
USACE / NAVFAC / AFCEA UFGS-05055A (September 2003)

Preparing Activity: USACE (CW) Superseding
UFGS-05055A (December 1992)

UNIFIED FACILITIES GUIDE SPECIFICATIONS

References are in agreement with UMRL dated 25 June 2004

Latest change indicated by CHG tags

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SECTION 05055A

METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS

09/03

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SECTION 05055A

METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS 09/03

NOTE: This guide specification covers the requirements for general workmanship applicable to the fabrication, assembly and testing of various items of metalwork and machine work.

Comments and suggestions on this guide specification are welcome and should be directed to the technical proponent of the specification. A listing of technical proponents, including their organization designation and telephone number, is on the Internet.

Recommended changes to a UFGS should be submitted as a Criteria Change Request (CCR).

Use of electronic communication is encouraged.

Brackets are used in the text to indicate designer choices or locations where text must be supplied by the designer.

PART 1 GENERAL

1.1 REFERENCES

NOTE: Issue (date) of references included in project specifications need not be more current than provided by the latest guide specification. Use of SpecsIntact automated reference checking is recommended for projects based on older guide specifications.

The publications listed below form a part of this specification to the extent referenced. The publications are referred to within the text by the basic designation only.

ALUMINUM ASSOCIATION (AA)

AA ADM1 (2000) Aluminum Design Manual

AMERICAN GEAR MANUFACTURERS ASSOCIATION (AGMA)

AGMA 2005 (1996; Rev C) Design Manual for Bevel Gears

AGMA 6001 (1997; Rev D) Design and Selection of
Components for Enclosed Gear Drives

AMERICAN WELDING SOCIETY (AWS)

AWS D1.1/D1.1M (2002) Structural Welding Code - Steel

AWS D1.2 (2003) Structural Welding Code - Aluminum

ASME INTERNATIONAL (ASME)

ASME B4.1 (1967; R 1999) Preferred Limits and Fits
for Cylindrical Parts

ASME B46.1 (1995) Surface Texture, (Surface
Roughness, Waviness and Lay)

ASME BPVC SEC IX (2001) Boiler and Pressure Vessel Code;
Section IX, Welding and Brazing
Qualifications

ASTM INTERNATIONAL (ASTM)

ASTM A 123/A 123M (2002) Zinc (Hot-Dip Galvanized) Coatings
on Iron and Steel Products

ASTM A 325 (2002) Structural Bolts, Steel, Heat
Treated, 120/105 ksi Minimum Tensile
Strength

ASTM A 325M (2003) Structural Bolts, Steel, Heat
Treated, 830 Mpa Minimum Tensile Strength
(Metric)

ASTM A 380 (1999e1) Cleaning, Descaling, and
Passivation of Stainless Steel Parts,
Equipment, and Systems

ASTM A 490 (2002) Structural Bolts, Alloy Steel, Heat
Treated, 150 ksi Minimum Tensile Strength

ASTM A 490M (2003) High-Strength Steel Bolts, Classes
10.9 and 10.9.3, for Structural Steel
Joints (Metric)

ASTM A 514/A 514M (2000a) High-Yield-Strength, Quenched and
Tempered Alloy Steel Plate, Suitable for
Welding

ASTM A 780 (2001) Repair of Damaged and Uncoated
Areas of Hot-Dipped Galvanized Coatings

ASTM B 177	(2001) Engineering Chromium Electroplating
ASTM B 766	(1986; R 2003) Electrodeposited Coatings of Cadmium
ASTM D 962	(1981; R 2003) Aluminum Powder and Paste Pigments for Paints
ASTM E 165	(2002) Liquid Penetrant Examination
ASTM E 446	(1998) Radiographs for Steel Castings Up to 2 In. (51mm) in Thickness
ASTM E 709	(2001) Magnetic Particle Examination
ASTM E 94	(2000) Radiographic Examination

1.2 UNIT PRICES

NOTE: If Section 01270A MEASUREMENT AND PAYMENT is included in the project specifications, this paragraph title (UNIT PRICES) should be deleted from this section and the remaining appropriately edited subparagraphs below should be inserted into Section 01270A.

1.2.1 Metalwork Fabrication and Machine Work

1.2.1.1 Payment

[Payment will be made for costs associated with metalwork fabrication and machine work not specifically provided for elsewhere, which includes costs for materials, fabricating work, shop and field painting, galvanizing or other metallic coatings and the installation of metal items shown or required by these specifications unless otherwise specified. Where payment is based on scale weights, no payment will be made for material in excess of a variation from the net weight calculated from the dimensions shown on the approved detail drawings of 4 percent for fabricated shapes, bars and plates and 5 percent for castings and forgings. Except where specifically indicated or specified, no separate payment will be made for bolts, nuts, pins, washers, studs and strap hangers and the cost of such items shall be included in the unit prices of items on which they are used.] [No separate payment will be made for the inspection of welds listed in Section 05055 METALWORK FABRICATION, MACHINE WORK, MISCELLANEOUS PROVISIONS, paragraph NONDESTRUCTIVE EXAMINATION.]

1.2.1.2 Measurement

[Metalwork fabrication and machine work for which payment is not otherwise specifically provided in these specifications, will be measured for payment based upon computed weights per fabricated piece, assembly or cast piece for the various metals as classified on the approved detail drawings except as indicated below. Computed weights shall be indicated on the detail drawings submitted for approval. Approval of the detail drawings will constitute acceptance of the computed weights shown thereon. When measurement of complicated shapes can be determined more readily by scale

weights per fabricated piece, cast piece or assembly the use of certified scale weights will be approved as the basis for measurement.]

a. [Computed Weights: Weights for payment shall be the net calculated weights based on the dimensions indicated on the detail drawings. The weight of rolled shapes and plates shall be computed on the basis of their nominal weights and dimensions. In calculating the net weights all copes, cuts and open holes except rivet and bolt holes shall be deducted. No additional weight shall be calculated for overweight allowance, protective coatings, allowance for milling, grip length of rivets and bolts and butt and groove welds. The weight of castings including fillets shall be computed on the basis of the dimensions shown on the detail drawings with deductions for all openings and cuts in the finished casting. Computed weights for fillet welds, rivets, bolts and cut washers shall be included in accordance with the following:

ALLOWANCES FOR WEIGHT OF EQUAL-LEG FILLET WELDS

Leg of weld in Millimeters	Kilograms per meter Length of weld
3	0.045
5	0.089
6	0.160
8	0.250
10	0.360
11	0.490
13	0.630
16	0.980
19	1.400
22	1.900
25	2.500

ALLOWANCES FOR WEIGHT OF EQUAL-LEG FILLET WELDS

Leg of weld in Inches	Pounds per foot Length of weld
1/8	0.03
3/16	0.06
1/4	0.11
5/16	0.17
3/8	0.24
7/16	0.33
1/2	0.42
5/8	0.66
3/4	0.96
7/8	1.30
1	1.70

Note: For unequal-leg fillet welds the weight corresponding to the smaller leg in the above listing shall be multiplied by the ratio of the longer leg to the smaller leg.

ALLOWANCES FOR WEIGHT OF RIVET HEADS

Diameter in Millimeters	Kilograms per 100 heads
13	1.8
16	3.2
19	5.4
22	8.2
25	12.0
29	16.0
32	22.0
35	27.0
38	37.0

ALLOWANCES FOR WEIGHT OF RIVET HEADS

Diameter in Inches	Pounds per 100 heads
1/2	4
5/8	7
3/4	12
7/8	18
1	26
1-1/8	36
1-1/4	48
1-3/8	59
1-1/2	82

Note: Allowances for rivets are based on weight data given in AISC Manual for high button type and shall apply to all types.

ALLOWANCES FOR WEIGHT OF BOLTS - REGULAR SIZE

Diameter in Millimeters	Kilograms per 100 units
13	6.12
16	12.20
19	20.00
22	31.30
25	46.70
29	68.50

ALLOWANCES FOR WEIGHT OF BOLTS - REGULAR SIZE

Diameter in Millimeters	Kilograms per 100 units
32	92.10

ALLOWANCES FOR WEIGHT OF BOLTS - REGULAR SIZE

Diameter in Inches	Pounds per 100 units
1/2	13.5
5/8	27.0
3/4	44.0
7/8	69.0
1	103.0
1-1/8	151.0
1-1/4	203.0

ALLOWANCES FOR WEIGHT OF BOLTS - HEAVY SIZE

Diameter in Millimeters	Kilograms in 100 units
13	9.1
16	16.3
19	27.7
22	41.7
25	61.2
29	86.2
32	113.0
38	195.0
44	311.0
50	454.0
57	635.0
64	855.0
70	1100.0
75	1460.0

ALLOWANCES FOR WEIGHT OF BOLTS - HEAVY SIZE

Diameter in Inches	Pounds in 100 units
1/2	20.0
5/8	36.0
3/4	61.0
7/8	92.0
1	135.0
1-1/8	190.0
1-1/4	250.0
1-1/2	430.0
1-3/4	685.0
2	1,000.0
2-1/4	1,400.0
2-1/2	1,885.0
2-3/4	2,430.0
3	3,210.0

Note: Allowances for bolts are based on weight data given in AISC manual. Allowances consist of weight of square head, bolt shank (in and projecting beyond nut) and hexagonal nut and shall apply to all type bolts without modification. Projections beyond nuts are assumed equal to 1/2 the bolt diameter up to M50 2 inch size bolts and 25 mm 1 inch for bolt sizes M50 2 inch and above. Where the number and size of another type of bolt would result in a significant difference in a pay item the allowances given above should be supplemented to include the additional type of bolt.

ALLOWANCES FOR WEIGHT OF CUT WASHERS

Bolt Diameter in Millimeters	Kilograms of 100 units
13	2.02
16	4.04
19	5.94
22	7.21
25	9.71
29	11.70
32	15.20
35	20.10
38	22.00
44	28.80
50	35.90
57	48.50
64	57.60
70	68.90
75	84.40

ALLOWANCES FOR WEIGHT OF CUT WASHERS

Bolt Diameter in Inches	Pounds of 100 units
1/2	4.45
5/8	8.90
3/4	13.10
7/8	15.90
1	21.40
1-1/8	25.90
1-1/4	33.50
1-3/8	44.30
1-1/2	48.40
1-3/4	63.60
2	79.20
2-1/4	107.00
2-1/2	127.00
2-3/4	152.00
3	186.00

Note: Each unit comprise cut washer and bolt shank in depth of washer.

The following weights, per cubic millimeter, will be used in computing weights of metalwork:

Iron Castings	7.20 mg
Steel (All Compositions)	7.83 mg
Copper, Bronze, Brass; Nickel-Copper Alloy	8.61 mg
Lead	11.30 mg
Aluminum	2.77 mg
All Other Metals	7.83 mg

The following weights, per cubic inch, will be used in computing weights of metalwork:

Iron Castings	0.260 pounds
Steel (All Compositions)	0.283 pounds
Copper, Bronze, Brass; Nickel-Copper Alloy	0.311 pounds
Lead	0.409 pounds
Aluminum	0.100 pounds
All Other Metals	0.283 pounds]

b. [Scale Weights - Shop scale weight measurements shall be made in the presence of the Contracting Officer unless otherwise specifically authorized. The weight of erection bolts, nuts and washers boxes, crates and other containers used for packing and the materials used for supporting members during transportation shall not be included in the scale weights. It shall be the responsibility of the Contractor to prepare the shipping lists required in paragraph SUBMITTALS in a format to allow the correct allocation of the scale weights of individual metal parts and members to the applicable payment classifications. Failure to comply with this requirement to the satisfaction of the Contracting Officer will necessitate measurement of computed weights. The weight of shop applied permanent protective coatings shall not be

deducted from scale weights.]

1.2.1.3 Unit of Measure

Unit of measure: per kilogram pound.

1.3 SUBMITTALS

NOTE: Submittals must be limited to those necessary for adequate quality control. The importance of an item in the project should be one of the primary factors in determining if a submittal for the item should be required.

A "G" following a submittal item indicates that the submittal requires Government approval. Some submittals are already marked with a "G". Only delete an existing "G" if the submittal item is not complex and can be reviewed through the Contractor's Quality Control system. Only add a "G" if the submittal is sufficiently important or complex in context of the project.

For submittals requiring Government approval on Army projects, a code of up to three characters within the submittal tags may be used following the "G" designation to indicate the approving authority. Codes for Army projects using the Resident Management System (RMS) are: "AE" for Architect-Engineer; "DO" for District Office (Engineering Division or other organization in the District Office); "AO" for Area Office; "RO" for Resident Office; and "PO" for Project Office. Codes following the "G" typically are not used for Navy projects.

Submittal items not designated with a "G" are considered as being for information only for Army projects and for Contractor Quality Control approval for Navy projects.

Government approval is required for submittals with a "G" designation; submittals not having a "G" designation are [for Contractor Quality Control approval.][for information only. When used, a designation following the "G" designation identifies the office that will review the submittal for the Government.] The following shall be submitted in accordance with Section 01330 SUBMITTAL PROCEDURES:

SD-02 Shop Drawings

Detail Drawings[; G][; G, [_____]]

Detail drawings for metalwork and machine work, prior to fabrication.

SD-03 Product Data

Welding of Structural Steel[; G][; G, [____]]

Schedules of welding procedures for steel structures, prior to commencing fabrication.

Welding of Aluminum[; G][; G, [____]]

Schedules of welding processes for aluminum fabrications, prior to commencing fabrication.

Structural Steel Welding Repairs[; G][; G, [____]]

Welding repair plans for steel, prior to making repairs.

Materials Orders

Copies of purchase orders, mill orders, shop orders and work orders for materials, prior to the use of the materials in the work.

Materials List

Materials list for fabricated items, at the time of submittal of detail drawings.

Shipping Bill

Shipping bill with the delivery of finished pieces to the site.

SD-06 Test Reports

Tests, Inspections, and Verifications

Certified test reports for materials with all materials delivered to the site.

SD-07 Certificates

Qualification of Welders and Welding Operators

Certifications for welders and welding operators prior to commencing fabrication.

Application Qualification for Steel Studs[; G][; G, [____]]

Certified reports for the application qualification for steel studs prior to commencing fabrication.

Welding of Aluminum[; G][; G, [____]]

Certified report for aluminum welding qualification tests prior to commencing welding.

1.4 DETAIL DRAWINGS

Detail drawings for metalwork and machine work shall include catalog cuts, templates, fabrication and assembly details and type, grade and class of material as appropriate. Elements of fabricated items inadvertently omitted on contract drawings shall be detailed by the fabricator and

indicated on the detail drawings.

1.5 QUALIFICATION OF WELDERS AND WELDING OPERATORS

NOTE: All three of the codes permitted for qualification should be retained except where the requirements of a particular structure require being more restrictive.

The Contractor shall certify that the qualification of welders and welding operators and tack welders who will perform structural steel welding have been qualified for the particular type of work to be done in accordance with the requirements of [AWS D1.1/D1.1M, Section 5,] or [ASME BPVC SEC IX, Section IX], prior to commencing fabrication. The certificate shall list the qualified welders by name and shall specify the code and procedures under which qualified and the date of qualification. Prior qualification will be accepted if welders have performed satisfactory work under the code for which qualified within the preceding three months. The Contractor shall require welders to repeat the qualifying tests when their work indicates a reasonable doubt as to proficiency. Those passing the requalification tests will be recertified. Those not passing will be disqualified until passing. All expenses in connection with qualification and requalification shall be borne by the Contractor.

PART 2 PRODUCTS

2.1 MATERIALS

2.1.1 Materials Orders

NOTE: The number of copies of purchase orders, mill orders, shop order and work orders to be specified by insertion in this paragraph should be determined on the basis of all factors involved in the anticipate inspection procedure. The number required will normally range from 3 to 5, depending upon whether mill or shop inspection is to be performed by personnel of the contracting district office or by inspection forces of another district or agency.

The Contractor shall furnish [_____] copies of purchase orders, mill orders, shop orders and work orders for all materials orders and items used in the work. Where mill tests are required purchase orders shall contain the test site address and the name of the testing agency.

2.1.2 Materials List

The Contractor shall furnish a materials list of the materials to be used in the fabrication of each item.

2.1.3 Shipping Bill

The Contractor shall furnish a shipping bill or memorandum of each shipment of finished pieces or members to the project site giving the designation

mark and weight of each item, the number of items, the total weight, and the car initial and number if shipped by rail in carload lots. Duplicate copies of shipping bills shall be mailed promptly to [_____].

2.2 FABRICATION

2.2.1 Structural Fabrication

Material must be straight before being laid off or worked. If straightening is necessary it shall be done by methods that will not impair the metal. Sharp kinks or bends shall be cause for rejection of the material. Material with welds will not be accepted except where welding is definitely specified, indicated or otherwise approved. Bends shall be made by approved dies, press brakes or bending rolls. Where heating is required, precautions shall be taken to avoid overheating the metal and it shall be allowed to cool in a manner that will not impair the original properties of the metal. Proposed flame cutting of material other than structural steel shall be subject to approval and shall be indicated on detail drawings. Shearing shall be accurate and all portions of the work shall be neatly finished. Corners shall be square and true unless otherwise shown. Re-entrant cuts shall be filleted to a minimum radius of 19 mm 3/4 inch unless otherwise approved. Finished members shall be free of twists, bends and open joints. Bolts, nuts and screws shall be tight.

2.2.1.1 Dimensional Tolerances for Structural Work

Dimensions shall be measured by an approved calibrated steel tape of approximately the same temperature as the material being measured. The overall dimensions of an assembled structural unit shall be within the tolerances indicated on the drawings or as specified in the particular section of these specifications for the item of work. Where tolerances are not specified in other sections of these specifications or shown, an allowable variation of 1 mm 1/32 inch is permissible in the overall length of component members with both ends milled and component members without milled ends shall not deviate from the dimensions shown by not more than 2 mm 1/16 inch for members 9 m 30 feet or less in length and by more than 3 mm 1/8 inch for members over 9 m 30 feet in length.

2.2.1.2 Structural Steel Fabrication

Structural steel may be cut by mechanically guided or hand-guided torches, provided an accurate profile with a surface that is smooth and free from cracks and notches is obtained. Surfaces and edges to be welded shall be prepared in accordance with AWS D1.1/D1.1M, Subsection 3.2. Where structural steel is not to be welded, chipping or grinding will not be required except as necessary to remove slag and sharp edges of mechanically guided or hand-guided cuts not exposed to view. Hand-guided cuts which are to be exposed or visible shall be chipped, ground or machined to sound metal.

2.2.1.3 Structural Aluminum Fabrication

Laying out and cutting of aluminum shall be in accordance with the AA ADM1, Section 6.

2.2.2 Welding

NOTE: The welding requirements provided are

applicable primarily to structural grade steel, low carbon steel castings and aluminum. Where welding of other grades of steel, castings or non-ferrous metals is contemplated, the additional provisions necessary for the welding of these particular metals should be inserted.

2.2.2.1 Welding of Structural Steel

a. Welding Procedures for Structural Steel - Welding procedures for structural steel shall be prequalified as described in AWS D1.1/D1.1M, Subsection 5.1 or shall be qualified by tests as prescribed in AWS D1.1/D1.1M, Section 5. Properly documented evidence of compliance with all requirements of these specifications for previous qualification tests shall establish a welding procedure as prequalified. For welding procedures qualified by tests, the test welding and specimen testing must be witnessed and the test report document signed by the Contracting Officer. Approval of any welding procedure will not relieve the Contractor of the responsibility for producing a finished structure meeting all requirements of these specifications. The Contractor will be directed or authorized to make any changes in previously approved welding procedures that are deemed necessary or desirable by the Contractor Officer. The Contractor shall submit a complete schedule of welding procedures for each steel structure to be welded. The schedule shall conform to the requirements specified in the provisions AWS D1.1/D1.1M, Sections 2, 3, 4, 7 and 9 and applicable provisions of Section 10. The schedule shall provide detailed procedure specifications and tables or diagrams showing the procedures to be used for each required joint. Welding procedures must include filler metal, preheat, interpass temperature and stress-relief heat treatment requirements. Each welding procedure shall be clearly identified as being prequalified or required to be qualified by tests. Welding procedures must show types and locations of welds designated or in the specifications to receive nondestructive examination.

b. Welding Process - Welding of structural steel shall be by an electric arc welding process using a method which excludes the atmosphere from the molten metal and shall conform to the applicable provisions of AWS D1.1/D1.1M, Sections 1 thru 7, 9, 10 and 11. Welding shall be such as to minimize residual stresses, distortion and shrinkage.

c. Welding Technique

NOTE: Vibratory type stress-relief treatment should not be approved as an alternate stress relieving means for applications covered by this specification.

(1) Filler Metal - The electrode, electrode-flux combination and grade of weld metal shall conform to the appropriate AWS specification for the base metal and welding process being used or shall be as shown where a specific choice of AWS specification allowances is required. The AWS designation of the electrodes to be used shall be included in the schedule of welding procedures. Only low hydrogen electrodes shall be used for manual shielded metal-arc welding regardless of the thickness of the steel. A

controlled temperature storage oven shall be used at the job site as prescribed by AWS D1.1/D1.1M, Subsection 4.5 to maintain low moisture of low hydrogen electrodes.

(2) Preheat and Interpass Temperature - Preheating shall be performed as required by AWS D1.1/D1.1M, Subsection 4.2 and 4.3 or as otherwise specified except that the temperature of the base metal shall be at least 20 degrees C 70 degrees F. The weldments to be preheated shall be slowly and uniformly heated by approved means to the prescribed temperature, held at that temperature until the welding is completed and then permitted to cool slowly in still air.

(3) Stress-Relief Heat Treatment - Where stress relief heat treatment is specified or shown, it shall be in accordance with the requirements of AWS D1.1/D1.1M, Subsection 4.4 unless otherwise authorized or directed.

d. Workmanship - Workmanship for welding shall be in accordance with AWS D1.1/D1.1M, Section 3 and other applicable requirements of these specifications.

(1) Preparation of Base Metal - Prior to welding the Contractor shall inspect surfaces to be welded to assure compliance with AWS D1.1/D1.1M, Subsection 3.2.

(2) Temporary Welds - Temporary welds required for fabrication and erection shall be made under the controlled conditions prescribed for permanent work. Temporary welds shall be made using low-hydrogen welding electrodes and by welders qualified for permanent work as specified in these specifications. Preheating for temporary welds shall be as required by AWS D1.1/D1.1M for permanent welds except that the minimum temperature shall be 50 degrees C 120 degrees F in any case. In making temporary welds arcs shall not be struck in other than weld locations. Each temporary weld shall be removed and ground flush with adjacent surfaces after serving its purpose.

(3) Tack Welds - Tacks welds that are to be incorporated into the permanent work shall be subject to the same quality requirements as the permanent welds and shall be cleaned and thoroughly fused with permanent welds. Preheating shall be performed as specified above for temporary welds. Multiple-pass tack welds shall have cascaded ends. Defective tack welds shall be removed before permanent welding.

2.2.2.2 Welding of Steel Castings

Unsound material shall be removed from the surfaces of steel castings to be incorporated into welded connections by chipping, machining, air-arc gouging or grinding. Major connections designed for transfer of stresses shall not be welded if the temperature of the casting is lower than 40 degrees C 100 degrees F. Castings containing over 0.35 percent carbon or over 0.75 percent manganese shall be preheated to a temperature not to exceed 230 degrees C 450 degrees F and welding shall be accomplished while the castings are maintained at a temperature above 180 degrees C 350 degrees F. Welding will not be permitted on castings containing carbon in excess of 0.45 percent except on written authorization. Castings requiring welding repairs after the first annealing and castings involving welding

fabrication shall be stress-relieved annealed prior to receiving final machining unless otherwise permitted.

2.2.2.3 Welding of Aluminum

Welding of aluminum shall conform to AA ADM1 or AWS D1.2, Sections 1 through 7, 9 and 10. The welding process and welding operators shall be prequalified as required by AWS D1.2, Section 5 or AA ADM1, Subsection 7.2.4 in accordance with the methods described in ASME BPVC SEC IX, Section IX. A certified report giving the results of the qualifying tests shall be furnished for approval. A complete schedule of the welding process for each aluminum fabrication to be welded shall be furnished for approval.

2.2.2.4 Welding of Steel Studs

The procedures for welding steel studs to structural steel, including mechanical, workmanship, technique, stud application qualification, production quality control and fabrication and verification inspection procedures shall conform to the requirements of AWS D1.1/D1.1M, Section 7, except as otherwise specified.

- a. Application Qualification for Steel Studs - As a condition of approval of the stud application process, the Contractor shall furnish certified test reports and certification that the studs conform to the requirements of AWS D1.1/D1.1M, Subsections 7.2 and 7.3, certified results of the stud manufacturer's stud base qualification test, and certified results of the stud application qualification test as required by AWS D1.1/D1.1M, Subsection 7.6, except as otherwise specified.
- b. Production Quality Control - Quality control for production welding of studs shall conform to the requirements of AWS D1.1/D1.1M, Subsection 7.7, except as otherwise specified. Studs on which pre-production testing is to be performed shall be welded in the same general position as required on production studs (flat, vertical, overhead or sloping). If the reduction of the length of studs becomes less than normal as they are welded, welding shall be stopped immediately and not resumed until the cause has been corrected.

2.2.3 Bolted Connections

2.2.3.1 Bolted Structural Steel Connections

Bolts, nuts and washers shall be of the type specified or indicated. All nuts shall be equipped with washers except for high strength bolts. Beveled washers shall be used where bearing faces have a slope of more than 1:20 with respect to a plane normal to the bolt axis. Where the use of high strength bolts is specified or indicated the materials, workmanship and installation shall conform to the applicable provisions of ASTM A 325M ASTM A 325 or ASTM A 490M ASTM A 490.

- a. Bolt Holes - Bolt holes shall be accurately located, smooth, perpendicular to the member and cylindrical.
 - (1) Holes for regular bolts shall be drilled or subdrilled and reamed in the shop and shall not be more than 2 mm 1/16 inch larger than the diameter of the bolt.
 - (2) Holes for fitted bolts shall be match-reamed or drilled in

the shop. Burrs resulting from reaming shall be removed. The threads of bolts shall be entirely outside of the holes. The body diameter of bolts shall have tolerances as recommended by ASME B4.1 for the class of fit specified. Fitted bolts shall be fitted in reamed holes by selective assembly to provide an LN-2 fit.

(3) Holes for high strength bolts shall have diameters of not more than 2 mm 1/16 inch larger than bolt diameters. If the thickness of the material is not greater than the diameter of the bolts the holes may be punched. If the thickness of the material is greater than the diameter of the bolts the holes may be drilled full size or subpunched or subdrilled at least 3 mm 1/8 inch smaller than the diameter of the bolts and then reamed to full size. Poor matching of holes will be cause for rejection. Drifting occurring during assembly shall not distort the metal or enlarge the holes. Reaming to a larger diameter of the next standard size bolt will be allowed for slight mismatching.

2.2.3.2 Bolted Aluminum Connections

Punching, drilling, reaming and bolting for bolted aluminum connections shall conform to the requirements of AA ADM1, Section 6.

2.2.4 Riveted Connections

2.2.4.1 Riveted Structural Steel Connections

a. Rivet Holes - Rivet holes shall be accurately spaced, cylindrical and perpendicular to the member. Countersinking shall be true and square with the hole. Rivet holes shall be 2 mm 1/16 inch larger than the diameter of the rivet. If the thickness of the material is not greater than the diameter of the rivet the holes may be punched full size. If the thickness of the material is greater than the diameter of the rivet the holes shall be drilled full size or subpunched or subdrilled at least 3 mm 1/8 inch smaller than the diameter of the rivet and then reamed to full size in accordance with the following provisions unless otherwise specified or authorized. For shop connections rivet holes may be drilled full size if the component parts to be riveted are welded, bolted or clamped together before drilling of rivet holes. For field connections the holes required to be subpunched or subdrilled shall be reamed in the shop if the work is assembled and matchmarked in the shop. For field connections not assembled in the shop the holes required to be subpunched or subdrilled shall be reamed in the field after the work has been assembled and bolted together.

(1) Punched Holes - Punching shall be accurate. The diameter of the punch shall be not more than 2 mm 1/16 inch greater than the diameter of the rivet. The diameter of the die opening shall not be more than 2 mm 1/16 inch greater than the diameter of the punch. Holes shall be clean cut without torn or ragged edges.

(2) Reamed and Drilled Holes - Reaming and final drilling shall be done with the component parts of the member assembled and firmly fastened together. Drilling shall be done with twist drills. Reaming shall be done with short taper reamers having not less than four flutes. Reamed holes shall be made smooth by the reamer touching the entire circumference of the hole. Outside burrs on reamed holes shall be removed to the extent of making a 2 mm 1/16 inch chamfer.

(3) Accuracy of Punched and Drilled Holes - The accuracy of holes punched or drilled full size shall be such that for assembled components with a group of contiguous holes in the same plane 75 percent of the holes shall admit a rod equal to the diameter of the cold rivet at right angles to the plane of the connection. The accuracy of holes required to be reamed or drilled after assembly shall be such that any group of contiguous holes in the same plane shall show no offset greater than 1 mm 1/32 inch between adjacent thicknesses of metal. Drifting to enlarge holes will not be allowed. Poor matching of holes will be cause for rejection. Reaming to a larger diameter for the next standard size rivet will be allowed for slight mismatching.

b. Driving Rivets - Components to be riveted shall have all parts well pinned and firmly drawn together with bolts before riveting is commenced. Rivets shall be heated uniformly to a light cherry red color at a temperature not over 1070 degrees C 1950 degrees F in a gas, oil or electric furnace constructed so that it can be adjusted to the proper temperature except that an approved coal or coke furnace may be used for heating field rivets. Rivets shall not be driven after their temperature falls below 540 degrees C 1000 degrees F. When heated and ready for driving rivets shall be free from slag, scale and adhesive materials. Rivets shall be hot driven with pressure tools. Driven rivets shall completely fill the holes. Rivet heads shall be neatly formed with dies of approved shape and shall be full size, concentric with the rivet hole and in full contact with the member. Loose, burned, badly formed or otherwise defective rivets shall be removed and replaced with care to avoid damage to adjacent metal. Recupping or caulking will not be permitted. Countersunk rivet heads shall be chipped or ground flush with the surface of the plate unless otherwise specified or authorized. Field rivets shall not be painted until they have been inspected and accepted.

2.2.4.2 Riveted Aluminum Connections

Punching, drilling, reaming and riveting for riveted aluminum connections shall conform to the requirements of AA ADM1, Section 6.

2.2.5 Patterns

NOTE: The first bracketed option in this paragraph (third sentence) will be generally used since in most cases it will be to the advantage of the Government not to retain any patterns, or core boxes or templates, and save the expense of repairs, shipment and storage. If the Government has patterns available for loan to the Contractor, subparagraph AVAILABLE PATTERNS should be included, with the appropriate information provided in the bracketed underlined spaces. If the first bracketed option is used and the Government has patterns available for loan to the Contractor, subparagraphs DISPOSITION OF PATTERNS, CORE BOXES, AND TEMPLATES should be suitably modified and included. If the second bracketed option (fourth sentence) is used, subparagraphs FABRICATION OF PATTERNS AND CORE BOXES and DISPOSITION OF PATTERNS, CORE BOXES AND

TEMPLATES should be included.

Care shall be taken to avoid sharp corners or abrupt changes in cross section and ample fillets shall be used in the construction of patterns. Draft and increases in pattern thicknesses shall be added as required to conform to the standard foundry practice applied and as necessary to ensure that all metal thicknesses of the finished castings conform to the dimensions shown and are within the tolerances specified in paragraph INSPECTION OF STEEL CASTINGS. [All patterns [, except those loaned to the Contractor by the Government,] shall remain the property of the Contractor.] [Patterns for those parts listed below shall be furnished by the Contractor, become the property of the Government and not be used for work under any other contract unless specifically authorized. All other patterns [, except those loaned to the Contractor by the Government,] shall remain the property of the Contractor.]

2.2.5.1 [Fabrication of Patterns and Core Boxes

Patterns and core boxes that shall become the property of the Government shall be substantially made from thoroughly seasoned Grade B or better sugar pine, northern white pine or an approved equal. Built-up patterns and core boxes shall be securely glued and screwed together. Glue shall be of an approved high grade, water resistant and suitably treated for resistance to fungus and insect infestation. Only light sections are permitted to be nailed. Screw holes shall be counterbored and neatly filled with wood plugs. Loose pieces shall be dovetailed or fastened with pull-out dowels. Split patterns and core boxes shall have metal dowels at partings. Skelton or sweep patterns will not be accepted unless specifically authorized. All nail and tool marks on molding surfaces shall be filled with beeswax. All surfaces shall be sanded with No. 0 grade sandpaper. Patterns shall be finished with not less than three coats of an approved phenolic-resin sealer colored in accordance with the standard trade practices for pattern colors. Each pattern, core box and loose piece shall be stamped with the part mark shown. Patterns shall be furnished complete with necessary core boxes and templates.]

2.2.5.2 [Available Patterns

NOTE: The serviceability and general condition of each pattern should be clearly indicated under the heading of "CONDITION."

The patterns listed below are available for loan to the Contractor. They are stored at [_____] and may be secured f.o.b. their place of storage upon request.

<u>PART NO.</u>	<u>PATTERN NO.</u>	<u>CONDITION</u>
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]
[_____]	[_____]	[_____]

The Contractor shall assume responsibility for the accuracy and adaptability of all parts made with the above listed patterns as if the parts had been made from new patterns produced under this contract and shall bear the expense of correcting any inaccuracies found in them.]

2.2.5.3 [Disposition of Patterns, Core Boxes, and Templates

Boxes and crates for the packing and shipment of patterns, core boxes and templates shall be substantially made and put together with screws so that they can be used several times. Each box and crate shall be plainly marked to indicate its contents. All patterns, core boxes and templates [including those loaned to the Contractor by the Government] used shall be thoroughly cleaned, crated and delivered in first-class condition with a list of same in duplicate to [_____] before final payment is made. The Contracting Officer reserves the right to withhold payment for final parts made from any pattern until such pattern is delivered. Patterns and core boxes shall be varnished and all templates given a coat of an approved paint before being crated. Any pattern, core box or template lost in shipment or damaged by the Contractor shall be replaced by the Contractor without charge to the Government.]

2.2.6 Castings

Each casting shall bear cast or stamped mark numbers. Castings weighing more than 225 required kilograms 500 required pounds shall also bear cast or stamped heat numbers. Deviations from the dimensions of castings shown shall not exceed amounts that will impair the strength of castings by more than 10 percent as computed from the dimensions shown. Dimensions of castings shown on approved detail drawings shall be finished dimensions. Castings that are warped or otherwise distorted or that are oversize to an extent that will interfere with proper fit with other parts of the machinery or structure will be rejected. The structure of metal in castings shall be homogeneous and free from excessive nonmetallic inclusions. Excessive segregation of impurities or alloys at critical points in castings will be cause for rejection. Repairs to castings shall not be made prior to approval. Minor surface imperfections not affecting the strength of casting may be welded in the "green" if approved. Surface imperfections shall be considered minor when the depth of the cavity prepared for welding is the lesser of 20 percent of the actual wall thickness or 25 mm 1 inch. Defects other than minor surface imperfections may be welded only when specifically authorized in accordance with the following requirements:

- a. The defects have been entirely removed and are judged not to affect the strength, use or machineability of the castings when properly welded and stress relieved.
- b. The proposed welding procedure, stress relief and method of examination of the repair work have been submitted and approved.

2.2.7 Machine Work

NOTE: Paragraphs, PIN HOLES, GEARS, SHAFTING, and BEARINGS, should be deleted when the details specified are provided in the machinery section.

Tolerances, allowances and gauges for metal fits between plain, non-threaded, cylindrical parts shall conform to ASME B4.1 for the class of fit shown or required unless otherwise shown on approved detail drawings. Where fits are not shown they shall be suitable as approved. Tolerances for machine-finished surfaces designated by non-decimal dimensions shall be

within 400 μm 1/64 inch. Sufficient machining stock shall be allowed on placing pads to ensure true surfaces of solid material. Finished contact or bearing surfaces shall be true and exact to secure full contact. Journal surfaces shall be polished and all surfaces shall be finished with sufficient smoothness and accuracy to ensure proper operation when assembled. Parts entering any machine shall be accurately machined and all like parts shall be interchangeable except that parts assembled together for drilling or reaming of holes or machining will not be required to be interchangeable with like parts. All drilled holes bolts shall be accurately located.

2.2.7.1 Finished Surfaces

Surface finishes indicated or specified shall be in accordance with ASME B46.1. Values of required roughness heights are arithmetical average deviations expressed in micrometers microinches. These values are maximum.

Lesser degrees will be satisfactory unless otherwise indicated. Compliance with surface requirements shall be determined by sense of feel and visual inspection of the work compared to Roughness Comparison Specimens in accordance with the provisions of ASME B46.1. Values of roughness width and waviness height shall be consistent with the general type of finish specified by roughness height. Where the finish is not indicated or specified it shall be that which is most suitable for the particular surface, provide the class of fit required and be indicated on the detail drawings by a symbol which conforms to ASME B46.1 when machine finishing is provided. Flaws such as scratches, ridges, holes, peaks, cracks or checks which will make the part unsuitable for the intended use will be cause for rejection.

2.2.7.2 Unfinished Surfaces

All work shall be laid out to secure proper matching of adjoining unfinished surfaces unless otherwise directed. Where there is a large discrepancy between adjoining unfinished surfaces they shall be chipped and ground smooth or machined to secure proper alignment. Unfinished surfaces shall be true to the lines and dimensions shown and shall be chipped or ground free of all projections and rough spots. Depressions or holes not affecting the strength or usefulness of the parts shall be filled in an approved manner.

2.2.7.3 Pin Holes

Pin holes shall be bored true to gauges, smooth, straight and at right angles to the axis of the member. The boring shall be done after the member is securely fastened in position.

2.2.7.4 Gears

Gears shall have machine cut teeth of a form conforming to applicable design requirements of AGMA 2005 and AGMA 6001 unless otherwise specified or shown.

2.2.7.5 Shafting

All shafting shall be turned or ground hot-rolled or cold-rolled steel as required unless otherwise specified or authorized. Fillets shall be provided where changes in section occur. Cold-finished shafting may be used where keyseating is the only machine work required.

2.2.7.6 Bearings

Bearings may be lined with babbit or bronze unless otherwise specified or shown. Where the bearing pressure is in excess of 1400 kPa 200 psi, bearings shall be lined with bronze. Pressures on lined bearings shall not exceed [_____] kPa psi of projected area unless otherwise required or authorized. Anti-friction bearings of approved types and of sizes not less than those recommended by the bearing manufacturer for the duty intended will be permitted subject to approval. All bearings shall be properly aligned and provided with a suitable means of lubrication. Anti-friction bearings shall be so installed as to provide for retention of the lubricant and to exclude dirt and grit.

2.2.8 Miscellaneous Provisions

2.2.8.1 Metallic Coatings

a. Zinc Coatings - Zinc coatings shall be applied in a manner and of a thickness and quality conforming to ASTM A 123/A 123M. Where zinc coatings are destroyed by cutting, welding or other causes the affected areas shall be regalvanized. Coatings 50 g 2 ounces or heavier shall be regalvanized with a suitable low-melting zinc base alloy similar to the recommendations of the American Hot-Dip Galvanizers Association to the thickness and quality specified for the original zinc coating. Coatings less than 50 g 2 ounces shall be repaired in accordance with ASTM A 780.

b. Cadmium Coatings - Cadmium coatings shall be of a quality and thickness conforming to the requirements of ASTM B 766 and inspection shall conform to the requirements of ASTM E 165, Type [_____].

c. Chromium Coatings - Chromium coatings for engineering use shall be applied in conformity with ASTM B 177.

2.2.8.2 Cleaning of Corrosion-Resisting Steel

Oil, paint and other foreign substances shall be removed from corrosion-resisting steel surfaces after fabrication. Cleaning shall be done by vapor degreasing or by the use of cleaners of the alkaline, emulsion or solvent type. After the surfaces have been cleaned they shall be given a final rinsing with clean water followed by a 24 hour period during which the surfaces are intermittently wet with clean water and then allowed to dry for the purpose of inspecting the clean surfaces. The surfaces shall be visually inspected for evidence of paint, oil, grease, welding slag, heat treatment scale, iron rust or other forms of contamination. If evidence of foreign substance exist the surface shall be cleaned in accordance with the applicable provisions of ASTM A 380. The proposed method of treatment shall be furnished for approval. After treatment the surfaces shall be visually reinspected. Brushes used to remove foreign substances shall have only stainless steel or nonmetallic bristles. Any contamination occurring subsequent to the initial cleaning shall be removed by one or more of the methods indicated above.

2.2.8.3 Lubrication

The arrangement and details for lubrication shall be as shown. Before erection or assembly all bearing surfaces shall be thoroughly cleaned and lubricated with an approved lubricant.

2.2.9 Shop Assembly

**NOTE: List structural and machinery units if
required by first sentence of this paragraph.**

[Only those machinery and structural units listed below] [Each machinery and structural unit furnished] shall be assembled in the shop to determine the correctness of the fabrication and matching of the component parts unless otherwise specified. Tolerances shall not exceed those shown. Each unit assembled shall be closely checked to ensure that all necessary clearances have been provided and that binding does not occur in any moving part. Assembly in the shop shall be in the same position as final installation in the field unless otherwise specified. Assembly and disassembly work shall be performed in the presence of the Contracting Officer unless waived in writing. Errors or defects disclosed shall be immediately remedied by the Contractor without cost to the Government. Before disassembly for shipment each piece of a machinery or structural unit shall be match-marked to facilitate erection in the field. The location of match-marks shall be indicated by circling with a ring of white paint after the shop coat of paint has been applied or as otherwise directed.

2.3 TESTS, INSPECTIONS, AND VERIFICATIONS

The Contractor shall have required material tests and analyses performed and certified by an approved laboratory to demonstrate that materials are in conformity with the specifications. These tests and analyses shall be performed and certified at the Contractor's expense. Tests, inspections, and verifications shall conform to the requirements of the particular sections of these specifications for the respective items of work unless otherwise specified or authorized. Tests shall be conducted in the presence of the Contracting Officer if so required. The Contractor shall furnish specimens and samples for additional independent tests and analyses upon request by the Contracting Officer. Specimens and samples shall be properly labeled and prepared for shipment.

2.3.1 Nondestructive Testing

When doubt exists as to the soundness of any material part such part may be subjected to any form of nondestructive testing determined by the Contracting Officer. This may include ultrasonic, magnaflux, dye penetrant, x-ray, gamma ray or any other test that will thoroughly investigate the part in question. The cost of such investigation will be borne by the Government. Any defects will be cause for rejection and rejected parts shall be replaced and retested at the Contractor's expense.

2.3.2 Tests of Machinery and Structural Units

The details for tests of machinery and structural units shall conform to the requirements of the particular sections of these specifications covering these items. Each complete machinery and structural unit shall be assembled and tested in the shop in the presence of the Contracting Officer unless otherwise directed. Waiving of tests will not relieve the Contractor of responsibility for any fault in operation, workmanship or material that occurs before the completion of the contract or guarantee. After being installed at the site each complete machinery or structural unit shall be operated through a sufficient number of complete cycles to

demonstrate to the satisfaction of the Contracting Officer that it meets the specified operational requirements in all respects.

2.3.3 Inspection of Structural Steel Welding

The Contractor shall maintain an approved inspection system and perform required inspections in accordance with Contract Clause CONTRACTOR INSPECTION SYSTEM. Welding shall be subject to inspection to determine conformance with the requirements of AWS D1.1/D1.1M, the approved welding procedures and provisions stated in other sections of these specifications.

Nondestructive examination of designated welds will be required. Supplemental examination of any joint or coupon cut from any location in any joint may be required.

2.3.3.1 Visual Examination

All visual examination of completed welds shall be cleaned and carefully examined for insufficient throat or leg sizes, cracks, undercutting, overlap, excessive convexity or reinforcement and other surface defects to ensure compliance with the requirements of AWS D1.1/D1.1M, Section 3 and Section 9, Part D.

2.3.3.2 Nondestructive Examination

The nondestructive examination of shop and field welds shall be performed as designated or described in the sections of these specifications covering the particular items of work.

a. Testing Agency - The nondestructive examination of welds and the evaluation of examination tests as to the acceptability of the welds shall be performed by a testing agency adequately equipped and competent to perform such services or by the Contractor using suitable equipment and qualified personnel. In either case written approval of the examination procedures is required and the examination tests shall be made in the presence of the Contracting Officer. The evaluation of examination tests shall be subject to the approval and all records shall become the property of the Government.

b. Examination Procedures - Examination procedures shall conform to the following requirements.

(1) Ultrasonic Testing - Making, evaluating and reporting ultrasonic testing of welds shall conform to the requirements of AWS D1.1/D1.1M, Section 6, Part C. The ultrasonic equipment shall be capable of making a permanent record of the test indications. A record shall be made of each weld tested.

(2) Radiographic Testing - Making, evaluating and reporting radiographic testing of welds shall conform to the requirements of AWS D1.1/D1.1M, Section 6, Part B.

(3) Magnetic Particle Inspection - Magnetic particle inspection of welds shall conform to the applicable provisions of ASTM E 709.

(4) Dye Penetrant Inspection - Dye penetrant inspection of welds shall conform to the applicable provisions of ASTM E 165.

c. Acceptability of Welds - Welds shall be unacceptable if shown to have defects prohibited by AWS D1.1/D1.1M, Subsection 9.25 or possess

any degree of incomplete fusion, inadequate penetration or undercutting.

d. Welds to be Subject to Nondestructive Examination

NOTE: List here the type, location and extent of welds to be subject to nondestructive examination. The welds so listed should also be shown using the appropriate designation of AWS A2.4 "Standard Symbols for Welding, Brazing and Nondestructive Examination".

Complete nondestructive examination of welds should be limited to welds upon which the structure is dependent. Spot nondestructive examination of welds should be used to ensure adequate welding quality and water tightness of seams where required.

Ultrasonic testing should be used for groove welds in tee or corner joints.

Radiographic or ultrasonic testing should be used for groove welds in butt joints.

Magnetic particle inspection may be used for the detection of cracks and other discontinuities at or near the surface of root and surface passes and intermediate layers not exceeding 6 mm (1/4 inch) thickness.

Dye penetrant inspection should be used only for detection of discontinuities that are open to the surface in single pass fillet welds.

This paragraph shall be omitted where nondestructive examination is covered in other sections of the specifications.

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2.3.3.3 Test Coupons

NOTE: For supply contracts a provision similar to that given under contract clauses should be written into this paragraph.

The Government reserves the right to require the Contractor to remove coupons from completed work when doubt as to soundness cannot be resolved by nondestructive examination. Should tests of any two coupons cut from the work of any welder show strengths less than that specified for the base metal it will be considered evidence of negligence or incompetence and such welder shall be removed from the work. When coupons are removed from any part of a structure the members cut shall be repaired in a neat manner with joints of the proper type to develop the full strength of the members. Repaired joints shall be peened as approved or directed to relieve residual

stress. The expense for removing and testing coupons, repairing cut members and the nondestructive examination of repairs shall be borne by the Government or the Contractor in accordance with the Contract Clauses INSPECTION AND ACCEPTANCE.

2.3.3.4 Supplemental Examination

When the soundness of any weld is suspected of being deficient due to faulty welding or stresses that might occur during shipment or erection the Government reserves the right to perform nondestructive supplemental examinations before final acceptance. The cost of such inspection will be borne by the Government.

2.3.4 Structural Steel Welding Repairs

Defective welds in the structural steel welding repairs shall be repaired in accordance with AWS D1.1/D1.1M, Subsection 3.7. Defective weld metal shall be removed to sound metal by use of air carbon-arc or oxygen gouging. Oxygen gouging shall not be used on ASTM A 514/A 514M steel. The surfaces shall be thoroughly cleaned before welding. Welds that have been repaired shall be retested by the same methods used in the original inspection. Except for the repair of members cut to remove test coupons and found to have acceptable welds costs of repairs and retesting shall be borne by the Contractor.

2.3.5 Inspection and Testing of Steel Stud Welding

NOTE: Provisions for radiographic inspection of castings should be limited to castings upon which the structural integrity of the structure is dependent. The drawings should indicate which castings and what areas are to be radiographed.

Fabrication and verification inspection and testing of steel stud welding shall conform to the requirements of AWS D1.1/D1.1M, Subsection 7.8 except as otherwise specified. The Contracting Officer will serve as the verification inspector. One stud in every 100 and studs that do not show a full 360 degree weld flash, have been repaired by welding or whose reduction in length due to welding is less than normal shall be bent or torque tested as required by AWS D1.1/D1.1M, Subsection 7.8. If any of these studs fail two additional studs shall be bent or torque tested. If either of the two additional studs fail all of the studs represented by the tests shall be rejected. Studs that crack under testing in either the weld, base metal or shank shall be rejected and replaced by the Contractor at no additional cost.

2.3.6 Inspection of Steel Castings

NOTES: Radiographic inspection of castings should be limited to castings upon which the structural integrity of the structure is dependent. The drawings should indicate which castings and what areas are to be radiographed.

Insert applicable type and severity level in the bracketed spaces of the table in this paragraph.

The Contractor shall perform radiographic inspection of steel castings as designated and as described in the section of these specifications covering the particular item of work. The procedure for making, evaluating and reporting the radiographic inspection shall conform to the requirements of ASTM E 94. The castings shall be unacceptable if shown to have defects of greater severity than the applicable reference standard specified in the following table:

DISCONTINUITY TYPE	SEVERITY LEVELS OR CLASSES
<u> </u>	<u> </u>
[]	[]
[]	[]

The applicable referenced standards shall be as illustrated in ASTM E 446. The evaluation of the radiographs shall be subject to approval and all records shall become the property of the Government.

PART 3 EXECUTION

3.1 INSTALLATION

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

3.1.1 Alignment and Setting

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

3.1.2 Blocking and Wedges

All blocking and wedges used during installation for the support of parts to be grouted in foundations shall be removed before final grouting unless otherwise directed. Blocking and wedges left in the foundations with approval shall be of steel or iron.

3.1.3 Foundations and Grouting

**NOTE: Required special provisions relative to
concreting and grouting machinery foundations and
bases should be inserted in Section 03307 CONCRETE
FOR MINOR STRUCTURES.**

Concreting of subbases and frames and the final grouting under parts of machines shall be in accordance with the procedures as specified in Section [[____]] [____].

3.2 PROTECTION OF FINISHED WORK

3.2.1 Machined Surfaces

Machined surfaces shall be thoroughly cleaned of foreign matter. All finished surfaces shall be protected by suitable means. Unassembled pins and bolts shall be oiled and wrapped with moisture resistant paper or protected by other approved means. Finished surfaces of ferrous metals to be in bolted contact shall be washed with an approved rust inhibitor and coated with an approved rust resisting compound for temporary protection during fabrication, shipping and storage periods. Finished surfaces of metals which shall be exposed after installation except corrosion resisting steel or nonferrous metals shall be painted as specified in Section 09964 PAINTING: HYDRAULIC STRUCTURES.

3.2.2 Lubrication After Assembly

After assembly all lubricating systems shall be filled with the lubricant specified and additional lubricant shall be applied at intervals as required to maintain the equipment in satisfactory condition until acceptance of the work.

3.2.3 Aluminum

Aluminum that shall be in contact with grout or concrete shall be protected from galvanic or corrosive action by being given a coat of zinc-chromate primer and a coat of aluminum paint. Aluminum in contact with structural steel shall be protected against galvanic or corrosive action by being given a coat of zinc-chromate primer and a coat of aluminum paint. The aluminum paint shall consist of a aluminum paste conforming to ASTM D 962, spar varnish and thinner compatible with the varnish. The aluminum paint shall be field mixed in proportion of 1 kg 2 pounds of paste, not more than 4 L one gallon of spar varnish and not more than 500 mL one pint of thinner.

3.3 TESTS

3.3.1 Workmanship

Workmanship shall be of the highest grade and in accordance with the best modern practices to conform with the specifications for the item of work being furnished.

3.3.2 Production Welding

Production welding shall conform to the requirements of AWS D1.1/D1.1M or AWS D1.2as applicable. Studs on which pre-production testing is to be

performed shall be welded in the same general position as required on production items (flat, vertical, overhead or sloping). Test and production stud welding will be subjected to visual examination or inspection. If the reduction of the length of studs becomes less than normal as they are welded, welding shall be stopped immediately and not resumed until the cause has been corrected.

-- End of Section --