

**Item No. 721S
Steel Structures**

721S.1 Description

This item shall govern the furnishing, fabricating, erecting, and painting steel and other metals for structures or portions of structures. The materials related to this specification are specified in Item 720S, "Metal for Structures" unless otherwise noted. Reinforcing steel (Item 406S) and other structural materials are not included. This specification is optional and is applicable for projects or work involving either inch-pound or SI units. Within the text inch-pound units are given preference followed by SI units shown within parentheses.

721S.2 Submittals

The submittal requirements of this specification item include:

A. Shop Drawings

1. The Contractor shall prepare and submit seven (7) copies of detailed shop drawings (or as required by the Contract Documents) for each detail of the Contract Drawings requiring the use of materials specified herein or in Item No. 720S, "Metal for Structures".
2. Shop drawings shall include complete details and schedules for fabrication and assembly, as well as camber and erection diagrams for all structures, bridges, plate girders, and other structural members as indicated on the drawings. The equipment, sequence of erection, location and type(s) of falsework (including calculations), location of splices, and proposed method of support to determine any overstress caused by the erection procedure shall also be included.
3. The drawings shall be prepared on sheets 22 x 36 inches (A1 sheet size or 559 x 914 mm) or larger. Each sheet shall include the following:
 - a. Project name and location.
 - b. Name of structure or detail. For details, include structure name or location of detail within the project.
 - c. Fabricator name and person responsible for preparation of drawing.
 - d. Contractor name.
 - e. Sheet numbering.
3. Preparation and submission of shop drawings may be on 11 x 17 inch sheets (A3 sheet size or 279 x 432 mm) or full size drawings may be reduced to half scale size if they are completely clear and legible.
4. Field Verification
 - a. The Contractor shall be responsible for field verification of design information and

shall inform the Fabricator of any discrepancies with the Contract Documents.

- b. When discrepancies are more than minor dimensional changes, the Contractor shall resolve with the Architect/Engineer.
 - c. Any changes from the Contract Documents due to field verification of information shall be clearly noted on the shop drawings.
5. All shop drawings shall be checked by the Fabricator before submitting them to the City of Austin. The Contractor shall also be responsible for reviewing the shop drawings prior to submittal to assure correctness and completeness and to coordinate shop fit and field connections. Resolution of problems and corrections to drawings, if necessary, shall be done prior to submittal.
 6. Changes in section(s), as allowed per this specification (P721S.4 C), shall be clearly noted on the shop drawings.
 7. Members proposed for heat curving. Also include with the shop drawings a detailed procedure for heat curving work.
 8. Color coding for any grade of steel to be used on the project and not listed in ASTM A6 (A6M).
- B. Painting shall conform to Item No. 722S, "Paint and Painting". Submit any proposed shop primers or paints that are not otherwise specified.

C. Connections

1. When structural members are to be fabricated by welding, a welding procedure shall be submitted. A welding procedure shall include the standard AWS symbol, size, length, type of weld, and any other pertinent information. Upon approval, the welding procedure will be assigned a Welding Procedure Number and the shop drawings shall include this number adjacent to the appropriate welding symbol.
2. When structural members with calculated stress are to be fabricated by bolting, a fabrication procedure shall be submitted. A fabrication procedure shall include a list of equipment to be used, sequence of assembly, sequence and detail of connections made, special processes such as planing, facing, etc., detail of heat treating procedures, when applicable and any other information concerning fabrication, as may be required by the Engineer/Architect.
3. Submit seven (7) copies of connection procedures along with the shop drawings.
4. Provide calculations for all standard connections, sealed by a Licensed Professional Engineer registered in the state of Texas.

D. Product Data

1. Submit product data for all items in accordance with this specification and those materials specified in Item No. 720S, "Metal for Structures". Include certification, mill

test reports, or other data as required. Mill test reports will not be required for miscellaneous hardware.

2. Quality Control

- a. The Contractor shall provide, if requested, facilities in the shop and as many helpers as needed for the inspector to properly inspect the materials and work quality. The Inspector shall be allowed free access to the necessary parts of the work.
- b. The inspector will have the authority to reject any material or work which does not meet the requirement of this specification. In case of dispute, the Contractor may appeal to the Engineer or designated representative, whose decision will be final.
- c. The acceptance of any material or finished members by the inspector will not prohibit subsequent rejection if found defective. Rejected material shall be replaced promptly, or made good by the Contractor to the satisfaction of the Engineer or designated representative.

3. As materials are shipped, the Fabricator shall furnish the Engineer or designated representative with four (4) copies of the shipping invoice. The Fabricator's shipping invoice shall include:

- a. Member piece mark identification.
- b. Number of pieces shipped.
- c. Total calculated or scale weight for each shipment per bid item.

4. Final payment for structural steel will not be made until shipping invoices indicating total weight of material used have been received and checked by the Engineer or designated representative. Shipping weights will not be used as measurement for payment.

E. Notice of Beginning Fabrication Work

1. The Contractor shall give the Engineer or designated representative seven (7) days notice prior to the beginning of fabrication work in the shop.
2. No work shall be performed in the shop before the Engineer or designated representative has authorized fabrication. Any purchases of material prior to authorization shall be at the Contractor's risk.

F. Material Safety Data Sheets (MSDS)

Submit MSDS for materials as required and keep on the project job site.

G. Welder Certifications

Provide certification that welders working on the project have satisfactorily passed qualification tests in accordance with AWS D1.1 (D1.1M). If recertification is required, retesting will be at the Contractor's expense.

H. Repair Procedures

Submit repair procedures in accordance with the requirements herein.

721S.3 Delivery, Storage, and Handling

A. Delivery

1. Deliver materials to the site at such intervals as required so as to ensure uninterrupted progress of work.
2. Anchor bolts, anchorages, and other embedded items shall be delivered to the site in ample time so as not to delay related work. Also, provide setting drawings, templates, and directions for installation as required to properly install these items.

B. Storage and Handling

1. Store materials so as to permit easy access for inspection and identification. Do not store materials in a manner that might cause distortion or damage to materials or support.
2. Keep materials off the ground using pallets, platforms or other supports.
3. Protect materials from corrosion and deterioration.
4. If bolts and nuts become dry or rusty, clean and lubricate them before use.

C. Repair or replace damaged materials, structures, or portions of structures as directed.

D. The handling of material, fabrication, blocking of partially completed members, and movement of completed members shall be done in such a manner that the safety of workers and inspection personnel will not be impaired at any time.

E. The storage, handling, and cleaning of corrosion resistant (“weathering”) steel shall be in accordance with ASTM A242 (A242M), ASTM A588 (A588M), or the requirements of the proprietary manufacturer as applicable.

721S.4 Quality of Work

A. Fabrication and Assembly

1. Fabrication shall be in accordance with either AISC 325 or 360.
2. Fabricate and assemble structural assemblies in the shop when possible. When shop fabrication is not practical, provide markings as required to facilitate assembly.
3. Fabricate in such a manner so as to limit storage and handling and not to hinder construction progress.

- B. Fabrication tolerances for rolled shapes, plate girders, plates, bars, wide flange sections, and miscellaneous steel shall be in accordance with ASTM A6 (A6M) or AWS D1.5 (D1.5M).
- C. Rolled fabricated sections of slightly different dimensions and weight than the standard sections shown will be acceptable, provided they have equal or greater Moment of Inertia and Section Modulus than the section(s) detailed. . Changes in section(s) shall be clearly noted on the shop drawings.
- D. Maximum deviation from flatness for webs of wide flange sections shall be the same as for built-up girders.
- E. Shoes shall be fabricated with a tolerance not greater than the following:
 - 1. The top bolster shall have the center 75 percent of the long dimension true to 1/32 inch (0.8 mm), with the remainder true to 1/16 inch (1.6 mm) and shall be true to 1/32 inch (0.8 mm) across its entire width in the short dimension.
 - 2. For a pin and rocker type expansion shoe, the axis of rotation shall coincide with the central axis of the pin.
 - 3. When the shoe is completely assembled and the top bolster is moved horizontally simulating the movement of the shoe in the finished structure, no point in the plane of the top bolster shall change elevation by more than 1/16 inch (1.6 mm) for the full possible travel of the rocker both ways from the neutral position nor shall the top bolster change inclination with respect to the horizontal by more than 1 degree during this same travel.
- F. I-beams and girders shall be fabricated with a tolerance not greater than the following:
 - 1. The plane of the bearing area of beams and girders shall be perpendicular to the vertical axis of the beam within 1/16 inch (1.6 mm).
 - 2. Correction of bearing areas of shoes, beams and girders to the above tolerances shall be with heat and/or external pressure. Grinding or milling will be permitted if reduction of required thickness of member is not reduced by more than 1/16 inch (1.6 mm).
 - 3. Rolled material must be straight before being laid off or worked.
 - 4. If straightening is necessary, it shall be done by procedures submitted to and approved by the Engineer or designated representative. Sharp kinks and bends will be cause for rejection of the material unless corrected to the satisfaction of the Engineer or designated representative.

721S.5 Execution

A. Finishing

- 1. Finishing details of materials specified herein and Item No. 720S, unless noted otherwise, shall be in accordance with AISC 325, Steel Construction Manual, and AISC

360, Specification for Structural Steel Buildings.

2. Surface finishes shall be in accordance with ASME B46.1 and as indicated in Table A:

TABLE A	
Condition	Roughness Value [micro inches (micrometers)]
Member ends not subject to calculated stress	2000 (50.8)
Cut surfaces 4 inches (100 mm) to 8 inches (200 mm) thick	1500 (38.1)
Cut surfaces up to 4 inches (100 mm) thick	1000 (25.4)
Milled ends of compression members, stiffeners, and fillers	500 (12.7)
Top surfaces of steel slabs, base plates, column cap plates, and pedestal cap plates	250 (6.4)
Surfaces of bearing plates intended for sliding contact, pins, and pin holes	125 (3.2)

3. Sheared edges of plates greater than 5/8 inch (15.9 mm) thickness and carrying calculated stress shall be planed to a depth of 1/4 inch (6.4 mm).
4. Re-entrant cuts shall be filleted to a minimum radius of 3/4 inch (19.1 mm), except for the corners of welding access cope holes adjacent to a flange.
5. Oxygen cutting shall be in accordance with AWS D1.1 and D1.5. Hand cutting shall be done only where approved by the Engineer or designated representative.
6. Edges of all main members which are sheared or oxygen cut, and all other exposed edges to be painted shall be rounded or chamfered to an approximate 1/16 inch (1.6 mm) dimension by grinding.
7. Unless otherwise indicated, steel plates for main members shall be cut and fabricated so that the primary direction of rolling is parallel to the direction of the main tensile and/or compressive stresses.
8. In all oxygen cutting, the flame shall be adjusted and manipulated to avoid cutting inside the prescribed lines. Roughness exceeding the values of Table A and occasional notches or gouges not more than 3/16 inch (4.8 mm) deep on otherwise satisfactory surfaces shall be removed by machining or grinding. Cut edges shall be left free of slag. Correction of defects shall be faired to the oxygen cut edges with a slope not exceeding 1 in 10.
9. Air carbon-arc or oxygen gouging, oxygen cutting, chipping, or grinding may be used for joint preparation or the removal of defective work or material. Oxygen gouging shall not be used on ASTM A514 (A514M), A517 (A517M), A242 (A242M), and A588 (A588M) corrosion resistant ("weathering") steels.
10. The top and bottom surfaces of steel slabs, base plates, and cap plates of columns and pedestals shall be planed or else the steel slabs and base plates hot-straightened. Parts of members in contact with plates shall be faced to fit.
11. In planing the surfaces of expansion bearings, the cut of the tool shall be in the direction of expansion.

12. Stiffeners shall provide an even bearing against flanges. Tight-fit, when indicated, shall have at least 1 point bearing on the flange surface and the remainder with a maximum clearance of 1/16 inch (1.6 mm) at any point. Where stiffeners are to be welded to the flange, the opening prior to shall not exceed 3/16 inch (4.8 mm) with the fillet weld size increased by the amount of the opening.
13. Structural members which are indicated on the Contract Documents to be annealed or normalized shall have finish machining, boring, and straightening done subsequent to heat treatment. Normalizing and annealing shall be as defined by ASTM A941. The temperatures during the heating and cooling process shall be maintained uniformly throughout the furnace so that the temperature at any two points on the member will not differ by more than 100 F (38 C) at any one time.
14. Special requirements for ASTM A514 (A514M) and A517 (A517M) shall be as follows:
 - a. Annealing and normalizing is not allowed.
 - b. Stress relieve only with the approval of the Engineer or designated representative.
 - c. Allowance for springback should be about three (3) times that of carbon steel.
 - d. For break press forming, the lower die span should be at least sixteen (16) times the plate thickness.
 - e. If steel plates to be bent are heated to a temperature greater than 1125 F (605 C), they must be requenched and tempered in accordance with the producing mill's practice.
 - f. The holding temperature for stress relieving shall not exceed 1100 F (595 C), except that 950 F (510 C) shall be maximum for welds and six (6) inches surrounding welds.
15. Short radii on steel plates shall be hot bent at a temperature not greater than 1200 F (650 C).
16. When indicated, bridge shoes, pedestals, or other parts which are built up by welding sections of plate together shall be stress relieved in accordance with approved procedures.

B. Repair of Defects

1. Correction of cutting defects and of occasional notches or gouges less than 7/16 inch (11.1 mm) deep for material up to 4 inches (100 mm) thick and less than 5/8 inch (15.9 mm) for material over 4 inches (100 mm) thick may be made on steel with yield strengths up through 65 ksi (450 MPa) by welding.
2. Discontinuities or defects in plate edges which form the faces of groove welds shall be removed to a depth of 5/8 inch (15.9 mm) and repaired by welding. Laminations

opening to these edges shall be removed. Weld repairs shall be made by suitably preparing the defect, welding in accordance with AWS D1.1 (D1.1M), and grinding the completed weld smooth and flush with the adjacent surfaces.

3. Occasional notches, gouges, or defects in oxygen cut edges of ASTM A514 (A514M) and A517 (A517M) steel may be repaired by welding when approved by the Engineer or designated representative under the following conditions:

- a. Cutting defects not more than 3/16 inch (4.8 mm) deep in plate edges which will form the faces of a groove weld joint and which will subsequently be completely fused with the weld may be repaired by welding. Discontinuities or defects to these edges shall be removed to a depth of 1/4 inch (6.4 mm) below the surface by grinding or chipping and the gouge repaired by welding. Laminations opening to these edges shall be removed.
- b. Cutting defects not more than 3/16 inch (4.8 mm) deep in plate edges which will form a fillet-welded corner joint shall be repaired by welding only on the part of the edge which will become the faying surface for the joint and the fusion zone of the fillet weld. The part of the defect outside the toe of the completed fillet weld shall be removed by machining or grinding and faired to the oxygen cut surface with a slope not exceeding 1 in 10. If the actual net cross-sectional area which would remain after removal of the discontinuity is 98 percent or greater than the area of the plate based on nominal dimensions, weld repairs shall be made as specified above using E11018-M electrodes and grinding the completed weld smooth and flush with the adjacent surface to produce a proper finish.

4. Straightening Bent Material

- a. The straightening of plates, angles, miscellaneous shapes, and built up members, when approved by the Engineer or designated representative be done by methods that will not produce fracture or other damage. A detailed procedure for straightening bent materials shall be submitted to the Engineer or designated representative for approval.
- b. Straightening of individual pieces shall be done prior to assembly into a built-up member.
- c. The temperature for heat straightening of steel members shall not exceed 1200 F (650 C).
- d. Heat straightening or correction of errors in camber of ASTM A514 (A514M) and A517 (A517M) steel members shall be done only under rigidly controlled procedures, each application subject to the approval of the Engineer or designated representative. The temperature shall not exceed 1100 F (595) nor shall the temperature exceed 950 F (510) at the weld metal or within 6 inches (150 mm) thereof.
- e. The temperature of the steel shall be controlled by approved temperature indicating devices, such as crayons, liquids or bimetal thermometers.
- f. Heat shall not be applied directly on weld metal.

- g. Following straightening, the metal shall be carefully inspected for evidence of fracture.

5. Pins, Pinholes, and Rockers

- a. Pinholes shall be bored true to the specified diameter, smooth and straight, at right angles with the axis of the member and parallel with each other, unless otherwise indicated. Pins and pinholes shall be finished to an ASME B46.1 value of 125.
- b. The diameter of the pinhole shall not exceed that of the pin by more than 1/50 inch (0.5 mm) for pins 5 inches (127 mm) or less in diameter or 1/32 inch (0.8 mm) for larger pins.
- c. Rockers shall be finished to an ASME B46.1 value of 250.

- 6. The limits of acceptability and repair of surface imperfections for all steels shall be in accordance with ASTM A6 (A6M).

4. Discontinuities

- a. Roughness exceeding an ASME B46.1 value of 2000 in oxygen cut surfaces and occasional notches or gouges not more than 3/16 inch (4.8 mm) deep on otherwise satisfactory surfaces, shall be removed by machining or grinding to a slope not exceeding 1 in 10.
- b. In the determination and repair of limits of internal discontinuities visually observed on rolled, sheared or oxygen cut edges and caused by entrapped slag or refractory, deoxidation products, gas pocket or blow holes, the metal removed shall be the minimum necessary to remove the defect or to determine that the permissible limit is not exceeded. All repairs made by welding shall be approved by the Engineer and shall conform to the applicable provisions of AWS D1.1 (D1.1M).
- c. The limits of acceptability and the repair of visually observed edge discontinuities in plates 4 inches (100 mm) or less in thickness shall be in accordance with Table B where the length of defect is the visible long dimension on the plate edge and the depth is the distance the defect extends into the plate from the edge.

TABLE B	
Description of Discontinuity	Repair Required
Any discontinuity 1 inch (25 mm) in length or less.	None – need not be explored.
Any discontinuity over 1 inch (25mm) in length and 1/8 inch (3.2 mm) maximum depth.	None – depth should be explored.
Any discontinuity over 1 inch (25 mm) in length with depth over 1/8 inch (3.2 mm) but not greater than 1/4 inch (6.4 mm).	Remove – need not weld.
Any discontinuity over 1 inch (25 mm) in length with depth over 1/4 inch (6.4 mm)	Completely remove and weld. Aggregate length of welding not over 20

but not greater than 1 inch (25 mm).	percent of plate edge length being repaired.
Any discontinuity over 1 inch (25 mm) in length with depth greater than 1 inch (25 mm).	Subject to approval by the Engineer. Gouge out to 1 inch (25 mm) and block off by welding. Aggregate length of welding not over 20 percent of plate edge length being repaired unless approved by the Engineer.

- d. Removal of metal by gouging shall be done in a manner assuring adequate width and slope for welding.
- e. Multiple discontinuities should be considered continuous when located in the same plane within 5 percent of the plate thickness and separated by a distance less than the length of the smaller of two adjacent continuities.

C. Heat Curving

The Contractor shall submit a list of steel members proposed for heat curving and a detailed procedure for this work to be completed. Heat curving shall not proceed prior to written approval by the Engineer or designated representative.

D. Color Coding

- 1. For each steel approved for use on the project, a distinct color code shall be required. The color code shall be as specified in ASTM A6 (A6M). White shall be required for A36 steel.
- 2. The color code used for any steels not specified by ASTM A6 (A6M) must be submitted to and approved by the Engineer or designated representative.
- 3. The appropriate color(s) shall be placed on the material upon entry into the shop and shall be carried on all pieces to final fabrication. Loss of color code marking on any piece and with no other positive identification shall require testing thereof prior to its use to re-establish positive identity of the material to the satisfaction of the Engineer or designated representative.

E. Shop Painting

Preparation of surfaces and shop painting shall conform to Item No. 722S, "Paint and Painting".

F. Marking and Shipping

- 1. All structural members shall be marked in accordance with the erection diagram.
- 2. The markings shall be over the painted surface. In no case shall shop paint be left off in

order to preserve original markings on steel to be painted.

3. Members weighing more than 3 tons (2.7 MT) shall have the weight marked thereon.
4. The loading, transporting, unloading, and storing of material shall be conducted so it will be kept clean and free from injury.
5. Bolts of each length and diameter and loose nuts or washers of each size, shall be packed separately and shipped in boxes, crates, kegs or barrels. A list and description of the contents shall be plainly marked on the outside of each package.

721S.6 Bolted Members

A. Detailing

Detailing of bolted connections, where not indicated on the drawings or specified herein, shall conform to the latest edition of AISC 325, Steel Construction Manual.

B. Bolts

Bolts shall be in accordance with Item No. 720S, "Metal for Structures".

C. Bolt Holes

1. All holes for bolts shall be either punched or drilled. Material forming parts of a member composed of not more than five (5) thicknesses of metal may be punched 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts, if the thickness of the metal is not greater than 3/4 inch for carbon steel, 5/8 inch (16.9 mm) for HS or 1/2 inch (12.7 mm) for XHS steel. For more than five (5) thicknesses or when any of the main material is thicker than shown herein, all the holes shall be subpunched or subdrilled 3/16 inch (4.8 mm) smaller and after assembling, reamed 1/16 inch (1.6 mm) larger or drilled from the solid to 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts.
2. For punched holes, the diameter of the die shall not exceed that of the punch by more than 1/16 inch (1.6 mm). If any holes must be enlarged to admit the bolts, they shall be reamed. Holes shall be clean cut without torn or ragged edges. Poor matching of holes will be cause for rejection.
3. Reamed, punched, and drilled holes shall be cylindrical, perpendicular to the member, and 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts. Reamers and drills shall be guided by mechanical means. Only holes which are not accessible to mechanically guided equipment shall be done by hand. Reaming and drilling shall be done with twist drills, except that for poorly aligned holes tapered reamers shall be used in conjunction with a template so placed and held so as to force the reaming to the best center of holes for that group. Connecting parts shall be assembled and held securely during reaming or drilling operations and match-marked before disassembling.

D. Preparation of Holes for Field Bolting

1. Holes in all field splices of main truss members, box girders, continuous I-beams, and plate girders shall be subpunched and reamed while assembled or drilled full size with all parts assembled, taking into account their relative position in the finished structure

due to grade, camber, and curvature. The assembly, including camber, alignment, accuracy of holes, and milled joints shall be approved by the Engineer or designated representative before reaming or drilling full size is started.

2. All holes for floor beams and stringer end connections shall be subpunched and reamed to a steel template of not less than 1 inch (25 mm) thickness or reamed while assembled.
3. Holes for secondary members such as diaphragms, laterals, sway bracing, etc. may be punched full size unless subpunching or subdrilling.

E. Accuracy of Holes

1. Accuracy of all holes punched full size, subpunched, or subdrilled shall be such that a cylindrical pin 1/8 inch (3.2 mm) smaller in diameter than the nominal size of the punched hole may be entered perpendicular to the face of the member, without drifting, in at least 75 percent of the adjoining holes in the same plane after assembling and prior to any reaming. Pieces not meeting this requirement will be rejected. Any hole which will not pass a pin 3/16 inch (4.8 mm) smaller in diameter than the nominal size of the punched hole will be cause for rejection.
2. After reaming or drilling, 85 percent of the holes in any adjoining group shall show no offset greater than 1/32 inch (0.8 mm) between adjacent thickness of metal.
3. Layout of shop work shall be done so that gage lines for bolts shall not vary from plan dimensions more than 1/16 inch (1.6 mm). Full size holes in any adjoining group or line shall not vary more than the following:
 - a. At least 8 percent of the holes shall be within 1/16 inch (1.6 mm) of plan gage.
 - b. Not more than 10 percent of the holes may vary as much as 1/8 inch (3.2 mm) from plan gage.
 - c. Holes varying more than 1/8 inch (3.2 mm) from plan gage will not be accepted.

F. Shop Assembly

1. Each truss or box girder section shall be assembled in its relative position in the shop before reaming is started. Match-marks shall be stamped in the metal at all field connections, conforming to erection diagrams, at the time reaming is done.
2. Surfaces of metal to be in contact shall be cleaned before assembling.
3. Disassembling after reaming will be required to remove shavings, burrs, etc.
4. When bolting is required, shop or field, faying surfaces of all joints, including splice plates, shall be cleaned in accordance with AISC 325, Steel Construction Manual, and AISC 360, Specification for Structural Steel Buildings.
5. The members shall be free from twists, bends, and other deformations. In no case shall tack welding be used in assembly for bolting without prior approval of the Engineer or

designated representative.

6. If necessary, the bolt holes shall be spear-reamed for the admission of bolts preparatory to the shop bolting of full-sized punched material. The spear reamer used for this purpose shall be not more than 1/16 inch (1.6 mm) larger than the nominal diameter of the bolts.
7. Parts not completely bolted in the shop shall be secured by temporary bolts, where practicable, to prevent damage in shipment and handling.
8. The drifting done during assembling shall be only that required to bring the parts into position and not sufficient to enlarge the holes or distort the metal. If any holes must be enlarged to admit bolts, they shall be reamed.

G. Preparation and Fit of Members

1. When indicated, abutting joints shall be milled and brought to an even bearing. Where joints are not milled, the openings shall not exceed 1/4 inch (6.4 mm).
2. Floor beams and girders with end connection angles shall be built to exact length back to back of connection angles. If end connections are faced, the finished thickness of the angles shall be not less than that indicated.

721S.7 Welded Members

A. General

1. All welding operations, processes, equipment, materials, qualifications of welders, quality of work, nondestructive testing, and inspection shall conform to Item No. 723S – “Structural Welding”, AWS D1.1 (D1.1M), AWS D1.5 (D1.5M), and the Shop Drawings.
2. Unless otherwise indicated, nondestructive testing (magnetic particle and radiographic) required in the shop will be done by, and at the expense of, the Contractor. This will include furnishing all materials, equipment, tools, labor and incidentals necessary to perform the required testing.
3. All magnetic particle inspection and all radiographic inspection shall be done in the presence of and at the locations selected by the Engineer or designated representative. The Engineer or designated representative shall examine and interpret all tests made.
4. Magnetic particle inspection shall conform to ASTM E709 and the following unless otherwise indicated:
 - a. For built-up members, 100 percent of the web to flange and bearing stiffener fillet welds on not less than 1 fabricated piece for each 15 pieces or fraction thereof when the maximum flange thickness is less than 2 1/2 inches (63.5 mm).
 - b. For built-up members, 100 percent of the web to flange and bearing stiffener fillet welds on not less than 1 fabricated piece for each 10 pieces or fraction thereof when the maximum flange thickness is 2 1/2 inches (63.5 mm) or greater.

- c. Welds requiring repairs shall be retested by magnetic particle inspection after the repairs are made.
 - d. No magnetic particle inspection will be required for rolled sections.
5. Radiographic inspection shall conform to ASTM E94, AWS B1.10, and the following unless indicated otherwise on the Drawings:
- a. For shop welds of material 65 ksi (450 MPa) yield strength and less, radiographic inspection will be made as follows:
 - 1) The full flange width of 35 percent of all flange splices where the plate thickness at the weld is 2 inches (50 mm) or less.
 - 2) The full flange width of 50 percent of all flange splices where the plate thickness at the weld is greater than 2 inches (50 mm).
 - 3) 1/5 the depth of the web of 50 percent of the web splices on each structure.
 - 4) If unacceptable work is found, additional radiographs will be made on sections welded by the same equipment and/or operator just prior to and just after the section containing the defect.
 - b. For shop welds of material greater than 65 ksi (450 MPa) yield strength, radiographic inspection shall be made on all groove welds. These welds shall be inspected not less than 48 hours after they are completed.
 - c. Welds requiring repairs shall be retested by radiography after repairs are made. All radiographic inspection and necessary repairs shall be done prior to assembly.
 - d. When radiographic inspection of particular welds is required by the plans, this shall be in addition to the radiographic inspection required herein.

B. Surface Preparation for Welding

- 1. Surfaces to be welded shall be smooth, uniform, and free from fins, tears, and other defects which would adversely affect the quality of the weld. Surfaces to be welded shall be free from loose scale, slag, rust, grease, or other material. Mill scale that withstands vigorous wire brushing or a light film of drying oil or rust inhibitive coating may remain. Finish of bevels of groove welds shall be milled or ground. Oxygen cut bevels without grinding will not be allowed.
- 2. When a zinc-rich paint is specified, surfaces within 4 inches (100 mm) of a groove weld joining main stress carrying members and within 2 inches (50 mm) of fillet welds joining diaphragms or lateral bracing to stiffeners or gusset plates shall be sandblast cleaned and coated with linseed oil. After welding is completed, the areas shall be sandblast cleaned and painted as required for the specified paint system.

3. For other paint systems, surfaces within 2 inches (50 mm) of any weld joining main stress carrying members shall be free from any paint or other material that would prevent proper welding.
4. Sheared plates for webs of built-up members shall be wide enough to allow for trimming of edges where built-in camber is required. Plates with rolled edges used for webs shall be trimmed by oxygen cutting.
5. The faying surfaces of the web and flange plates and the adjacent surfaces that are to be fillet welded shall be cleaned by grinding prior to assembly and welding of web to flange.

C. Assembly of Parts

1. Parts to be joined by fillet welds shall be brought into as close contact as possible, with a maximum separation of 3/16 inch (4.8 mm). If the separation is 1/16 (1.6 mm) inch or greater, the leg of the fillet weld shall be increased by an equivalent amount. The separation between faying surfaces of lap joints and of butt joints landing on a backing strip shall not exceed 1/16 inch (1.6 mm). The fit of joints not sealed by welds throughout their length shall be close enough to exclude water after painting. Where irregularities in rolled shapes or plates after straightening prevents this, the procedure necessary to bring them within the above limits shall be approved by the Engineer or designated representative. The use of fillers is prohibited, except as indicated or as approved by the Engineer.
2. Members to be welded shall be brought into correct alignment and held in position by clamping, welding, or tacking until the joint has been welded.
3. Adequate clamps must be provided to prevent cupping or warping of the parts when welding them to the web. The clamping devices must be designed to not interfere with the operation or guiding of automatic welding equipment.
4. Temporary stiffeners used for jigs and/or warpage control shall not be tack welded to the flange material. Tacking to the web is permissible if the welds are at least $d/6$ distance away from the flange, where "d" is the web depth. The tack weld shall be removed by grinding flush with the parent metal prior to acceptance.
5. Suitable allowance shall be made for shrinkage. The joint shall never be restrained on both sides when welding.
6. Abutting parts to be joined by groove welds shall be aligned carefully. All shop groove welds in flange plates shall be ground smooth and flush with the base metal on all surfaces. This shall apply both to parts of equal thickness and parts of unequal thickness.
7. The surfaces shall be ground so that the radii at the points of transition will be 4 inches (100 mm) minimum.
8. When groove welds are used to join materials of different thickness or width, there shall be a smooth transition between offset surfaces with a slope of not greater than 1 in 4 in

thickness transition and to the proper radii in the case of width transition.

9. Groove welds in web plates need not be ground unless indicated.
10. Grinding shall be done in the direction of stress and in a manner that keeps the metal below the blue brittle range of 350 F (177 C).
11. Intermediate stiffeners within 12 inches (300 mm) of a splice point shall be shipped tack welded in place. Final welding shall be done in the field.

D. Surface Preparation and Shop Assembly for Field Welds

1. Ends of beams and girders shall be prepared in accordance with the requirements herein or as indicated. The centerline of the land of opposing web and flange bevels shall not deviate from each other by more than 1/16 inch.
2. For Shop Assembly, members should be brought into abutting contact in accordance with the shop drawings. Root faces shall not vary in excess of 1/16 inch (1.6 mm) from contact. Corrections by additional cutting and/or grinding shall be made to bring the splice within this tolerance. Finish of bevels for groove welds shall be milled or ground. Oxygen cut bevels without grinding will not be allowed.
3. Ends of beams or girders to be welded shall be prepared in the shop taking into account their relative positions in the finished structure due to grade, camber, and curvature. Each splice shall be completely shop assembled, checked and match-marked while assembled.

721S.8 Field Erection

A. General

1. Field erection shall be in accordance with the approved shop drawings. Such approval shall not relieve the Contractor of responsibility for the safety or adequacy of methods or equipment or from carrying out the work in full as indicated. No work shall be done without the approval of the Engineer or designated representative.
2. Field erection plans for I-beam units will not be required unless indicated.
3. Spot welding for the purpose of eliminating field erection bolts or for holding steel parts together while bolting will not be permitted.
4. The Contractor shall provide falsework and all tools, machinery, and appliances (including drift pins and fit-up bolts) necessary for the expeditious handling of field erection work. Drift pins sufficient to fill at least 1/4 of the field holes for main connections shall be provided.
5. When railroad or roadway traffic must be maintained beneath girders or beams already placed, traffic shall be protected against falling objects during the erection of diaphragms

and other structural members, during the placing of cast-in-place concrete, and during the erection and dismantling of forms thereof. The protection shall consist of safety nets of 1 inch (25 mm) mesh maximum or a flooring with openings not larger than 1 inch (25 mm).

B. Storing, Handling, and Assembling Materials

1. All material shall be handled in a manner that prevents damage.
2. Stored material shall be placed on skids above the ground and kept clean and properly drained. Girders and beams shall be placed upright and shored. Long members, such as columns, shall be supported on skids placed closely enough to prevent excessive deflection.
3. The parts shall be match-marked and assembled accurately as indicated on the approved erection drawings
4. Hammering which will injure or distort the members is not allowed.
5. All bearing and faying surfaces of structural steel in bolted connections shall be cleaned before the connection members are assembled. When ASTM A588 (A588M) steel is used these, surfaces shall receive a Class B blast cleaning conforming to Item No. 722S, "Paint and Painting", prior to assembly of the connection members. The areas of the outside ply under washers, nuts, or bolt heads shall be cleaned prior to installation of the bolts.
6. Unless erected by the cantilever method, truss spans shall be erected on blocking located so as to provide proper camber. The blocking shall be left in place until the tension chord splices are fully connected and all other truss connections pinned and bolted. Main connections shall have 1/2 of the holes filled with bolts and erection pins (1/2 bolts and 1/2 pins) before swinging the span. Splices and connections carrying traffic during erection shall have 3/4 of the holes so filled.
7. Fit-up bolts shall be of the same nominal diameter as the connection bolts. Erection pins shall be 1/32 inch (1 mm) larger diameter.
8. There shall be no temporary welds for transportation, erection, or other purposes on main members, except at approved locations more than 1/6 the depth of the web from the flanges of beams and girders, unless otherwise approved by the Engineer or designated representative.

C. Falsework

1. Falsework shall be properly designed for the loads to be supported and shall be substantially constructed and properly maintained. The Contractor shall prepare and submit to the Engineer falsework plans, including calculations.
2. The falsework plans shall include all details of members, connections, equipment, etc., so that a structural check can be made of them.
3. Approval of the falsework plans does not relieve the Contractor of responsibility/liability

for the falsework during field erection.

D. Welding and Nondestructive Testing

Welding and nondestructive testing shall conform to Item No. 723S, "Structural Welding".

E. Ancillary Items

All ancillary items such as castings, bearing plates, etc. shall be in accordance with the drawings or as specified elsewhere.

F. Errors in Shop Work

1. Any errors in shop work which prevent the proper assembling and fit-up of parts by the moderate use of drift pins or a moderate amount of reaming and slight chipping or cutting shall be reported immediately to the Engineer or designated representative, along with the proposed method(s) of correction.
2. Corrections of minor misfits and a reasonable amount of reaming will be considered a legitimate part of the work.
3. Corrections shall be made in the presence of the Engineer or designated representative, unless otherwise directed. Such work is to be done at the entire expense of the Contractor.

721S.9 Paint and Painting

Unless otherwise indicated, painting shall conform to Item No. 722S, "Paint and Painting".

721S.10 Measurement and Payment

No direct compensation will be made for "Steel Structures". Measurement and payment for quantities of metals, concrete, reinforcement, railing, ancillary items, and other bid items which constitute the completed and accepted structure(s) shall conform to pertinent specifications.

End

SPECIFIC Cross Reference Materials
Specification Item 721S, "Steel Structures"

City of Austin Standard Specification Items	
Designation	Description
Item 406S	Reinforcing Steel
Item 720S	Metal for Structure
Item 722S	Paint and Painting
Item 723	Structural Welding

American Institute of Steel Construction (AISC)

Designation	Description
325	Steel Construction Manual
360	Specification for Structural Steel Buildings

American Society for Testing and Materials (ASTM)

Designation	Description
A6/A6m	Standard Specification for General Requirements for Rolled Structural Steel Bars, Plates, Shapes, and Sheet Piling
A242/A242M	Standard Specification for High-Strength Low-Alloy Structural Steel
A588/A588M	Standard Specification for High-Strength Low-Alloy Structural Steel with 50 ksi [345 MPa] Minimum Yield Point to 4-in. [100-mm] Thick
A941	Terminology Relating to Steel, Stainless Steel, Related Alloys, and Ferroalloys
E94	Standard Guide for Radiographic Examination
E709	Standard Guide for Magnetic Particle Examination

American Society of Mechanical Engineers (ASME)

Designation	Description
B46.1	Surface Texture (Surface Roughness, Waviness & Lay)

American Welding Society (AWS)

Designation	Description
B1.10	Guide for Nondestructive Inspection of Welds
D1.1/D1.1M	Structural Welding Code – Steel
D1.5/D1.5M	Bridge Welding Code

RELATED Cross Reference Materials
Specification Item 721S, "Steel Structures"

City of Austin Standard Specification Items

Designation	Description
Item 406S	Reinforcing Steel

TxDOT Specifications

Designation	Description
Item 441	Steel Structures
Item 442	Metal for Structures
Item 447	Structural Bolting
Item 448	Structural Field Welding