod.
 - b. Adhesive:
 - 1) Two-component, designed to be used in adverse freeze/thaw environments, with gray color after mixing.
 - 2) Cure Temperature, Pot Life, and Workability: Compatible for intended use and environmental conditions.
 - 3) Non sag, with selected viscosity base on installation temperature and overhead application where applicable.

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- 4) Manufacturers and Products:
 - a) Hilti HIT HY 200 Adhesive Anchor System, (use HIT HY 20 for hollow masonry).
 - b) ITW Construction Products; Ramset/Red Head; C6 Adhesive Anchor System or A7 Adhesive Anchor System. (Use A7 Adhesive Anchor System for hollow masonry.)

- 7. Adhesive Threaded Inserts:
 - a. Stainless steel, internally threaded insert.
 - b. Manufacturer and Product: Hilti HIS-R Insert with HIT HY 200 adhesive.

G. Pipe Sleeves: As specified in Section 40 27 01, Process Piping Specialties.

H. Galvanized steel sheet: ASTM A653- Class Z275 zinc coating.

I. Hot rolled steel sheet: ASTM A1011.

J. Cold rolled steel sheet: ASTM A1008.

K. Steel Pipe: ASTM A53 - Type S Grade A or ANSI B36.10.

L. Neoprene: Premium grade Durometer A 40.

M. Fasteners: 19 mm diameter minimum.

N. Stainless Steel: Alloy 316.

Item	ASTM	UNA Designations
Structural	A666	S31600 or S31603
Architectural	A666	S31600 or S31603
Plates, Sheets and Strips	A240	S31600 or S31603
		<u>Grade</u>
Fasteners	A193	B8A
Castings	A743	CF-8M

O. Aluminum:

Item	ASTM	UNA Designations
Extruded Shapes - Structural	B211	A96351-T6
Extruded Shapes - Architectural	B221	A96063-T6
Smooth Plates and Sheets	B209	A93003-H16
Checkered or Tread Plates	B632	A96061-T6

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Gratings	B221	A96061-T6
Rivets	B316	A96061-T6
Castings	B26	A03560-T6 or A05350-F
Tubing & Pipe	B241	A96061-T6
Fasteners - Bolts	F468	A96061-T6
- Nuts	F467	A96061-T6

- P. Primer: CISC/CPMA 2-75a unless otherwise noted.
- Q. Isolation coating: Coal Tar-Epoxy Coating.
- R. Grouting: As specified in Section 03 60 00, Grouting.

2.2 FINISHES

- A. Rough Edges and Mill Scale:
 - 1. Following completion of fabrication of any item, grind rough edges straight and finish smooth. Remove mill scale and rust.
- B. Electrolytic Corrosion:
 - 1. Back paint metal surfaces in contact with dissimilar metal or concrete or masonry, with coal tar-epoxy coating, 1.0 mm (40 mils) DFT minimum.
 - 2. Paint galvanized metal surfaces to be in contact with or encased in concrete with rust inhibitive epoxy coating ICI Devoe Coating: Devran 201. Prepare surfaces to SSPC SP1, apply coating to 125 microns DFT.
- C. Aluminum:
 - 1. Restore aluminum to original mill finish after fabrication. Buff and brighten exposed aluminum surfaces, which have been damaged during construction.
 - 2. Paint the surfaces to be in contact with aluminum with coloured coal tar-epoxy coating where aluminum is intended to be in contact with dissimilar metals, concrete, or masonry.
 - 3. Use anodizing quality aluminum where anodizing is required.
- D. Carbon Steel:
 - 1. Hot dip galvanize metal fabrications where carbon steel is intended to be exposed to atmospheric conditions or sewage.
 - 2. Hot dip galvanize the surfaces to be in such contact where carbon steel is intended to be in contact with either concrete, brick or mortar.
- E. Galvanizing:
 - 1. Hot-dip galvanized items after fabrication. Galvanize steel scheduled for exposure to exterior conditions or corrosive materials.
 - 2. Clean surfaces to be galvanized of slag and impurities immediately before being galvanized or cadmium plated.

3. Where specified or detailed, galvanize plates and other structural shapes in accordance with ASTM A123. Where fabrications are too large to be hot-dipped, employ zinc metallizing.
 4. Repair of Damaged Galvanized Surfaces:
 - a. Repair hot-dip galvanized coatings damaged by welding, cutting, rough handling during shipping or erection or otherwise, in accordance with ASTM A780 using organic zinc-rich primer. Dry film thickness on repairs to exceed original coating thickness by 25 percent.
- F. Shop Finishes:
1. Aluminum finish:
 - a. Where shop finishing is specified or indicated, after fabrication or forming, prepare surfaces, shop prime, and factory finish in accordance with PPG specifications for the manufacturer's Duranar two-coat fluoropolymer enamel system for aluminum. Shop finishing: Performed by an accepted applicator. Minimum dry film thickness – 30 microns (1.2 mil).
 - b. Color : To be determined by the Contract Administrator.
 - c. After installation, touch-up shop finished surfaces damaged during construction.
 - d. Anodized finish: Anodizing Architectural Class I Anodic Coating 0.018 mm (0.7 mil) thickness, one-hour coating 215 RI (AA-C22A41 clear) preceded by a caustic etch.
- G. Stainless Steel:
1. Remove rust and postweld discoloration from stainless steel by grinding, using only stainless steel tools.
 2. Passivate stainless steel, which was cleaned by grinding, with a solution of 12-15 percent nitric acid and 3 percent hydrofluoric acid.
 3. During finishing ensure no carbon steel gets into contact with the stainless steel surfaces.
 4. Finishes: 2B mill finish.
- H. Steel Finish:
1. Where shop finishing is specified or indicated, after fabrication or forming, prepare surfaces, shop prime, and factory finish in Stelcolor 8,000 Series.
 2. Shop finishing: Performed by an accepted applicator. Minimum dry film thickness – 30 microns (1.2 mil).
 3. After installation, touch-up shop finished surfaces damaged during construction

2.3 FABRICATION - GENERAL

- A. Where possible, verify dimensions on site before preparing shop drawings or proceeding with shop work. Fit and shop assemble insofar as possible various sections of the work and deliver to the project site in the largest practical sections.
- B. The general dimensions and details of the metal fabrications are shown on the Drawings where practical. Such details and dimensions are suggested concepts for design.

- C. Assume responsibility for the correctness of the actual detailed dimensions used in fabrication and carefully check the same, by field measurement.
- D. Variations from suggested details are subject to acceptance in writing by the Contract Administrator. Such acceptance does not in any way waive the above mentioned responsibility.
- E. Wherever overlapping or contacting surfaces cannot be avoided, completely seal weld these surfaces. Rusting or deterioration of finish in such areas will require remedial seal welding and refinishing.
- F. Fabricate the work true to dimensions and square. Accurately fit members with hairline joints, and join using adequate fastening. Assemble members without twists or open joints.
- G. Construct finished work free from distortion and defects detrimental to appearance and performance.
- H. Stainless steel grain direction: One direction throughout.
- I. File or grind exposed welds smooth and flush. Finish to match adjacent surface finish. Do not leave grinding marks. Construct internal and external corners with sharp lines. Provide continuous welds unless otherwise accepted by the Contract Administrator in writing. Brighten and buff aluminum and stainless steel welds to match appearance of adjacent surface.
 - 1. Remove weld spatter and slag. After finish grinding and smoothing welds, passivate welds with pickling paste.
- J. Fabricate metal work complete with components required for anchoring to concrete; bolting or welding to structural steel frames; standing free; or resting in frames or sockets, in a safe and secure manner.
- K. Countersink exposed fastenings, where such are accepted in writing, and make as inconspicuous as possible with bolts cut off flush with nuts. Construct fastenings of the same material and finish as the base material on which they occur.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Install work of this Section using skilled craftsmen and in accordance with manufacturer's recommendations where applicable.
- B. Install metal fabrications in the correct locations and positions, plumb, level, structurally sound, securely fastened, free from defects detrimental to finished appearance and to acceptance of the Contract Administrator.
- C. Perform drilling of steel, concrete or masonry to fasten the work of this Section.

- D. For aluminum and stainless steel items, and exterior locations, use stainless steel anchors.
- E. After installation, spot prime bolt heads and nuts, field rivets, field welds and any abrasions or damage to the shop coat of primer.
- F. Touch-up galvanized steel where galvanizing is damaged during installation with zinc rich primer.
- G. Apply isolation coating to surfaces between dissimilar metals, and between metal and concrete, mortar, grout or masonry.
- H. Where items are specified to be installed by other Sections, fabricate items to the appropriate trade with necessary instructions and templates required for proper installation. Include required fastenings, such as screws, bolts, expansion shields and similar items.
- I. Tolerances: CAN/CSA S16.
- J. Deliver items to be cast into concrete with instructions for setting.

3.2 INSTALLATION - ANCHORS AND FASTENERS

- A. Use anchor bolts of sufficient length to embed into concrete to develop full strength of the anchor or 200 mm minimum, the maximum governs, and project the threaded portion a minimum of 50 mm for the installation of the nuts.
- B. Do not offset bolts by deformation.
- C. For submerged conditions where bolts are used, use lock nuts or nuts with lock washer.

3.3 FASTENER SCHEDULE

- A. Unless indicated otherwise on the Drawings, provide fasteners as follows:

Service Use and Location	Product	Remarks
1. Anchor Bolts Cast Into Concrete for Structural Steel, Metal Fabrications and Castings		
Interior Dry Areas	Hot-dip galvanized steel headed anchor bolts, unless indicated otherwise.	
Exterior and Interior Wet Areas	Stainless steel headed anchor bolts.	
Submerged and Corrosive Areas	Stainless steel headed anchor bolts	

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Service Use and Location	Product	Remarks
2. Anchor Bolts Cast Into Concrete for Equipment Bases		
Interior Dry Areas	Hot dip galvanized carbon steel headed anchor bolts, unless otherwise specified with equipment	
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel headed anchor bolts, unless otherwise specified with equipment	
3. Drilled Anchors for Metal Components to Cast-in-Place Concrete (e.g., Ladders, Handrail Posts, Electrical Panels, and Equipment)		
Interior Dry Areas	Stainless steel wedge or drop in expansion anchors	Use undercut anchors for overhead and ceiling installations.
Submerged, Exterior, Interior Wet, and Corrosive Areas	Stainless steel Adhesive anchors or Stainless heavy duty sleeve anchor	Use undercut anchors for overhead and ceiling installations.
4. Anchors in Grout-Filled Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Hot-dip galvanized steel headed anchor bolts, or stainless steel heavy duty sleeve anchors, or stainless steel adhesive anchors	
5. Anchors in Hollow Concrete Masonry Units		
Exterior and Interior Wet and Dry Areas	Stainless steel adhesive anchors with screen tube	
6. Connections for Structural Steel Framing		
Exterior and Interior Wet and Dry Areas	High-strength steel bolted connections	Use hot-dipped galvanized high-strength bolted connections for galvanized steel framing members and for Exterior areas
7. Connections for Steel Fabrications and Wood Components		
Exterior and Interior Wet and Dry Areas	Hot-dip galvanized carbon steel bolted connections	
8. Connections of Aluminum Components		
Submerged, Exterior and Interior Wet and Dry Areas	Stainless steel bolted connections, unless otherwise specified with equipment	

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Service Use and Location	Product	Remarks
9. All Others		
Exterior and Interior Wet and Dry Areas	Stainless steel fasteners	

- B. Anti-seizing Lubricant: Use on all stainless steel threads.
- C. Do not use adhesive anchors to support fire-resistive construction or where ambient temperature will exceed 49 degrees C.

END OF SECTION

SECTION 05 50 02

METAL FABRICATIONS (STRUCTURAL)

PART 1 GENERAL

1.1 SUMMARY

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

1.2 REFERENCES

- A. Refer to Section 05 50 00, Metal Fabrications (Basic).

PART 2 PRODUCTS

2.1 STEEL LINTELS AND SHELF ANGLES

- A. CSA G40.20/21 – 300W hot-dip galvanized after fabrication.
- B. Where lintel or shelf angle size is not shown, design lintels to NBC 9.20.5.2 Lintels or Arches.
- C. Provide adjustable lintel anchors where indicated and detailed.

2.2 EMBEDDED STEEL SUPPORT FRAMES FOR FLOOR PLATE AND GRATING

- A. Steel angle support frames to be embedded in concrete shall be stainless steel, A276, AISI Type 316, unless indicated otherwise.
- B. Provide stainless steel welded anchors for stainless steel support frames.

2.3 CHECKERED FLOOR PLATE

- A. Design Requirements:
 - 1. Floor plate shall have regular pattern of raised diamond or lines on top surface for better grip.
 - 2. Design floor plates and frames.
 - 3. Subdivide floor plates with side larger than 1000 mm by reinforcing each subdivision with stiffeners.
 - 4. Limit deflection under a concentrated midspan load of 5.0 kN to 1/360th of the span, and under superimposed 15 kN/m² uniformly distributed load, 6 mm maximum.
 - 5. Provide handles or lifting holes as detailed.
 - a. Lifting holes or handles on process and sanitary sumps shall be gas tight.
 - 6. Provide hinges as indicated and hold down fasteners.

- B. Fabricate angle frames and border bars with the following features:
 - 1. Corners neatly fitted, welded, mitred.
 - 2. Shop welded border bars.
 - 3. Weld strap anchors to angle frames for casting into concrete.
 - 4. Size angle frames to fit floor plate with clearances between frames and floor plate not exceeding 3 mm on any side.

- C. Fabricate floor plates on process and sanitary sumps with the following features:
 - 1. Gastight.
 - 2. Hinged.
 - 3. Hold open assembly.
 - 4. 3 mm full face neoprene border gasket secured in place with a suitable adhesive.
 - 5. Gastight lifting handles.
 - 6. Countersunk stainless steel screws to fasten plate down.

- D. Where indicated, fabricate checkered floor plate with 50 mm thick styrofoam SM insulation and 1.3 mm thick galvanized backpan secured to underside of checkered plate.

- E. Material:
 - 1. Aluminum: ASTM B632/B632M, Alloy 6061-T6.

- F. Minimum Thickness:
 - 1. Aluminum: 10 mm, unless shown otherwise on Drawings.

- G. Surface shall be raised-lug pattern or diamond tread, unless shown otherwise on Drawings.

- H. Slip-Resistant Surface:
 - 1. Provide where indicated on Drawings.
 - 2. Manufacturers and Products:
 - a. IKG/Borden, MEBAC 2.
 - b. W.S. Molnar Co., SLIPNOT Grade 2-Medium.

2.4 STAIRS

- A. Material:
 - 1. Aluminum: ASTM B632, Alloy 6060-T6.

- B. Fabricate stairs as detailed on drawings and install using stainless steel anchor bolts.

- C. For railing requirements, refer to Section 05 52 00, Aluminum Guards and Handrails.

- D. Fabricate stairs with open grating treads of welded grating with slip-resistant, 32 mm cross hatch solid nosing.
 - 1. Manufacturers:
 - a. Borden Metal Products Ltd.
 - b. Fisher & Ludlow Ltd.

2.5 ALUMINUM LADDERS

- A. Fabricate aluminum ladders of the lengths required as indicated on Drawings.
- B. Flat Stringer Ladder
 - 1. Fabricate ladders with the following features:
 - a. Welded construction with 13 mm by 63.5 mm stringers and 25 mm wide by 19 mm deep top-fluted rungs.
 - b. Stringers spaced 500 mm apart and rungs equally spaced at 300 mm centers.
 - c. Locate the bottom rung 300 mm above the finished floor, roof or platform.
 - d. Fabricate attachment brackets to space ladder rungs 150 mm min. from finished wall surface.
 - e. Weld attachment brackets to the stringers. Locate within 300 mm of the top and bottom of each ladder and at intermediate points spaced not more than 1200 mm o.c.
 - f. Reinforce stringer extensions above the top rung to provide rigid support for the personnel using the ladder.
 - g. Grind welds smooth.
 - h. Finish: Architectural Class I Anodic Coating, AA-C22A41 clear.
 - 1) spacing

2.6 LIFTING HOOKS

- A. Design hooks to withstand loads imposed with a minimum safety factory of 3.
- B. Material: 316 Stainless Steel.
- C. Cast hooks into concrete slab or beams at location shown.

2.7 METAL GRATING

- A. Design:
 - 1. Design metal grating to support loads indicated on drawings but not less than 4.8 kPa (100 psf) or 4.5 kN (1000 lbs) concentrate loads apply to mid span.
 - 2. Grating deflection shall not exceed $L/180$.
- B. Product:
 - 1. Grating for exterior applications shall be aluminum.
 - 2. Grating for exterior applications shall be serrated.
- C. Installation:
 - 1. Anchor grating to supporting members with clips and bolts with spring as indicated or at 300 mm centre to centre minimum.
 - 2. Grating supporting equipment shall be weld to supporting members with 5 mm fillet welds, at 300 mm centre to centre, 50 mm long.
 - 3. Use stainless steel bolts for aluminum construction.

PART 3 EXECUTION

3.1 FIELD QUALITY CONTROL

- A. Clean off dirt on installed miscellaneous metal surfaces.

END OF SECTION

SECTION 05 50 03

METAL FABRICATIONS (MECHANICAL)

PART 1 GENERAL

1.1 SUMMARY

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

PART 2 PRODUCTS

2.1 MANWAYS

- A. Provide watertight compartments/cells access man ways in the Anoxic zone of each bioreactor as indicated on the Drawings/Details and specified with the following requirements:
- B. Manufactured Units: Door and frame assemblies designed for no visible leakage under design hydrostatic pressure.
- C. Design Requirements:
1. Complete assembly, each component and anchorage to building structure.
 2. Design to withstand a hydrostatic water pressure of 8 metres.
 3. The free space, manway opening to be 900mm (36").
 4. Design to ensure watertight with variation of hydrostatic pressure variation.
 5. Safety Factor: 2; based on yield.
- D. Materials:
1. Structural Plates and Shapes: ASTM A167 Type 316 stainless steel with a minimum thickness of 6 mm (1/4").
 2. Gaskets: Gore-tex. Provide one spare gasket per door.
- E. Frame and Subframe: Continuously welded stainless steel with continuous ring. Provide stainless steel sleeve complete with grout ring to suit the wall thickness.
- F. Door:
1. Stainless steel Type 316, circular configuration.
 2. In-tank opening
- G. Hardware:
1. Hinges: Stainless steel Type 316.
 2. Handwheel and yoke: Stainless steel Type 316.
- H. H. Finishes:
1. Stainless Steel: ASTM A480, Number 2B.

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- I. Size: 900mm diameter, nominal opening.
- J. Quantity: 3 units.
- K. Test and Inspections:
 - 1. Test all welds in leak path.
 - 2. Certify watertightness of assembly under hydrostatic pressure specified. Base certification on full scale factory tests of assembly, or assembly of similar design.
- L. Manufacturers:
 - 1. Douglas Barwick Inc.:
 - a. 150 California Ave., Box 756, Brockville, ON, K6V 5W1
 - b. Phone: 613-342-8471
 - 2. Overly Manufacturing Co.:
 - a. 574 West Otterman Street, Greensburg, PA 15601-0070 U.S.A.
 - b. Phone: 724-834-7300
 - 3. Standard Equipment Company:
 - a. 75 Beauregard Street, Mobile, AL 36602, USA,
 - b. Phone: 251-432-1705

END OF SECTION

SECTION 05 52 00

ALUMINUM GUARDS AND HANDRAILS

PART 1 GENERAL

1.1 SUMMARY

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

1.2 REFERENCES

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

1.3 DEFINITIONS

- A. Guard: A protective barrier around openings in floors or at the sides of stairs, landings, balconies, mezzanines, galleries, raised walkways or other locations, capable of withstanding the loadings prescribed by codes.
- B. Handrail: A horizontal or inclined rail at one or both sides of a stair or ramp, continuous and without interruptions, intended to be grasped by hand when ascending or descending and capable of withstanding the loadings prescribed by codes. A handrail may function as a guard on the open side of a stair.
- C. Post: Supporting member for a guard or handrail, capable of transmitting the guard or handrail loadings prescribed by code to the supporting structure.
- D. Railing: A horizontal or inclined rail supported by posts, acting as a guard at or below the minimum prescribed guard height.
- E. Toeboard: Vertical barrier along exposed edges of platforms, ramps, landings or other floor openings preventing miscellaneous items from falling over the exposed edge.

1.4 SYSTEM DESCRIPTION

- A. Fabrication Requirements
 - 1. Comply with Section 05 50 00, Metal Fabrications (Basic).
 - 2. Fabricate guard and handrail components in accordance with applicable Codes.

1.5 SUBMITTALS

- A. Metal fabrication details for all guard and handrail assemblies.
- B. Shop Drawings:
 - 1. Indicate guard and handrail profiles, connections, terminations, and accessories.
 - 2. Project specific plans, elevations, and details of guards and handrails.

- C. Samples:
 - 1. Guard and post assembly minimum 300 mm long indicating connections and finish.
 - 2. Handrail assembly minimum 300 mm long indicating connections and finish.
- D. Information Submittals:
 - 1. Manufacturer's assembly and installation instructions.
 - 2. Manufacturer's Certificate of Proper Installation in accordance with Section 01 43 33, Manufacturer's Field Services.
 - 3. Manufacturer's written recommendation describing procedures for maintaining guards and handrails including cleaning materials, application methods, and precautions to be taken in the use of cleaning materials.

1.6 QUALITY ASSURANCE

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

1.7 DELIVERY, STORAGE AND HANDLING

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

1.8 WARRANTY

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

PART 2 PRODUCTS

2.1 MATERIALS

- A. Aluminum: ASTM B241, A96061-T6.
- B. Stainless Steel: Type 304 with minimum yield strength of 350 MPa.
- C. Stainless Steel Rods and Plates: Type 2205 with minimum yield strength of 450 MPa.
- D. Stainless Steel Self Drilling Fasteners: Type 302 PFHUC, S-WD 12-14x25mm #3 bimetal flex by HILTI, or Type 302 EHE352, 14x25mm type AB self tapping, flat undercut head, ALLFLEX by ELCO.

2.2 FINISHES

- A. Grind all welds and terminations smooth.
- B. Restore aluminum to original mill finish after fabrication. Buff and brighten all aluminum surfaces.
- C. Where aluminum is in contact with dissimilar metals, concrete, or masonry, paint contact surfaces with aluminum coloured bituminous paint.

2.3 ANCHORS AND FASTENERS

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

2.4 FABRICATION – WELDED ALUMINUM GUARDS AND HANDRAILS

- A. Comply with Section 05 05 23, Welding-Quality Assurance.
- B. Provide guard and handrail systems in accordance with the National Building Code, and for additional requirements specified.
- C. Fabricate posts of 40 mm nominal size 6061-T6 Schedule 80 aluminum pipe, 42.16 mm o.d., 4.83 mm wall thickness with shop welded connections.
- D. Fabricate railings of 40 mm nominal size 6061-T6 Schedule 40 aluminum pipe, 42.16 mm o.d., 3.56 mm wall thickness with shop welded connections.
- E. Fabricate guards, posts and railings with the following characteristics:
1. Vertical posts and horizontal or inclined railings of identical outside diameter.
 2. Vertical posts spaced at maximum 1200 mm o.c.
 3. Handrail and guard not less than 1070 mm above the floor, landing or platform on which it is installed.
 4. Handrail and guard at stair flight not less than 920 mm above line drawn through the front of nosing of stair.
 5. Guard and handrail assembly design configuration:
 - a. Two rails as indicated – for interior locations
 - b. Three rails as indicated – for exterior locations
 6. All railings aluminum construction.
 7. All connections, except expansion connections, continuously welded using welding rod to achieve welds identical in appearance to railings.
 8. Fabricate Type 2205 stainless steel base plate assemblies with Type 2205 vertical stainless steel rod sized for friction fit within aluminum posts.
 9. Anchor Handrail System with:
 - a. Exterior:
 - 1) Side mounted post bracket anchored to supporting structure as indicated. Anchor posts to rod with stainless steel self drilling fasteners in predrilled pilot holes.
 - 2) Top mounted post base plate anchored to supporting structure as indicated. Anchor posts to rod with stainless steel self drilling fasteners in predrilled pilot holes.
 - b. Interior:
 - 1) Posts embedded into formed blockouts cast into slab.
 - c. Connection as indicated.
 10. Formed elbows at changes of direction of rails and handrail.
 11. Expansion sleeves at location of building expansion joints and at 8000 mm o.c. maximum spacing. Locate expansion sleeves within 300 mm of post.
 12. Handrail turned back to wall, floor or post at end of run.
 13. Posts located maximum 300 mm each way from corner or point of change of direction. Space both posts equal distance from corner.

14. Welded aluminum end caps at railing terminations.
 15. Aluminum toe-board 125 mm high, 6.0 mm thick aluminum plate.
 16. Hairline joints at butt connections.
 - a. Interior welds: concave profile.
 - b. Exterior or butt welds: smooth profile.
 - c. End caps, closure plates, exposed edges: pencil round.
 17. Wall Brackets: Extruded aluminum Julius Blum Model 498. Hollaender Model 82A. Grind exposed edges pencil round.
 18. Hardware: Stainless steel.
 19. Finish assembly after fabrication.
 20. Do not field weld.
- F. Fabricate gates and hinged assemblies complete with all necessary hardware including but not limited to hinges, hasps, cane bolts and receivers. All hardware to be stainless steel.
- G. Fabricate safety chains of Type 304 stainless steel safety chain with links 34 mm long by 6 mm cross section, and stainless steel safety snap and eyebolt. Install eyebolt through handrail post and fasten with stainless steel nut and lock washer.
- H. Finish: Architectural Class I Anodic Coating, AA-C22A41 clear.

PART 3 EXECUTION

3.1 INSTALLATION - GENERAL

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

3.2 INSTALLATION - ANCHORS AND FASTENERS

- A. Comply with Section 05 50 00, Metal Fabrications (Basic).

3.3 INSTALLATION – GUARDS AND RAILINGS

- A. Install guards and handrails to meet design requirements.
- B. Fasten posts to SST rod in predrilled pilot holes, sized as recommended by fastener manufacturer.
- C. Set posts into holes of post diameter plus 20 mm maximum, 100 mm deep. Side mount railing with brackets and anchors as shown. Top mount railing with brackets as shown.
- D. Grout posts with epoxy grout, plumb and aligned.

3.4 INSTALLATION – WALL MOUNTED HANDRAILS

- A. Install handrails to meet design requirements.

- B. Anchor handrails to walls with wall brackets. [Provide wall bracket filler for gypsum board application.
- C. Anchor wall brackets with bolts. Exposed threads and nuts are not acceptable.

3.5 INSTALLATION – TOEBOARD

- A. Provide continuous toeboard at all platforms, ramps, landings or other floor openings, except at gates or where 125 mm or higher curbs are installed.
- B. Accurately measure in field for correct length, after handrail post installation, cut and secure to posts with stainless steel fasteners.
- C. Dimension between bottom of toeboard and walking surface not to exceed 3.0 mm. Cope toeboard at baseplates.
- D. Provide expansion and contraction connections at each post. Provide expansion sleeves at location of railing expansion sleeves.

END OF SECTION